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Symposium on Drought in Africa

Proceedings and Summary Report of a Symposium held in Ottawa, Canada, on 12–14 August 1985

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CANADA

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Esta serie incluye ponencias de reuniones, informes internos y documentos técnicos que pueden posteriormente conformar la base de una publicación formal. El informe recibe distribución limitada entre una audiencia altamente especializada.

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SYMPOSIUM ON DROUGHT IN AFRICA

Proceedings and
Summary Report of a
Symposium
held in Ottawa, Canada on
12 - 14 August 1985

Compiled by
Vivien J. Escott

Sponsored by the International Development Research Centre (IDRC), the Canadian International Development Agency (CIDA), and the International Council of Scientific Unions (ICSU).

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INTRODUCTION AND OVERVIEW

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Vice-President, Research Programs
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PURPOSE OF THE MEETING

The extreme and extensive suffering inflicted upon millions of rural African people as a consequence of the recent pervasive drought is familiar to most North Americans and Europeans whose communications media have vividly portrayed the appalling conditions in Ethiopia, the Sahel, and many other countries of Northern, Eastern, and Southern Africa. The demonstrations of humanitarian concern, and contributions of food and money to relieve the distress have indeed been encouraging to all directly engaged in international programs of economic and social development, technical assistance, and emergency relief.

Most of the consequences of the widespread drought have been described as seen through the eyes of North American journalists and commentators. The sponsors and conveners of the symposium, whose proceedings are described below, believed that it was time that the voice of Africans be heard since it is they, their families, and friends who have suffered most and who, in the short and long term, must repair the damage brought about by the ravages of drought and make preparations as are necessary to prevent any comparable recurrence in the future.

For this reason, from August 12 to 14 1985, an international symposium was held in Ottawa on "Drought in Africa." It was jointly sponsored by the International Development Research Centre (IDRC), the Canadian International Development Agency (CIDA), and the International Council of Scientific Unions (ICSU). The purpose was to review drought in Africa through the eyes and experience of Africans, together with others who have spent many years working in Africa. The invited speakers and other participants reviewed the difficulties experienced and the opportunities for improvement and future beneficial development among those African countries whose fragile ecologies and economies have been so severely devastated. Various contributors reviewed the impact of repeated drought on countries in Eastern, Western, and Southern Africa and the Middle East, particularly the Nile Valley. They reached a clear and unequivocal consensus, based upon historical record, that the recent highly-publicized droughts are by no means unique or isolated phenomena but are a further manifestation of what has occurred in the same African regions over many hundreds of years. It was also made clear that the droughts have served to aggravate existing adverse conditions resulting from a variety of unimaginative and often counter-productive policies by both African governments and donor agencies, as well as from demographic patterns, accelerated population growth, political unrest, and social turmoil, the latter well-illustrated by the fact that more than 70 coups d'état have occurred in African countries during the last two decades. Speakers repeatedly emphasized that to prevent future disasters of a comparable scale calls for long-term commitments by all the governments of those African countries affected, together with the world community of development and donor agencies: multilateral, bilateral, governmental, and nongovernmental.

Although long periods of inadequate rainfall are familiar to the arid and semi-arid regions of Africa, the droughts of the past two decades have been more devastating in their intensity, extent, and persistence than any previously recorded. Never before have African nations been confronted with such conditions at a time when populations and expectations were rising; when political states newly liberated from colonial rule were attempting to establish essential and reliable governmental, institutional, economic, and social structures; when a world-wide recession was accelerating; when the price of imported petroleum was escalating and world prices offered for African exportable commodities were in decline. The coincidence of the drought together with all of these other adversities has been tragic indeed.

SEVERITY OF THE DROUGHT

The drought struck in the Southern African region with unusual intensity between 1981 and 1984: two-thirds of the region received less than 60 percent of normal rainfall and aggregated cereal production fell by 41 percent. In the Sahelian countries the degree of variability of rainfall was far greater even than that generally experienced in this area of unpredictable climate.

More than half of the 20 million inhabitants of the Sudan have been directly affected, with some 8.5 million people requiring food aid during 1984. Kenya's 1984 harvest was more than 40 percent below normal. In the Southern African countries, during 1984, direct costs resulting from the drought amounted to more than US$920 million: $576 million in direct losses to agricultural production and $345 million for emergency relief operations. Among the Sahelian countries the increased incidence of malnutrition and associated health problems from 1981 to 1984 was estimated at close to 31 percent. Altogether, among the 24 African countries affected, more than 150 million people are presently exposed to hunger and malnutrition and 20 million face possible starvation. Among many, particularly the young children, malnutrition may well have irreversibly affected their mental and physical capacities, depriving them of the right to a normal, healthy life.

The temporary camp settlements established for the feeding of starving migrants have served to increase the transmission of communicable diseases, and cholera is now reported to be a matter for serious concern in some areas. Furthermore, water resources in these camps have been seriously strained and the social disruption caused by mass migrations has been of catastrophic proportions.

Animals are immensely important in African agricultural economies, being integral components of most farming systems. In the most severely affected regions of the Sahel and Northern Africa, more than 90 percent of the cattle and 30 percent of the sheep and goats are estimated to have died. Throughout the region as a whole, cattle mortality from small herds increased from 32 percent to 54 percent between 1980 and 1983. Even nomadic populations, moving through whatever pastureland could be found, are believed to have lost over 30 percent of their cattle, sheep, and goats in 1984.

EXACERBATION OF AN ALREADY SERIOUS SITUATION

The drought seriously aggravated existing patterns of environmental and economic stress. As already stated, the economic stress was made more severe by the rising costs of food imports (necessitated by inadequate agricultural productivity), falling world prices for export commodities, increasing prices for petroleum products tied to an escalating U.S. dollar, government fiscal and development policies favouring urban consumers over rural communities, rising balance-of-payment deficits, and higher debt-servicing costs, resulting in serious declines in foreign exchange reserves. This combination of adverse domestic and international factors has increased accumulated external debts of the countries south of the Sahara from US$5.4 billion in 1970 to US$48 billion in 1982, an average yearly increase of 20 percent. Debt-service payments have increased from US$450 million to US$5.5 billion over the same period and could well double again by 1987. Most of these debilitating factors have been outside the control of the governments and peoples of the African countries affected.

Other more controllable factors have not been adequately addressed. An indisposition among some African governments to offer adequate incentives to smallholder farmers has discouraged levels of food production sufficient to meet the needs of growing populations. Since 1960, average population growth south of the Sahara has increased by more than 2.5 percent per annum whereas increases in food production have averaged barely 1.5 percent per annum. It is clear, in many cases, that the immense pressures upon their limited resources have prevented African governments from providing the farming communities with the resources and inputs necessary to achieve greater productivity. Similarly, governments have not found the resources or exercised the necessary will to increase investment in agricultural production in the more favourable rainfall areas: around lakes, along rivers and other inland waterways, where irrigation might sustain more reliable farming systems, as it has along the Nile in Egypt for many centuries.

Increased human and animal populations have led to over-cultivation, over-grazing, shortened fallow periods, and extension of cultivation into marginal lands, together with excessive destruction of trees and shrubs to provide fuel. In sub-Saharan Africa, more than 90 percent of the cultivated land is entirely rain-fed and there is an urgent need to provide small-scale irrigation facilities. The decline in numbers of animals among smallholder farms has been accelerated by drought-induced lack of water and fodder, leading to malnutrition and increased susceptibility to disease. Farm animals provide milk, meat, manure, and draught power - a family limited to hand tools can cultivate only 3 hectares while one with a single ox team can farm more than 10 hectares. Also, in sub-Saharan Africa the collection of fuelwood destroys 4 million hectares of tree cover annually; shifting cultivation destroys another 11 million hectares. The semi-arid tropics receive the world's highest level of solar radiation. When the vegetative cover is removed, much of the limited rainfall is evaporated before it can be taken up by cultivated plants. Furthermore, excessive destruction of the vegetative cover causes leaching and soil erosion and disturbs the hydrological cycle of cloud formation from the atmospheric moisture which evaporates from tree leaves and other vegetation.

In most African countries communication systems - roads, railways, and inland waterways - are totally inadequate and many in existence are rapidly deteriorating. Thus communications and transportation facilities between rural and urban centres are in serious need of expansion and improvement, to permit the movement of food from regions of surplus to those of scarcity.

RESPONDING TO THE CHALLENGE

From the foregoing it might be concluded that the situation in the African countries is near hopeless. Such is not the case and the specific recommendations formulated by the African participants give clear indications of what steps need to be taken to address the immediate, short, and longer term difficulties. Under the best of agroclimatic conditions, several of the African countries will be dependent upon offshore supplies of food on concessionary terms for many years into the future. With the inevitability of repeated droughts, the need for food aid will also increase. However, as pointed out by the speaker from the World Food Programme, there are more imaginative and creative ways of providing food aid than have been common in the past. Food as wages for work and as a means of stabilizing rather than depressing prices to farmers are but two mechanisms which deserve wider implementation.

Highest priority and greatest investment must be given to ensuring the lively survival and increased productivity of the smallholder. For those who are totally deprived of resources in consequence of repeated crop failures, packages of locally acceptable well-adapted seed, fertilizer, and small tools need to be distributed urgently. The recommendations for longer and more sustained efforts to improve production, conservation, and distribution speak for themselves and need no further comment.

Of greatest importance is the need for truly sympathetic cooperation between development and donor agencies, and the governments and peoples of the African nations. Greater sensitivity is required by all in responding to the true needs and opportunities of African rural communities. There was broad consensus among the participants of the symposium on the absolute necessity of engaging African farmers and rural communities in all planning and implementation processes. It was strongly suggested that, in many instances, nongovernmental organizations, both African and external, can work more effectively with rural communities than can either donor or recipient national governments.

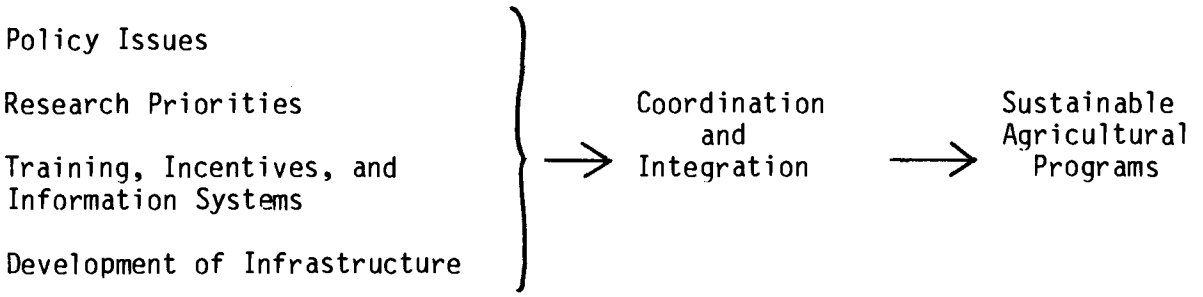
Widespread concern was expressed at the seeming lack of willingness among donors to be more liberal and flexible in their economic and technical assistance programs. It was also recommended that different donors, multilateral, bilateral, and nongovernmental, seek more careful coordination and cooperation in planning and implementing their assistance programs.

The symposium participants were greatly encouraged by the remarkable outpouring of goodwill that followed the persuasive publicity given to the distress caused by the drought. This spirit of goodwill must be nurtured and maintained among the wealthier nations over many years if the citizens of African nations are to reach that level of self-sufficiency and security which is surely every human being's birthright.

RECOMMENDATIONS

In order to formulate recommendations, subcommittees were convened, composed of speakers and commentators at each session. Based upon the principal points raised in the papers presented and the subsequent discussions, these subcommittees drafted a series of recommendations. The chairman and rapporteur, in presenting the following recommendations, have sought only to ensure uniformity of style, syntax, and spelling, without in any way distorting or detracting from the original essential meaning and substance. Additional comments not included in the formal recommendations can be found in Appendix 3.

In preparing the recommendations, the speakers concluded that the focus should be limited to those issues of highest priority applicable to many countries. Recommendations fall into two broad categories of emergency/short term and medium/long term; within the latter, the following key areas have been highlighted:



A continuing theme throughout the symposium was the urgent need for the countries of Africa to rehabilitate and improve their agricultural economies, particularly with regard to the traditional food crops and livestock subsectors. Participants clearly recognized that the stimulation of positive agricultural reform towards the goal of self-sufficiency can only be realized through increased attention to the human factor in the development process. In particular, the role of smallholder farmers, extension workers, and indigenous researchers as prime agents of renewal deserve much more support and encouragement. It is their active participation and commitment which lie at the heart of all hopes for the long-term rehabilitation and economic development of African countries. Therefore, the policy initiatives, research, training, and technological improvements proposed should all serve to dignify and support the individual agricultural worker and rural inhabitant.

EMERGENCY/SHORT TERM RECOMMENDATIONS

1. Food Aid

* Food aid on concessionary terms will be needed in some African countries for many years. It should be systematically programed over multi-year periods and be integrated with other forms of development assistance so as to enhance its effectiveness.

* Food aid should be provided in a manner that will stimulate rather than discourage local agricultural production and rural development.

* Development food aid should be used to support food-for-work programs wherever feasible so that an infrastructure of essential services may be created (e.g. food as wages for building roads, digging wells, reforestation).

* Food aid should be integrated with African national food production policies. Money generated from sales of food from aid can be used to stabilize food prices in urban areas while guaranteeing attractive price incentives to farmers.

2. Rehabilitation of Production Systems during the 1986 Growing Season

* Many African farmers have neither seed for planting nor money to buy seed and other inputs. There is urgent need for resettlement packages of locally produced seed of traditional crops, fertilizer (N and P), and small tools to permit destitute smallholders to resume crop production. African governments, with the assistance of donor agencies, should take steps to provide these packages. Local representatives of farming communities should be trained to facilitate smooth distribution and most effective utilization of packages.

* In many areas, particularly those with heavy soil, animal draught power should be made available for land preparation. Communal use of draught animals may be necessary where individual farmers possess too few animals.

* There is urgent need for an expanded distribution network, including food handling, marketing, and transportation facilities, to allow delivery of resettlement packages to smallholders and, later, to bring harvested crops to market. Donor agencies should assist recipient countries in their efforts to establish these facilities.

MEDIUM/LONG TERM RECOMMENDATIONS

These recommendations generally apply to African agricultural economies and are intended to create an environment in which improved technologies can emerge and flourish. They cover the period to 2010.

1. Policy Issues

* Foremost, governments of the countries of Africa must recognize the crucial importance of and give higher priority to the rural and agricultural sectors in their national development plans. This requires the implementation of specific programs in support of these sectors.

* Production incentives to the agricultural sector must be introduced to encourage rehabilitation and improvement of, especially, smallholder farms. Incentives could take the form of guaranteed support prices, more efficient marketing channels, prompt cash payments, liberal credit arrangements, overall improvement in rural facilities and amenities, participatory mechanisms, and better extension services. Donor agencies should explore all possible ways of helping national governments to provide these incentives.

* Greater emphasis should be placed on land-use control and management practices. Increased support is needed for agro-forestry, soil conservation, reforestation of denuded land, and integration of multipurpose trees with food crops and livestock.

* Realizing the need for long-term strategy development, African governments should strengthen their capacity to carry out reliable agricultural policy analysis through the use of special training programs.

* There should be more flexibility and responsiveness on the part of governments to changing development needs. Greater decentralization of government planning and management will facilitate this. More input should be elicited from farmers, rural communities, and NGOs in the planning of development programs.

2. Research Priorities

* Of highest priority is the strengthening of agricultural research capabilities so that they may be devoted to the improvement of traditional farming systems. The main emphasis for R & D should be on livestock in the unreliable rainfall zones, and on traditional food crops in the higher and more reliable rainfall zones.

* Extensive support and upgrading of agricultural faculties and colleges is required in order to fulfill the need for high-quality scientists and technicians to carry out research, development, and extension services. Provision of essential equipment and services to these institutions is of vital importance. They should be strengthened at least to the point where

they can take full advantage of the assistance that is available from donor agencies and International Agricultural Research Centres (IARCs).

* Another research need is for more efficient assembly, analysis, use, and dissemination of existing climatic data and provision of adequate facilities for climatic monitoring. The participants support the creation of an African Centre for Meteorological Applications, one concerned with training and dissemination of practically useful research results.

* IARCs should be encouraged to work more closely with national and regional research institutes and have as part of their mandate a financial commitment towards meeting some of the essential capital and operating expenses of collaborative programs with such institutions.

* Similarly, bilateral and multilateral donors need to adopt more flexible policies in their support of indigenous research and development programs.

3. **Training, Incentives, and Information Systems**

* Development of integrated training systems for those involved in agriculture, livestock, and directly related disciplines is most urgent. More effective links between the research community and smallholder farmers must be established.

* Primary and high school curricula should have expanded treatment of land-use management and agricultural/livestock practices and seek to elevate the role of the farmer in the eyes of young Africans.

* Post-graduate training should focus more on major problems of the countries concerned and should be primarily of an applied nature.

* Specialized training in climatology and agroclimatology is necessary in order to provide a basis for collection and analysis of agroclimatic data and to conduct research on global meteorological systems associated with drought conditions in Africa.

* Training of agricultural extension specialists should be accelerated. Provision of essential equipment and services to improve the extension environment should be assured. A massive training program with emphasis on project implementation should be developed. Special measures should be taken to involve rural communities in both planning and implementation stages.

* There should be recognition of the need for improved incentives to local personnel working in agricultural development. African governments will have to come to terms with the market value of their scientists and technicians. Incentives could take the form of better working conditions,

adequate financial rewards, prospects for promotion, and more involvement in the design and management of research programs.

* It is essential that donor agencies become involved in supporting these initiatives. NGOs have a major role to play in the development of extension services and in many other facets of grass roots rural development. IARCs should continue to expand training facilities in Africa to meet present and changing needs. Local personnel should be trained and involved in the design and management of these programs.

* There is a need for better communications, particularly between zones of higher and lower rainfall, so that trade between them may be facilitated, both within and across national boundaries.

* Information systems among farmers, research and extension workers should be improved. Recognition should be made of the necessity of getting relevant information to the grass roots level.

4. Development of Infrastructure

* Attention must be paid to the very serious problem of infrastructure development and maintenance. Improved roads, railways, and telecommunications are of paramount importance in the development of African countries. The drought, with its serious consequences of migration of untold numbers of people and movement of tonnes of food, has clearly demonstrated how inadequate the present system is in many countries and how essential these services are.

* Specifically, greater investment is required in comprehensive rural delivery systems for agricultural inputs, including seed and agricultural chemicals, as well as mechanisms for the efficient marketing of produce.

5. Coordination and Integration

* All national agricultural policy initiatives should be integrated into and compatible with the overall development plan of that country.

* Research, development and extension services in support of smallholder traditional farming systems should be well coordinated to derive maximum benefit from each.

* There should be integration of institutional support by governments and development assistance agencies.

* The efficiency of assistance programs would be greatly enhanced by more systematic and responsive coordination and cooperation and less competition among bilateral and multilateral donors. Furthermore, all donor agencies should seek to be more responsive to the priorities defined and expressed by recipient governments and be prepared for long-term commitments to agricultural and rural development.

* As already mentioned, development food aid should be integrated with other forms of development assistance and with national food policies to minimize disincentives to food production.

6. Agricultural Programs

Each of these recommendations suggests means of achieving a particular aim: securing and refining production inputs, increasing production, or limiting pre-harvest and post-harvest losses. Full participation of the beneficiaries concerned is essential to the success of these efforts.

Secure and Refine Production Inputs

* Every African country should develop efficient, well-supervised seed multiplication facilities. Every effort should be made to ensure optimum use of local germ plasm and breeds in breeding programs for both crops and livestock. Indigenous and well-adapted crop varieties and animal breeds should be collected and protected for this purpose. Less hardy exotic species, new to the semi-arid environment, will inevitably suffer more severe stress in conditions to which they are not adapted.

* Tissue and meristem culture techniques can be used to provide the tree and shrub cultivars for the massive requirements of reforestation programs.

Increase Production

* There should be intensified crop production in areas of most stable and consistent rainfall, leaving Sahelian and other low rainfall areas to cattle raising.

* Small- to medium-scale irrigation schemes based on appropriate technology should be developed. The whole question of water control, storage, and management needs to be seriously addressed. Water harvesting techniques for human and animal consumption should also be considered.

* There should be wider application of locally developed and adapted technologies.

* Greater use of animal manure as fertilizer should be encouraged.

Limit Pre-harvest and Post-harvest Losses

* Development of national food security systems (Food Banks) should be encouraged, in the form of increased adapted on-farm storage facilities based on traditional models. These facilities must protect against damage by insects, molds, and rodents and so limit post-harvest losses.

* Pre-harvest losses should be minimized by timely procurement of essential inputs (pesticides, fertilizers), efficient cropping practices, improved disease control, and more effective extension services.

PATTERN AND IMPACT OF DROUGHT IN THE SAHEL COUNTRIES

Edward S. Ayensu

The successive severe drought years(1), the widespread degradation of the environment, and the overall impact of human activity on the resource base in the Sahelian countries have brought about a growing sense of drift and uncertainty among the people and governments of this African region. The problem facing these drought-stricken countries is, therefore, the result of the progressive decline of a combination of factors including the climate, economic, social, and political conditions.

From the very outset, I want to state that, although some people and governments in Africa have used the weather as an excuse to cover failures of policy, this does not invalidate the enormous difficulties under which African agriculture operates. There is a degree of variability of rainfall not generally experienced in temperate zones. In some regions, clearly outside the Sahara, rain has not fallen in years. African farmers in these areas have always existed in precarious balance with their harsh environment.

In 1978 I participated in the work of an Advisory Committee on the Sahel created by U.S. National Academy of Sciences' Board on Science and Technology for International Development at the request of the U.S. Agency for International Development. The Committee conducted two studies: Environmental Change in the West African Sahel (1983) and Agroforestry in the West African Sahel (1983), which focused on the formulation of long-term environmental strategy for the region. The results of the studies brought home very clearly the difficulties and the opportunities that abound in the region. The studies also revealed the untenable nature of the situation as it exists and as it will continue until we break the pattern of environmental and economic disintegration.

Those of us who have had the opportunity of travelling and conducting field studies in the Sahelian countries are aware that agriculture is by far the most important sector that influences the social and economic livelihood of 70 to 90 percent of the people. The gross domestic product (GDP) ranges from 22 percent in Senegal to 42 percent in Gambia and Mali. Agricultural exports account for 50 to 90 percent of the Sahelian foreign exchange earnings except Cape Verde. The economic activities in other sectors are also dependent on the agricultural sector. But because of the almost total dependence on rainfed agriculture, which covers 96 percent of the cultivated area, those in the region cannot overcome the most unsettling significant annual variations in the agrarian and therefore their economic performance(2). The highly variable rainfall which affects the landscape during the dry and wet seasons within a year has undermined the people's ability to plan ahead, let alone to have some control over their environment.

There are, however, four fundamental problems that the countries of the Sahel have to overcome. First is the poor quality of the soils and the loss of arable land. This is followed by limited access to water for domestic and agricultural purposes. Third is the inadequate educational facilities for, and educational levels of the people. The fourth factor compounds the others. It is the pursuit of inappropriate policies, especially the lack of resolve by all concerned to help the rural populations who should (but do not) produce the bulk of the food that is required to feed the urban areas.

It must also be realized that many of the Sahelian countries face immediate difficulties that must be overcome. Presently the countries are so over-burdened with debts that government expenditure and investment are severely limited. These debts are the result of poor agricultural productivity, rising costs of food imports, the drop in world prices for export commodities resulting from the global recession, and expansive governmental fiscal and development policies which favour the urban centres. For example, the debt servicing in Cape Verde has quadrupled from the 1980-83 average. This has been brought about by major infrastructural investments undertaken since 1979. Niger's foreign debt now represents about 40 percent of gross national product (GNP). Also, the strength of the U.S. dollar has actually affected the real debt significantly. The inability of the countries to service their debts has resulted in debt rescheduling and standby credit from the International Monetary Fund. Furthermore, the debt servicing difficulties have not permitted these countries to make any step by step adjustment back into credit-worthiness and thereby achieve a steady growth.

The 1983 cereals production of 4.45 million tonnes in the Sahelian countries was far below the present consumption requirements of 5.81 million. The poor harvests that necessitated the need for large food imports reduced the capacity of the countries to pay for them. Some recovery in world prices should help offset the decline in export volume for groundnuts, livestock, cotton, and other commodities. It is however instructive to note that an estimated 42 percent of the region's 1983/84 food import requirements were met by aid: for example, food aid accounted for 85 percent in Cape Verde, 75 percent in Chad, 55 percent in Mauritania, 50 percent in Mali, 35 percent in Niger, 22 percent in Senegal, and 18 percent in Gambia.

Although such emergency food aid is greatly appreciated, I find it most difficult to reconcile the fact that during the same period countries such as Burkina Faso, Chad, Mali, Niger, and Senegal harvested some 139.7 million tonnes of cotton fibre when at the same time these same countries could not produce enough basic food for themselves. While I realize that these countries should exploit their comparative advantage by producing cash crops to earn foreign exchange, the permanent dependence on donor countries for food to feed their people is a matter of great concern to me. It is absolutely essential that these countries should strive to attain a reasonable level of self-sufficiency in food production.

Recently the United States Secretary of Agriculture, Mr. John R. Block, informed the World Food Ministerial Council in Paris that "the pursuit of self-sufficiency in developing countries can be harmful for them and the world economy as a whole"(3). Although I understand the rationale behind his statement, I also believe that any food strategy that is likely to place any nation in a vulnerable position will be counterproductive and, in fact, the wrong policy to follow in this unpredictable state of the world economy.

You may recall that soon after the attainment of independence, many African countries began to neglect the production of food crops because of favourable market prices for cash crops. The balance between cash crops and food crops was such that while local farmers were producing abundant cash crops they had difficulty feeding themselves. Furthermore, the continuous production of cash crops has earned many African countries, including the Sahelian countries, far less foreign exchange than they had hoped. In fact most of the countries have been placed in a situation whereby they have to import more fetilizer, pesticides, equipment, and fuel only to produce more cash crops to earn them even less money.

The cash crops face uncertain world price prospects and any further expansion would lead to serious declines in prices and in total earnings for the producers. Unfortunately, some of the donor countries as well as the major world financial organizations have advocated the expansion of cash crops, thus creating a global glut. The net result is that the stimulation of the production of the export crops has become a subsidy for the benefit of the consuming populations in the affluent world.

There is no question that present international financial policies - especially those that have contributed to the creation of enormous debt burdens - are self-defeating. At this moment, many countries cannot meet their interest payment let alone make a dent in the loan repayments themselves. The spectre of large portions of Africa remaining in fiscal gridlock decade after decade should be of great concern to the commercial and political processes of the West. In strategic terms, the only likely outcome will be a zone of instability, frustration, and even terrorism that can sprawl across the continent and the globe. Since there is no end in sight to this dilemma, and there seems to be a continuous net outflow of money from the developing countries to the developed nations, present world financial policies will continue to undermine the Sahelian countries' viability. Such policies must change if Africa is ever to begin the establishment of a self-reliant future.

Presently, the governments in the Sahelian region are taking significant structural adjustment measures to correct their long-term economic imbalances. The adjustments include reforms in producer and consumer prices, the building of suitable institutions, and austerity budgeting. Substantial amounts of food aid have paradoxically become a major disincentive - if not the major disincentive - to local food production. The governments of the region are paying special attention to this key factor, and are currently ensuring that prices received by farmers are significantly increased and are announced prior to the planting season (4). But above and beyond these measures, the governments of the Sahelian countries should realize that continous dependence on food aid is

certainly the wrong policy to follow and one that will sooner or later reduce their ability to become either self-sufficient or self-reliant. Several of the governments are admitting their past errors in these matters and are determined not to repeat them. It is therefore unfortunate that while attempts are being made to alter the course of current aid programs, some donor countries are still dumping excess agricultural produce in the form of food aid. What the Sahelian countries need - and for that matter most of the African countries - is the kind of aid that brings opportunity for the rural farmers to be productive and not the kind of aid that kills the entrepreneurial spirit of a people.

I would like to repeat a call that I made with respect to the current crisis in Africa. "The greatest contribution donor countries can make to help Africa is to stop providing food aid in its current form and help establish innovative national agricultural and industrial recovery plans ... If all the donor countries are able to take this bold stand in concert, it may well be considered the best foreign aid package of the century"(5). Such an action will require tremendous political will by the international community (especially the donor countries and agencies) if the present conditions in the drought-stricken countries are to be turned to advantage. This can happen if there is the desire to help in the formulation of rehabilitation programs that will, in particular, affect the livelihood of the rural populations. The kinds of aid that will provide an integrated framework for cooperative rural development projects will represent a major turning point in food-aid packages. Food aid as presently constituted seems to harm the confidence of the people and undermine the economy of these countries. An alternative strategy is required. Such a new deal must, above all, heighten the awareness of the temporary and transitional nature of the current emergency relief food aid program. This knowledge will help to restore the confidence of the people. In such an atmosphere inappropriate policies by governments can and must change. Then hard work can lead to the fulfillment of realistic expectations. The erosion of living standards can be stopped. Marginal lives and marginal lands can be reclaimed.

I want to record the appreciation of all Africans to all the non-governmental organizations that have been helping with food aid and other emergency relief efforts side by side with government-donor agencies. The invaluable services they have been performing, especially during the recent African crisis, indicate the depth of humanitarian feeling that these NGOs hold for their fellow men and women. Yet, continuous supply of food after the emergency is likely to lead to the institutionalization of food aid for the Sahelian countries. Food aid - a blessing in the short term - can become a curse in the long term.

In the midst of the relief efforts, the Sahelian countries must look beyond the emergency to better times. This is also true for the development and donor agencies, such as the major sponsors of this symposium. Let our main objective be aid designed to help the Sahelian countries to establish a solid foundation for sustainable development. Let us also realize that for such an objective to be fulfilled, the full cooperation of the Sahelian governments and their burning desire to overcome their present difficulties will be required. Since the

serious problems facing these countries are many and complex, stemming mostly from long-term trends in agriculture, the donor countries should therefore help these governments to determine the root causes for failure and inefficiency. Appropriate research and development institutions must be established. Countries need to gain improved capacity and the expertise to undertake mission-oriented research as well as technological adaptations fitted to break specific bottlenecks that retard the development process. Such institutions are sorely needed to act as centres of knowledge to help both the rural agricultural and industrial programs.

For example, rainfed agriculture dominates the Sahelian region. It is obvious that a substantial increase in irrigation schemes is required. But what type of irrigation schemes are needed? To put it mildly, the record of irrigation schemes on the continent of Africa has been most uneven. While there have been notable successes, a large number of badly conceived, uneconomic, socially disruptive, and technically mismanaged irrigation schemes have shaken the confidence of the rural populations. Nevertheless, irrigation on a far wider scale than present is not only possible but imperative. Research can lead the way to proper development. Continuous progress in the mid and long term depends on such preliminary work. Fortunately, effective stop-gap measures can be accelerated at little cost throughout the Sahel. Representatives of several nongovernment organizations have the judgement, built of experience, to help out immediately at the village level. As a cadre for building up a large corps of professional conservation and development volunteers, these NGO personnel may be the Sahel's most valuable asset - that is, after the people themselves. We are all finally learning the greatest lesson. The people themselves are paramount - the key to Africa's recovery and the key to Africa's future. They should be the proper focus of our efforts.

The soils in the Sahelian region and indeed most of Africa require careful handling. Nutrient levels fall within two to three seasons of crop production. Hence the slightest disturbance of the soils, resulting from the indiscriminate clearing of the vegetation, causes leaching, erosion, and indeed alters the hydrological cycle. To regain their fertility these soils should be subjected to 10 to 15 years of fallowing. The current human and animal impact on the land makes it almost impossible for these soils to recover from excessive use. The destruction of tree and shrub cover in most of the Sahelian countries demonstrates the dilemma this region has to face. The excessive dependence on wood for energy to cook a simple meal tells the whole story.

It is obvious that a bold new initiative has to be taken in mass propagation of trees and shrubs using the proven techniques available. The two important methods of vegetative propagation are cuttings and tissue culture. Cuttings remain by far the most popular method used in many countries. However, the latest tissue culture techniques permit the propagation of clones in a rapid fashion that results in the production of thousands or even millions of plantlets from an initial explant harvested from a superior tree or shrub. The Institute for Natural Resources in Africa (INRA) proposed by the United Nations University, for example, holds most promise to undertake such a mission. It is envisaged that the rural populations will be deeply involved in the tree and shrub growing projects. INRA will be cooperating with existing institutions in many African countries as well as various international agencies working in Africa.

But the crucial question is to what extent can the Sahelian countries as a group cooperate with the other regional bodies such as the Southern African Development Coordination Conference (SADCC)? Or should each country establish its own bilateral arrangements? While I am a great believer in regional cooperation, especially among the African countries, I am also realistic enough to judge its usefulness in the light of past and present performances. In the first place the Organization of African Unity (OAU) produced an excellent document The Lagos Plan of Action for the Economic Development of Africa in April 1980. To date very little concrete action has emanated from this laudable document. We are all aware that beautifully stated policy pronouncements do not necessarily translate into real action unless a special effort is made. First, the current African crisis, coupled with the recent new resolve by the Heads of State of OAU, indicates that a real action plan is going to emerge on the continent. Second, the Club du Sahel, which was established to play an innovative coordinating role between the Sahelian countries and the donor organizations, has had little success in alleviating the suffering of the poor and the neglected. My answer to the question of regional cooperation is that it is important and highly desirable to encourage such relationships, but it is equally important for the African countries to act locally. It is only when each country is strong economically and politically, without the chanting of foreign ideologies and slogans, that we can see meaningful regional cooperation on the continent of Africa.

Furthermore, I find it totally unconscionable that in the midst of the current food crisis the African governments are spending US$8.2 billion annually on armaments and other military trappings. A fraction of this sum could purchase the necessities to help those who are presently too weak to work and are in a very debilitating state of health. Only a fraction could provide a "price incentive package" for the agriculture producers in each country. Add to this the US$8 billion a year spent on some 80,000 foreign, "expatriate", development "experts" and you arrive at a truly impressive amount for investing in real progress.

In conclusion, let us do our best to see what is going on in the Sahel and indeed the whole of Africa through the eyes of the rural millions. I feel that we can make no better start than to consider the remarkable words written in 1972 by Robert S. McNamara, then President of the World Bank:

> To many in the affluent world, to be a farmer suggests a life of dignity and decency, free of the irritation and pollution of modern existence: a life close to nature and rich in satisfaction.
>
> That may be what life on the land ought to be. But for hundreds of millions of these subsistence farmers, life is neither satisfying nor decent. Hunger and malnutrition menace their families. Illiteracy forecloses their futures. Disease and death visit their villages too often, stay too long and return too soon.
>
> Their nation may be developing, but their lives are not. The miracle of the Green Revolution may have arrived, but for the most part, the poor farmer has not been able to participate in it. He simply cannot afford to pay for the irrigation, the pesticide, the fertilizer - or perhaps even for the land itself on which his title may be vulnerable and his tenancy uncertain(6).

NOTES

(1) The data collected by meteorologist Sharon Nicholson of Florida State University from 300 stations in the Sahelian countries show graphically the general decline in the rainfall pattern for about 20 countries. The data are reproduced in Lester R. Brown and Edward C. Wolf. June 1985 Reversing Africa's Decline, World Watch Paper 65, page 20.

(2) In 1983, the total cereal production in the eight countries - Cape Verde, Chad, Gambia, Mali, Mauritania, Niger, Senegal, and Burkina Faso - with a population of 33.3 million, fell by 10 percent to 4.45 million tonnes. Senegal's cereal production declined by one-third to 487,000 tonnes. Production of groundnuts which normally account for 25 percent of Senegal's foreign exchange earnings, declined by almost half to 495,400 tonnes. Cereal production in Mauritania fell to 10,900 tonnes from 43,100 tonnes in 1982 because of insufficient rain and the absence of flooding in the Senegal River basin. The basin is the main agricultural area and flood recessional farming is practised there. Lack of pastorage caused heavy losses to Mauritania's livestock. Cereal production in Gambia declined 50 percent to 43,500 tonnes. Output of groundnuts which account for 90 percent of export-earnings in a normal year also dropped by nearly half, to 81,700 tonnes. Burkina Faso's cereal production, affected in the north by insufficient rainfall, was damaged throughout the country by the early end of the rainy season. Output fell 30 percent to 907,000 tonnes. Cape Verde's chronic drought continued in 1983, reducing area planted and yields. Harvest of corn and beans declined slightly to 2,700 and 1,300 tonnes, respectively. Mali, however, was slightly affected by the drought. National cereal production increased slightly to 1 million tonnes. Adequate rainfall in the major producing areas of Niger helped raise cereal output slightly to 1.54 million tonnes. Normal rainfall in Chad's main agricultural region (the South), a lull in the civil war, and increased cotton producer prices boosted cereal and cotton output in 1983. However, Chad's production has not recovered to the levels of the mid-1970s.

Source: Sub-Saharan Africa: Outlook and Situation Report, July 1984. United States Department of Agriculture.

(3) Remarks by the U.S. Secretary of Agriculture, Mr. John R. Block before the World Food Council, Ministerial meeting in Paris, France, on 10 June 1985. Secretary Block expressed the U.S. Government policy on the food situation in Africa, and commented particularly on the pursuit of self-sufficiency instead of self-reliance in food productivity by developing countries. He also discussed the importance of the developing countries keeping the principle of comparative advantage in mind.

(4) In Mali, for example, producer prices were increased and the cereals marketing system was reorganized to reduce the role of the State and increase that of licensed private traders. Niger has substantially increased producer prices for food crops and disbanded unprofitable

parastatals as part of the IMF structural adjustment program. Retail prices have also increased throughout the region. Gambia eliminated its consumer rice subsidy. Mauritania increased its retail rice price by 43 percent, and Cape Verde raised its retail corn price closer to import costs. In addition, producer import subsidies are being reduced.

Source: Sub-Saharan Africa: Outlook and Situation Report, July 1984. United States Department of Agriculture.

(5) Edward S. Ayensu, 1985. The African Crisis: An open Challenge. Bull. of Atomic Scientists (in press).

(6) Robert S. McNamara, 1972. Address to the Board of Governors by the President of the World Bank. 25 September 1972, Washington, D.C.

PATTERN AND IMPACT OF DROUGHT IN EAST AFRICA

F.J. Wang'ati

INTRODUCTION

Drought is often conceived as the prolonged absence of rain which is a purely meteorological phenomenon. This meeting is, however, more concerned with agricultural drought which may be defined as lack of adequate soil moisture to sustain crop growth and production. Causes of agricultural drought are therefore not only meteorological but also include soil characteristics such as infiltration and water holding capacity. Severity of agricultural droughts therefore depends on climatic and soil factors and the ability of the crops grown to adapt to the constraints of soil moisture availablity. Agricultural droughts occur in many regions of the world at relatively frequent intervals but their severity and impact depends on both technological and resource capacity of the communities affected.

PATTERN OF DROUGHT IN EAST AFRICA

East Africa which comprises the territories of Kenya, Uganda, and Tanzania lies approximately between latitudes 11°S and 4°N and longitudes 30°E and 41°E on the East Coast of Africa. Except for Uganda which is better endowed with rainfall, the climate of the greater land area of Kenya and Tanzania ranges from dry to subhumid. At least 70 percent of land area in Kenya is actually classified as semi-arid to arid. Rainfall also generally increases with altitude which means that the high-land potential coincides with low air temperatures and hence slow plant growth. In places where soils are suitable and irrigation water available, the warmer lowland areas have proved very productive. Rainfall near the equator is bimodal with peaks in March-April and November-December. It is however monomodal over the larger part of Tanzania which is further from the equator. Annual crops therefore have only short periods (usually less than four months) of adequate rainfall. Timeliness of land preparation and planting, and deep soils are crucial factors for successful crop production.

The seasonal rainfall belts in East Africa move northwards and southwards in a regular manner with the Intertropical Convergence Zone (ITCZ) which follows the overhead sun. It follows therefore that any major natural interference with the ITCZ pressure patterns does affect seasonal rainfall creating large peaks or severe deficits as the case may be. It also means that once the ITCZ has passed through a region, there is little chance of widespread rain until the next cycle is in place. Although there are other mechanisms which cause rainfall in various parts of the region, such effects are localized and are usually small. Seasonal dry spells of varying lengths therefore occur in most parts of East Africa at least once a year but their effects vary depending on the agricultural practices and the overall rainfall and soil regime of the area concerned.

Recognizing that there is little one can do to influence the energetics of the meteorological systems, a major effort has been made by meteorologists to analyze the rainfall patterns in East Africa with the hope of being able to at least predict the return period of both surplus, and severe deficits (Ogallo 1980, 1981, 1982). Results from spectral analysis of rainfall have, however, so far ruled out major climatic changes in the region but revealed at least four spectral peaks centred around 2.2-2.8 years, 3.0-3.7 years, 4.8-6.0 years, and 10.0-12.5 years (Ogallo 1982). It appears therefore that while we can state with confidence that widespread rainfall deficits - and surpluses - will occur in the region from time to time, we are still unable to predict the precise causes and return periods of such events.

The second approach which has been tried is to examine the pattern of rainfall once a season starts in search of indicators of whether the seasonal rainfall will be normal, above, or below normal. Initial studies on a few areas in Kenya (Stewart 1980; Stewart and Hash 1982; Stewart and Kashasha 1983) have yielded promising results which can be used to formulate extension advice to farmers provided soil moisture storage and crop water use characteristics are well understood and a good record of daily rainfall is maintained. This approach is, however, based on the assumption that the factors which influence seasonal rainfall are stable over time and that a farmer is able to react in a timely manner to the resulting advice. It is hoped that with the increasing capacity of meteorologists to study short-term changes in regional and global weather patterns through remote sensing by satellites, the rationale for agricultural decisions based on both historical and short-term indicators will be improved to the point of acceptance by farmers and the government advisory and support systems. These observations nevertheless point to the need for a major investment in detailed and concentrated studies of the agro-climatology of the region especially the mechanisms which link the East African climate with global occurrences.

IMPACT OF DROUGHT IN EAST AFRICA

There is good evidence in oral literature and tradition that both localized and widespread severe droughts have occurred with associated famines in East Africa during the past 100 years at least. The impact of such experiences was to encourage development of subsistence farming systems with crop and livestock mixes designed to guarantee at least some yields under most but the severest of droughts. In many semi-arid areas with a single crop season, traditional techniques were evolved for storage of sorghums and millets for at least a year with periodic treatment against insect damage. Beyond that period, livestock and root and tuber crops, which store longer in the soil, provided temporary sustenance. In spite of these systems, the more severe droughts resulted in drastic reductions in both human and livestock populations through death and migration and hence some ecological balance in natural resources was restored naturally.

The situation in present-day East Africa has changed drastically, especially in the last three decades. Impact of drought has reached alarming levels as a result of population increases (due to improvements in health standards), and

the shift of large portions of the labour force to urban areas. Effects of drought have also been intensified by the deterioration of the land resource due to overuse and failure to increase agricultural inputs to ensure commensurate increase in food production. Droughts have further put, especially the children and the poorer sections of the communities, increasingly at risk as food storage and distribution become more and more commercialized without commensurate increase in total food production. The impact of droughts has been to reduce greatly the reliability of farm income thus discouraging investment in farm inputs and encouraging migration of the younger and better educated persons from rural to urban areas in search of more secure incomes.

Agricultural droughts in East Africa have therefore had far-reaching impacts, both short-term and long-term, on the welfare of the individuals and nations as a whole. Prolonged inadequate nutrition of children has undoubtedly affected their mental and physical capacity, a condition they may not recover from for the rest of their lives. Droughts have thus deprived individuals and the communities concerned of the potential for rapid social and economic development in the future. At the national level, prolonged droughts have forced governments to suspend development programs in order to finance food imports and the attendant costs of food handling and distribution. Another major impact of drought has been the severe loss of livestock. The nomadic populations in the region have been particularly affected by the 1984 drought in which at least 30 percent of cattle, sheep, and goats were lost. Even if good rains occur during the next few years these livestock herds cannot be rebuilt in less than five years by which time the region may experience another drought. Of particular concern is the impact of the drought on the genetic quality of the livestock herds which may take even longer to rebuild. Under the circumstances shortages of meat and milk can be expected, hence the urgent need to develop alternative sources of protein, especially the grain legumes. Loss of adapted seed has also been severe in some regions and such seed may be particularly difficult to replace. Continued dependence on external sources of food is therefore an inevitable impact of drought on some communities in the region resulting in far-reaching economic and sociological implications. For example, reduced exports and increased imports aggravate the already difficult balance-of-payments and foreign-exchange problems as well as reduce capacity to service loans leading to further cutbacks in public services.

Droughts have also had an impact on energy and industry. Reduced streamflow has affected hydropower generation at a time when the countries are trying to reduce the use of expensive fuel oil. Rationing of electricity became necessary at the height of the drought. Reduced production of raw materials has in turn affected agro-industries and hence the economic utilization of both capital installations and labour.

ACTION REQUIRED FOR DROUGHT-STRICKEN COUNTRIES

One of the effects of the recent series of droughts in the East African region has been the realization that centralized food storage is unlikely to meet the needs of the largely rural populations in such emergencies. The role of the

small farmer in creating national food self-sufficiency is also being emphasized and some countries are already taking measures to increase the economic returns to small farmers through more direct participation in food marketing and periodic reviews of minimum prices for farm produce. Such measures are, however, being frustrated by the heavy crop losses both in the field and in storage. An example of the extent of crop losses is the extract from the Commonwealth Agricultural Bureau database based on FAO data collection which cites an estimated 57 percent loss in maize in Kenya caused by: grain weevil (30 percent); stem borer (15 percent), army worm (7 percent); and rodents (2 percent) (Walker 1984). Any programs that reduce such losses even by one half would make a great impact on return to the farmers and the long-term internal food security. A greater awareness of this problem has prompted governments in the region to devote more resources to modern but, unfortunately, expensive grain silos for national strategic reserves. Scientists are also devoting more effort to simple technologies - including traditional practices for on-farm food storage. There is a greater awareness of the need to conserve water and soil fertility through afforestation and control of soil erosion. The efforts being made by governments therefore need to be strengthened through technical and financial assistance especially in making available appropriate seed, building of dams and reservoirs, and rehabilitation of denuded land through agro-forestry and development of shelter belts.

While the role of agricultural research in increasing food production is recognized, the continuing large gap between the yield potential of available crops and livestock breeds and the actual yields realized by farmers is a matter of concern. Various countries are therefore giving high priority to development of agricultural extension systems to establish better linkages between research and agricultural production. The Training and Visit approach is one of the systems being tried. The educational level of frontline extension personnel is, however, still inadequate and while improving research capacity substantial effort will be needed to upgrade and motivate the extension personnel. Furthermore, to enhance the awareness of the future farmers, teaching of agriculture, which has largely disappeared from school curricula, should be restored and intensified at primary and secondary levels. The role of traditional food crops like sorghum and millets, sweet potato, and cassava which have tended to disappear from diets is also now better recognized. However a major effort is needed in both research and food technology to integrate these important foods into the package of preferred foods which is currently dominated by maize, wheat, and rice. The problem of bird pests needs particular attention. It has largely contributed to the replacement of sorghum and millets, which are better adapted to erratic rainfall, by maize, which is less susceptible to injury by birds but which needs a long rainfall season to give a reasonable yield.

Soil fertility is a major factor in crop production even where rainfall is sufficient. In drought situations, soil fertility becomes an even more important factor since most biomass cover is destroyed giving way to extensive erosion of topsoil at the onset of rains or through wind erosion. Under drought conditions, agro-forestry becomes vital as it enhances the water holding capacity of the soil and the capacity of crops planted to mature before soil moisture is exhausted. Availability and cost of artificial fertilizers after

drought need much more attention especially in the case of small farmers with limited capacity for purchased inputs. In this respect, agro-forestry and intercropping with legumes offer promise in the establishment of more stable farming systems due to in situ fixation of nitrogen and nutrient recycling. Nitrogen fixation in soils depends on availability of well adapted rhizobia and phosphates in the soil. Local scientists have made commendable efforts in developing cultures of rhizobia and efficient methods of inoculating seed, activities which need much more support. Raising levels of available phosphorus in tropical soils is, however, still a major problem due to rapid fixation of phosphorus in the soils and the high cost of phosphatic fertilizers. Fortunately natural rock phosphate deposits exist in the region but need substantial capital for economic exploitation as well as research on efficient methods of their application to various soil types.

Irrigation can make a significant contribution to the stabilization of food production in the region. Unfortunately much of the surface water available requires very large capital investments due to topography and the need to move water over long distances to suitable soils. A number of irrigation schemes have already been established but the low monetary returns from such schemes has limited much needed private investments especially for minor irrigation schemes. There is also a shortage of basic skills and experience in irrigation systems which are relatively new in the region. Success of irrigation schemes will therefore depend on access to long-term soft loans and grants for initial development and rapid development of government support services in the form of extension, infrastructure, and efficient marketing systems. This is an area where donor agencies can make a significant and long-lasting contribution to the reduction of drought impact in the region.
The plan for rehabilitation of drought-stricken countries in East Africa could therefore be summarized as follows:

* Droughts of varying intensities will occur in the region at intervals which are at present impossible to predict. Internal food security is therefore a paramount objective which deserves all attention and financial support possible.

* Food production per capita is either stagnant or diminishing in most of the countries in the region. Rapid increase in population, relative inertia in the adoption of more efficient methods of food production, and the increasing inability of countries to purchase agricultural inputs are major reasons for the decline in food production.

* A large proportion of food produced is lost either in the field or in storage. Accelerated development of appropriate post-harvest technology, especially programs to install pest-free on-farm food storage structures and to increase the storage capacity of strategic national food reserves, needs special support by donor agencies.

* National research efforts in plants breeding, agronomy, pest and disease control, livestock development, and food storage need substantial and long-term support. Special programs for development of drought-tolerant and

drought-avoiding crop varieties need particular attention. In this respect sorghum and millets, pulses, and cassava should be revived as preferred foods through varietal development and food technology research to enhance their incorporation in both human diets and livestock feeds. Cassava in particular offers important but largely untapped opportunities due to its drought tolerance and capacity to yield heavily even in impoverished soils.

* Maximum use of water resources through increased groundwater retention, reduced siltation of rivers, and development of water resources for irrigation, especially for minor irrigation schemes, would make a vital contribution to internal food security. Creation of dams, reservoirs and other necessary infrastructure needs long-term financial support.

* Even with all production systems in place, the farmers will not produce surpluses to their family requirements without assurance of an economic return. The governments of the region should therefore be encouraged to develop appropriate food- and land-use policies which will motivate farmers to increase food production.

COOPERATION AMONG AFRICAN COUNTRIES

Although the task of feeding a nation is the responsibility of its government, good neighbourliness has often helped to cushion impacts of localized food shortages through inter-state food trade. Unfortunately, food trade is seriously curtailed by lack of internal food security in the countries concerned. The environment for such mutual support is further affected by low purchasing power and absence of mechanisms for barter trade. The recent efforts by the countries in the region to establish Preferential Trade among themselves and the grouping of states for development cooperation need support from all well-wishers. It is hoped that as these institutions and systems develop, economies-of-scale will facilitate development of cheaper agricultural inputs and provide a stimulus to farmers due to expanded markets. Efficient communication is, however, a vital input to the success of inter-state cooperation. Although progress has been achieved in the past decades since independence, support from donors is needed to facilitate proper maintenance and further development of the network of roads, railways, and water routes. Cooperation is also essential in research, especially in the fields of crop and livestock diseases and crop varietal improvement which needs a wide range of ecological testing and agroclimatic studies and a large network of cooperating observation stations.

CONCLUSIONS

Droughts are not a new phenomenon in East Africa. What is urgent and disturbing is the extent of famine and suffering which are on the increase in spite of the efforts being made by both national governments and donor agencies. The impact of these droughts on the environment due to high livestock and human population pressures is also disturbing in that the process of soil degradation and

desertification is on the increase and future droughts may have much worse consequences. While national governments have initiated commendable efforts in combating rapid population increase and promoting higher food production, these measures will take time to produce desired effects. There are many problems which, though not insurmountable in the long run, require urgent solution beyond the current resource capacity of national governments. The rational exploitation of all available natural resources to cope with the increasing populations and decreasing standards of living is more urgent now than ever before.

The tropical environment presents obstacles to food production even where rainfall is not a limiting factor. The high levels of weed and insect pressure and the plant diseases which thrive in the warm humid atmosphere compete with farmers' resources of labour and chemical inputs. Research aimed at producing more tolerant crops as well as methods of integrated pest and disease management requiring minimal purchased inputs is therefore a prerequisite. A more detailed analysis of climate, weather, and plant production in sub-Saharan Africa (Wang'ati 1984) has further demonstrated contrasts with temperate regions that preclude transfer of technologies. The present status of agricultural and agroclimatic research in the region is, however, such that it will require substantial technical and financial support to address adequately even the short-term aspects of these problems. Long-term solutions will further depend on the development of a cadre of local scientists willing and able to conduct well planned long-term agricultural research under difficult economic and social conditions. The International Agricultural Research Centres have a special role in this effort. ICRISAT which has expertise in dryland agriculture; CIMMYT in the development of the staple food, maize; CIAT which in collaboration with IITA can help accelerate development of cassava and drought-tolerant grain legumes; ILCA in increasing output of the vast rangelands; and ILRAD for economic control of livestock diseases, can all be mobilized to support national programs and to promote collaborative research and manpower development at the regional level.

A higher level of technical and financial assistance from donor agencies is therefore required on a more sustained basis to augment national efforts in establishing a viable basis for food production and preservation of the environment. Better and more comprehensive packages of developmental assistance, better terms of trade, and development of appropriate farming technologies will have a more lasting effect on the countries' ability to cope with droughts than emergency food aid which can only alleviate short-term suffering. In all these efforts, development of human resources through training and research and improvement of the basic infrastructures indicated in this paper provide the only hope for long-term alleviation of human suffering due to droughts in the East African region.

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PATTERN AND IMPACT OF DROUGHT IN THE SADCC COUNTRIES

R.M. Mupawose

INTRODUCTION

The Southern African Development Co-ordination Conference, SADCC, comprises some nine independent states of Southern Africa, namely Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe.

The region has an estimated total population of about 67 million, occupying an area of approximately 470 million hectares, of which 23 million hectares, or 5 percent, are currently defined as being suitable for agricultural production.

At the inaugural summit meeting held in Lusaka, Zambia, in April 1980, Heads of State and Government of the nine countries signed a Declaration called From Dependence Toward Economic Liberation, in which the twin objectives of promoting regional economic development through co-ordinated collective action and lessening the region's dependence on countries outside the region were specified.

To that end, each member state was assigned a specific sectoral portfolio to co-ordinate on behalf of the region as follows:

Angola	- Energy conservation
Botswana	- Agricultural research and animal disease control
Lesotho	- Soil and water conservation and land utilization
Malawi	- Wildlife, fisheries, and forestry
Mozambique	- Transport and communications
Swaziland	- Manpower development
Tanzania	- Industrial development
Zambia	- Southern African Development Fund, mining
Zimbabwe	- Food security

Member countries have each been given responsibility for drawing up proposals, and identifying specific projects with the assistance of outside countries and international agencies.

Agriculture has been defined as the principal area of SADCC co-operation, largely in view of the fact that the majority of the people in the region depend on agriculture and livestock for subsistence, and also because food production is currently insufficient in most member countries.

In the area of food security, SADCC has so far approved 11 projects which form a comprehensive strategy for the region and these are as follows:

- general technical assistance program designed to achieve co-ordination and co-operation on all agrarian issues
- early warning system for regional food security
- regional resources information system
- regional inventory of agricultural resources base
- regional food reserve
- regional post-harvest food loss reduction
- regional food processing technology
- regional food marketing infrastructure
- regional food aid
- regional seed production and supply, and
- regional irrigation management program

Considerable progress has already been achieved in the initial implementation of some of these regional food security projects since 1980, notwithstanding the effects of drought.

The main focus of this paper is to review the impact of repeated droughts in Southern Africa, to assess the direct and indirect consequences of drought on the economies and the people of the region, and to indicate action required to reduce the effects of future droughts on the part of the countries affected as well as the world community and donor agencies at large.

THE INCIDENCE OF DROUGHTS IN THE SADCC SUB-REGION

Apart from Tanzania and Lesotho, the majority of SADCC countries lie between 12 degrees and 25 degrees south latitude, implying that the region predominantly experiences a sub-tropical type of climate, which is characterized by dry, mild winters and hot, wet summers.

Repeated observations over the past 100 years suggest that intense and recurrent droughts are a very common phenomenon throughout the region, and these droughts are purely a result of natural processes and not man-made.

Seasonal droughts are quite endemic and, when they occur, rains are not only insufficient to support normal plant growth, but they either come late, thereby shortening the production season, or they make an abrupt stop mid-season when crops have been planted, or the rains do not come at all. The unreliability of rainfall is one of the most critical constraints to increased agricultural production in the region. Even during the so-called "normal seasons," the bulk of the region lies in "marginal rainfall" areas receiving inadequate rainfall for normal cropping.

The SADCC region has been drought-stricken for a four-year consecutive period, between 1981 and 1984, and this has been the severest drought known in the recorded history of most member states.

It is estimated that approximately 66 percent of the region, particularly in Botswana, Lesotho, Swaziland, Mozambique, Zambia, and Zimbabwe, on average received less than 60 percent of normal rainfall during this period.

Drought will continue to pose a serious threat to the future development of the region, and future droughts will be even more devastating unless appropriate programs to alleviate their impact are set in motion without delay.

CONSEQUENCES OF DROUGHT

On Food Production and Food Supply

The most immediate effect of drought is a direct reduction in food production and food availability. This is because droughts lead either to complete crop failures or reduction in cultivated areas. Farmers lose inputs and confidence. There is a reduction in subsistence production with reduced yields of marketable crops which would largely supply urban consumers.

Aggregated cereal production in the six affected countries (Angola, Botswana, Lesotho, Mozambique, Zambia, and Zimbabwe) during the 1984 drought year was estimated at 3.4 million tonnes compared with 4.8 million in a normal year (FAO), representing a 41 percent loss.

A serious shortage of seeds was experienced in most of the countries and this adversely affected the recovery of production, given the more favourable rainfall in 1985.

As a result, some countries are still facing serious food supply problems, with considerable requirements for cereal food aid and commercial imports in 1984/85, estimated to total 2.2 million tonnes, compared with 1.4 million tonnes in 1983/84.

Reduced grazing and water supplies took a heavy toll on livestock, with up to 30 percent of national herds being lost, particularly in Zimbabwe, Botswana, Lesotho, and Mozambique. Livestock deaths have been particularly high amongst the smaller and poorly managed herds, implying that many of the already disadvantaged rural households have become further impoverished.

The impact of drought and the extent of food shortages in the SADCC sub-region have been aggravated by the low capacity of the countries to respond effectively due to organizational deficiencies in the transport, storage, and distribution sectors. There also exist inefficient pricing mechanisms and other structural imbalances. Acute shortages of capital, foreign exchange, and skilled manpower greatly limit the capacity of each country to expand, service, and fuel its transport systems, to maintain strategic food reserves, and to distribute basic supplies to remote drought-affected communities.

Drought impact has also been accentuated by the destabilizing effect of South Africa. Farmers' activities are disrupted either by banditry or war operations of South Africa's forces or their agents. This has also destroyed infrastructure.

On the Agricultural Economy

Periodic droughts and the resultant food crises, besides having catastrophic political, economic and, social consequences, also reenforce economic dependence and underdevelopment and impede progress in the implementation of development programs.

Food shortages result in a very rapid rise in food imports and government expenditures and an unavoidable diversion of national resources and personnel to drought-related activities.

The SADCC food security objective is to achieve national food self-sufficiency and overall development strategy is based on the desire to satisfy the basic need for food. It is desirable to alleviate periodic food crises, and to reduce present heavy drains on foreign exchange which are imposed by food imports - strategies which are heavily dependent on rainfall.

It goes without saying that the major impact of the recent drought has been to further worsen the already deteriorating economic and social conditions in member states. Real regional output is estimated to have fallen by 1.3 percent in 1981, increased by only 1.3 percent in 1982, and stagnated in 1983 and 1984 (Economic Commission for Africa). In per capita terms, the loss in output is around 10 percent, with only about 86 percent of total food requirements being met from their own production.

The agricultural sector was at the same time not able to achieve the projected growth rate of 4 percent a year, but only managed to achieve about 1.7 percent per annum, against an estimated population growth rate of about 3 percent per annum.

On Human Health and Welfare

Malnutrition and associated health problems have been and still are a major concern in the region, and perhaps considered to be the most serious consequence of prolonged drought, with the rate of increased incidence calculated at 30.8 percent over a three-year period.

In addition, water supplies to a number of rural communities have been depleted. The situation of many settlements which normally rely on sources such as seasonal rivers, wells, or dams for their water supply has become precarious. Boreholes which had been installed to assist many communities experienced serious drops in yields and some actually dried up. Due to drying up of water sources, fish also died which would be a source of food.

It must be noted that those parts of the region which were already experiencing greater food shortages and high rates of malnutrition also had the poorest conditions with a cumulative effect on the households in terms of loss of incomes, assets, inputs and draught power for the cultivation of food crops, and loss of employment in the agricultural economy, resulting in a rather miserable level of social welfare and health for the people concerned.

Other effects of drought are of an indirect nature and these often culminate in drought-induced soil erosion, loss of vegetative cover, desertification, lowering of the groundwater level, and deterioration of the productive capacity of land due to poor conservation.

Financial Losses from Drought

A special appeal for drought relief was launched by SADCC member states in Lusaka, Zambia, in January 1984 and it was estimated at that time that direct costs resulting from drought would amount to some US$921 million. There are two forms of financial losses which are associated with drought. First, heavy costs are incurred by drought-relief emergency programs such as feeding programs, food imports and related costs, cattle rescue operations, distribution of free farm inputs, water supply schemes, and related administrative costs. In other words, this refers to those additional expenditures which would otherwise not be incurred in a year of normal rainfall.

Secondly, financial losses also result from decreases in crop yields or complete crop failures, as well as losses from livestock deaths. The value of losses resulting from reduced crop yields is calculated by subtracting actual recorded production from what is assumed to be the average yield in a given area during a normal rainfall season, then multiplying the difference by the average price for that crop. This is course assumes that other agro-economic factors which affect production in a normal year, are held constant.

The rapid accumulation of farm debt is another indicator of drought-induced financial losses.

On livestock losses, it is estimated that more than one million head of cattle died in the region during the drought, and this represented a direct loss of income and wealth, and loss of draught power for peasant farmers in particular.

The extent of drought-induced losses and related costs, calculated on the basis of direct agricultural losses and drought-relief costs, are indicated below for six of the most affected countries in the region at the end of the 1982/83 farming period.

The estimated total value of direct losses in agricultural production for six countries was US$575.4 million for 1982/83, while costs incurred for emergency relief operations amounted to $345.5 million. Further expenses were incurred in 1983/84 and in early 1985 as the scourge persisted.

Unrecorded losses were also incurred by most commercial and industrial sectors dependent on agriculture such as food processors and other agro-industries, with obvious damaging effects to overall economic performance.

Financial cost and losses from the 1982/83 drought (US$ million)

Country	Direct agricultural losses	Drought relief costs	Total
Botswana	68.9	51.9	120.8
Lesotho	45.0	78.7	123.7
Malawi	-	13.4	13.4
Mozambique	75.1	79.0	154.1
Swaziland	26.4	2.9	29.3
Zimbabwe	360.0	119.6	479.6
Total	575.4	345.5	920.9

Source: SADCC Drought Report, January 1984.

PAST ACTIONS FOR COMBATING THE EFFECTS OF DROUGHT

At National and Sub-regional Levels

SADCC's response to the recent drought crisis at both national and sub-regional levels included first and foremost the mobilization of emergency relief, followed by the mobilization of resources for the implementation of national projects aimed at increasing production, or minimizing the impact of future droughts.

Drought and human relief programs included the supplementation of food supplies in order to avoid famine and reduce the incidence of malnutrition and to maintain an adequate flow of food supplies to the urban sector in particular. Significant food imports were made for this purpose as pointed out earlier.

Cattle rescue operations were extensively carried out, which included moving cattle to areas with better grazing, provision of supplementary feeds and destocking to alleviate the effects of drought on the surviving herds.

Agricultural relief measures, which included the provision of crop packs comprising basic seeds and fertilizers, ploughing subsidies for farmers, and rescheduling of debts, were introduced in order to assist farmers to regain productivity following crop failures and loss of income.

Efforts were also made to supplement rural incomes through drought-related public works projects and to help compensate for lost production and lack of purchasing power.

At The International Level

Extensive donor support in the fields of commodity and food aid, technical assistance and financial contributions were provided by the international community and SADCC Governments are extremely grateful in this regard. However, the aid given was inadequate in some parts of the region.

ACTIONS TO DEAL WITH FUTURE DROUGHTS

The major aim of this paper is to focus attention on future national and sub-regional co-operative programs which will be required to reduce the vulnerability of SADCC member states to drought.

National Action

The recent prolonged drought has exposed certain significant structural weaknesses in the agricultural sectors of the SADCC economies. This has led to a serious rethinking by agricultural planners as to the most effective ways and means of ameliorating the effects of any future droughts.

Lack of preparedness planning and proper arrangements to cope with acute food emergencies in most cases resulted in inadequate food relief reaching the target population.

To redress these shortcomings it will be necessary, among other measures, to establish early-warning systems where they do not exist, special drought-relief emergency funds, appropriate organizational and administrative structures to deal with emergencies, and the removal of transport and logistical constraints.

It has become necessary to re-examine some of the earlier proposed projects so as to identify priority areas.

In addition, it has also been noted that there is an urgent need to implement projects and agricultural policies, at the national level, which will lead to optimal land use, greater production, and service specialization, thereby rectifying some of the structural imbalances which have been highlighted by the drought situation.

Some of these projects include the provision of adequate food storage facilities, farm credit schemes, small and, where appropriate, medium-scale irrigation schemes, projects to deal with water supply problems during drought and projects to improve livestock management and soil conservation.

Improved storage will help to reduce post-harvest losses and enhance goals of national food security as well as facilitate the execution of relief operations.

There is an urgent need to improve services to the farmer, especially the small peasant farmer who desperately needs advisory extension services, financial resources, and appropriate delivery systems for seed, fertilizers, pesticides, and other inputs. These measures will be necessary to assist farmers to improve production techniques and achieve greater yields per unit of area planted.

Careful maintenance of the environment and ecological balance to sustain productivity should at the same time be emphasized.

There is need to train and provide inservice training courses to research, extension, and veterinary manpower. The servicing of farmers is dependent on availability of properly trained personnel. Concerted efforts will have to be made by each SADCC member state not only to increase local production but also to keep adequate reserve stocks of the basic food stuffs, primarily grains, which can be drawn upon while arrangements are being made to augment supplies from domestic sources or from abroad.

Co-operative Action

To assist the SADCC region to cope with future droughts, there is need to accelerate the implementation of projects under the portfolio of Regional Food Security and the Agricultural Research program, particularly as it relates to the development of drought-resistant crops, which will make the region less susceptible to drought. The opening of the SADCC millet-sorghum research centre in Zimbabwe is beginning to show benefits. The establishment of programs in the areas of Soil and Water Conservation and Land Utilization should be speeded up as well.

There are also some new sub-regional food security projects which deserve active assessment and these include regional irrigation management programs, the establishment of a regional seed reserves project for the esssential food crops, and co-ordination of migrant pest and disease control.

It is a recognized fact that the elimination of periodic food crises, such as the ones recently experienced, and the implementation of longer term projects for the rehabilitation of agriculture, require that domestic efforts be supplemented by international assistance.

According to FAO estimates, it is considered that annual investments of up to US$2.2 billion would be required to improve agricultural performance to a level which would meet a 4 percent annual growth in total agricultural demand - resources which are obviously beyond the reach of the sub-region on its own.

Since 1980 the SADCC region has received US$4.4 million for regional food security projects and in addition US$12.6 million has been secured for food security drought-related projects, excluding food aid.

More financial contributions are expected from the international community in this respect.

At a SADCC meeting held in Lusaka, Zambia, in February 1984, whose main focus of attention was Food and Agriculture with particular attention to drought, a total funding of US$185 million was sought by member states for food- and agriculture-related programs.

The recent drought coupled with gloomy predictions of SADCC's limited ability to reduce its worsening food deficit situation within a reasonable time to come, has focused renewed attention on the role food aid can continue to play in the region. Food aid is necessary to assist countries during policy transition periods, and can also be used as an agricultural development tool to ultimately enhance the food security situation. Such food aid can be channelled through the food reserve system, which should in turn be linked with price incentives, credit facilities, and other measures as part of a longer term development program.

The idea of triangular arrangements for procuring food aid from neighbouring countries with surplus production, as opposed to direct shipments from abroad, should be actively pursued, together with the simultaneous use of counterpart funds from the food aid to finance development projects.

At the same time products for food aid should as much as possible take into account the nutritional requirements and cultural and diet preferences of the recipients, to improve the effectiveness of the food aid.

However, food aid is not an end in itself. It is not an objective of the region to depend forever on aid.

CONCLUSION

While droughts are not entirely new to the SADCC region, the recent prolonged drought is bound to be remembered for some years to come.

It occurred at a time when population growth rates have reached unprecedented levels and at a time when severe economic recession and mounting external debts are gripping the economies of African countries. The structural mechanisms and policy measures are not yet adequately geared to deal with severe droughts and chronic food deficit situations.

This particularly devastating drought has however marked a turning point in the agricultural development and investment policies of the affected countries. More emphasis is now being placed on speeding up projects for combating the effects of drought, and for boosting domestic food production.

It must be mentioned that given good rains, there exists the potential to become productive. Even after this long drought period, one reasonable season in 1985 has resulted in maize (corn) surpluses in Malawi and Zimbabwe both of which are able at present to export grain. However, even if these countries are able at present to export grain, they still require assistance to consolidate and expand their production base.

The assistance rendered by the international community in averting what could have been a catastrophic loss of human life through hunger, starvation, and disease deserves special mention and acknowledgement.

Because of the diversity and magnitude of the problems experienced and highlighted during the drought, and the variety of action programs being proposed, SADCC member states wish to renew and reenforce their appeal. Interested government agencies, non-governmental organizations, and national and international development agencies are requested to seriously review their assistance programs for Africa, with respect to some of the projects indicated.

This is necessary to complement the revived efforts and commitment so far being shown by African countries themselves in tackling their own domestic problems, despite the numerous internal and external constraints which have been highlighted in this paper.

PATTERN AND IMPACT OF DROUGHT IN THE SUDAN

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INTRODUCTION

Sudan is one of the African countries which has been severely hit by drought. Because of drought persistence and severity, and because of the continous flow of refugees, the Sudan has hit the international news media more than any other drought-affected country. It is estimated that 11.5 million persons of the 20 million inhabitants (1983 Census) are affected at varying levels ranging from loss in income, loss of animals, hunger, starvation, malnutrition to death.

It is both sad and amazing that as recently as eight years ago, this starving country was foreseen as the "food basket" of the Arab world. "As international organizations pointed to a possible world food shortage in the years ahead, the Sudan Government realised that by reason of climate, irrigation potentials...and the nature of their soils, their country has the opportunity of becoming the 'Garden of Africa'" (World Crops 1978, p.109).

In fact, during this catastrophic era of Sudano-Sahelian drought, both climate and irrigation have failed to support food production required even for subsistence! Earlier, in the late 1960s and the 1970s, other drought-afflicted African countries dominated the scene in the international press, because in the Sudan there was some drought relief from irrigation schemes. Later the Nile receded, drought persisted, and an ecological imbalance was evident almost everywhere.

GENERAL BACKGROUND

Sudan is the largest country in Africa; its economy is predominantly agricultural with about 80 percent of the population living in rural areas. Water availability to a great extent affects the distribution of population. In the hyper-arid north, people can only dwell in the narrow strip along the Nile banks. Southward, because of the steady increase in rainfall, settlements can survive beyond the Nile banks. However, population density varies enormously from one part of the country to another. Riverine strips are the most populous areas, where intensive peasant farming is practised. Irrigation schemes are other areas of high density. These include Gezira, the largest agricultural scheme in the world under a single administration. Other populous schemes are New Halfa, Rahad and, to some extent, the flood areas of the Gash river in the east.

In rainfed areas 11 million persons engage in different forms of livelihood. To the north in an area of 50-300 mm of rainfall, camel herds graze vast undulating plains. Southwards and especially in the goz-country(1), tapping gum Arabic from Acacia senegal is combined with sedentary and nomadic pastoralism as well as the raising of a variety of crops. The most important crops in both the sand and clay plains of the arid and semi-arid parts are sorghum, sesame, and peanuts. Over large areas gum Arabic trees (nitrogen fixing) are part of the land rotation. Unfortunately, the gum Arabic belt has shrunk enormously as the vegetative cover and soil are degraded by drought and mismanagement.

DEFINITION OF THE TERM "DROUGHT"

"Drought means various things to various people depending on their specific interest. To the farmer, drought means a shortage of moisture in the root zone of his crops. To the hydrologist, it suggests below-average water level in streams...Each has a concern which depends on the effect of a fairly prolonged weather anomaly" (Palmer 1965, p.1).

THE NATURE OF RAINFALL OVER THE SUDAN AND PATTERNS OF DROUGHT

The isohyetal map of the Sudan shows a simple, west to east pattern. This latitudinal trend is broken in the east where the isohyets are deflected to the north in response to relative wetness. The opposite is true in the Sudd region where the isohyets taper southwards, indicating relative dryness as is the case along the White Nile. Over Jebel Marra the cellular pattern of isohyets reflects the geographic effect there (Figure 1). These rainfall features are reflected in the climatic regionalization of the country (Figure 2).

Drought patterns are sought along different time units over selected stations assumed representative of the central belt of the Sudan which is the most critical zone. To the north investigations of agricultural drought are not very worthwhile because dry conditions there are the norm rather than the exception. To the south of this central belt, rainfall is sufficient for crops like sorghum. The central drought-prone region is the belt extending from latitude 17°N to 10°N.

Spatially, drought-hit areas can be delineated only vaguely, because of the nature of rainfall over the tropics in general and the Sudan in particular. Rainfall over the Sudan is characterized by its local confinement. In fact, good understanding of drought patterns must be preceded by some background on the nature of rainfall over the Sudan. Investigations on area rainfall suggest extended drought areas as well as patchy patterns of drought-hit areas during the last two decades. In an attempt to find out how rainfall over a station is affected by the amounts in other areas, an inter-station correlation analysis was made. Results are shown in Table 1.

The table shows clearly how rainfall over one station is independent of the amount at other locations, on an annual basis. Unlike the middle latitudes, rain is not caused by a series of depressions, but results as a matter of chance from clouds which develop vertically over confined areas.

In fact, over one station the two extremes of maximum and minimum rainfall over a few decades can follow one another successively. Figure 3 shows seasonal rainfall over Manaqil which is centrally located in the Sudan. There, as seen from the figures each year, rainfall seems to be independent, and looks different from year to year.

By-and-large, the poor inter-station correlation in rainfall (Table 1) suggests no significant areal patterns. Temporally, in the case of Manaqil, Figure 1 suggests the same. This seems to be the general case over non-extreme periods,but looking at the present situation of the Sudano-Sahelian drought, a general pattern extending over wide areas has been evident to some extent. Although many people concerned with the Sudan, including some drought investigators, have thought of the Sudan as being affected by drought from west to east, all along the productive central belt, data analysis has proven otherwise. Although most areas in Northern Darfur and Kordofan as well as the central region have had drought since sometime in the 1960s, Gedaref to the east, at a similar latitude, has revealed above-average rainfall continuously for about a decade. In fact, what caused the confusion in generalizing about drought-hit areas was the decline in productivity at Gedaref during the time of the Sudano-Sahelian drought when rainfall records at Gedaref were really above average. Because Gedaref is the main grain producer in the Sudan, its drop in productivity was perceived as a case of agricultural drought. In fact the case of Gedaref is rather complex. There, soil tests have proven no decline in fertility, but the decline in productivity at a time of above-average rainfall is explainable in terms of : (a) a decrease in rainfall effectiveness, because of the removal of the vegetative cover over vast areas for extended contiguous mechanized schemes which lack any sort of shelterbelt or vegetative demarcation and (b) lack of planning for the agricultural season and late sowing of seeds which is the main factor in crop failure.

Figure 1. Annual Rainfall in the Sudan 1941-70 (in mm)

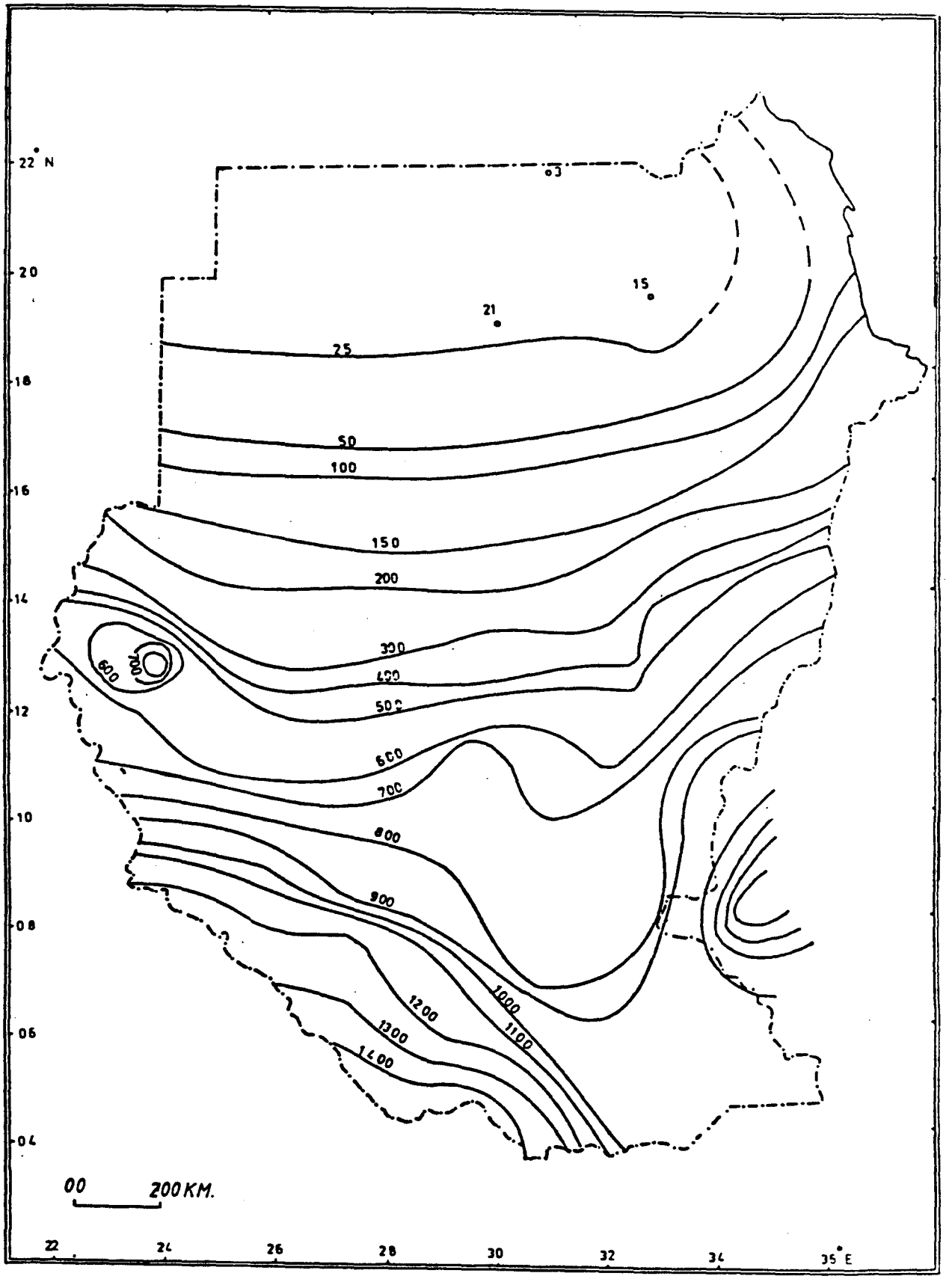
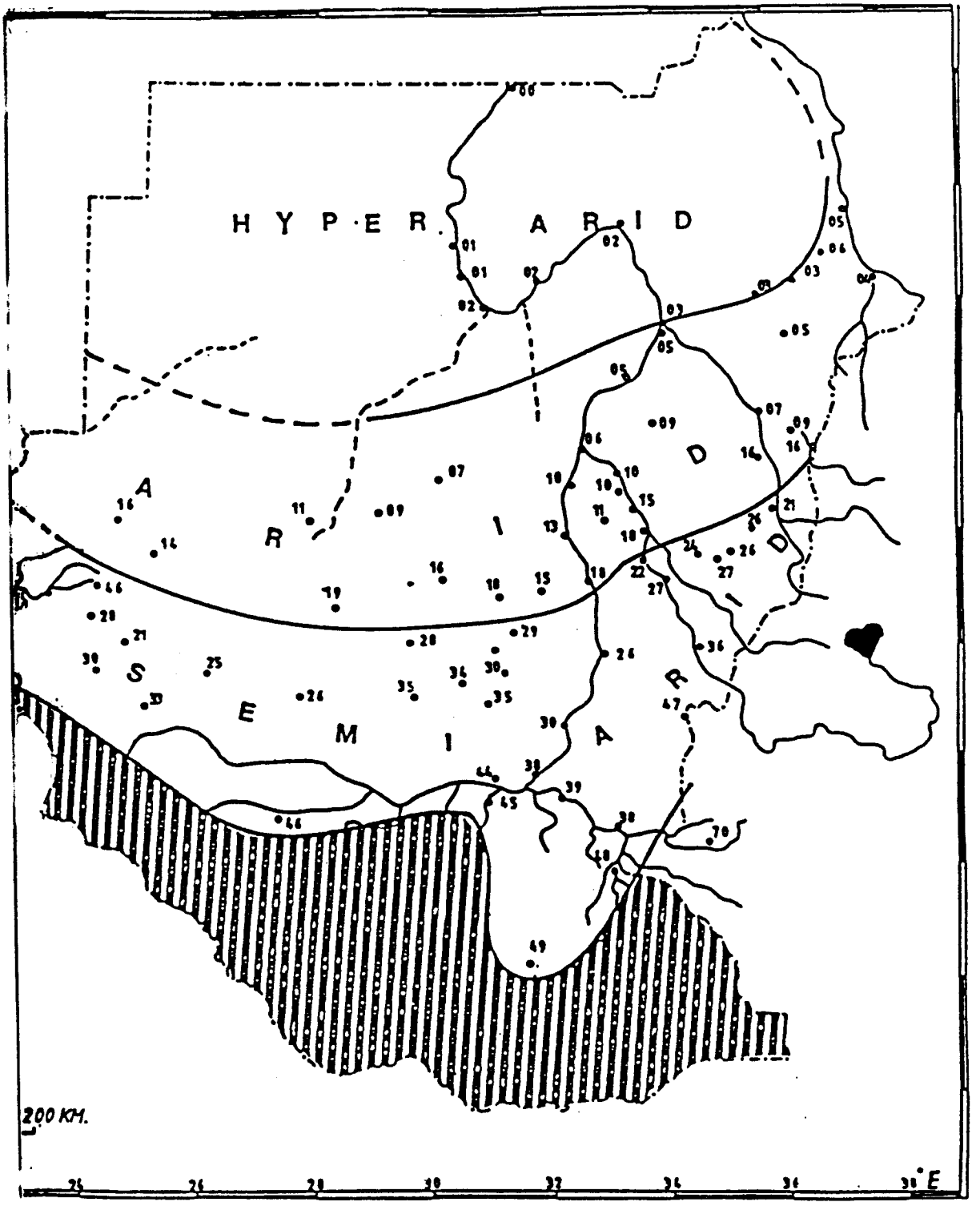


Figure 2. The Arid Regions of the Sudan

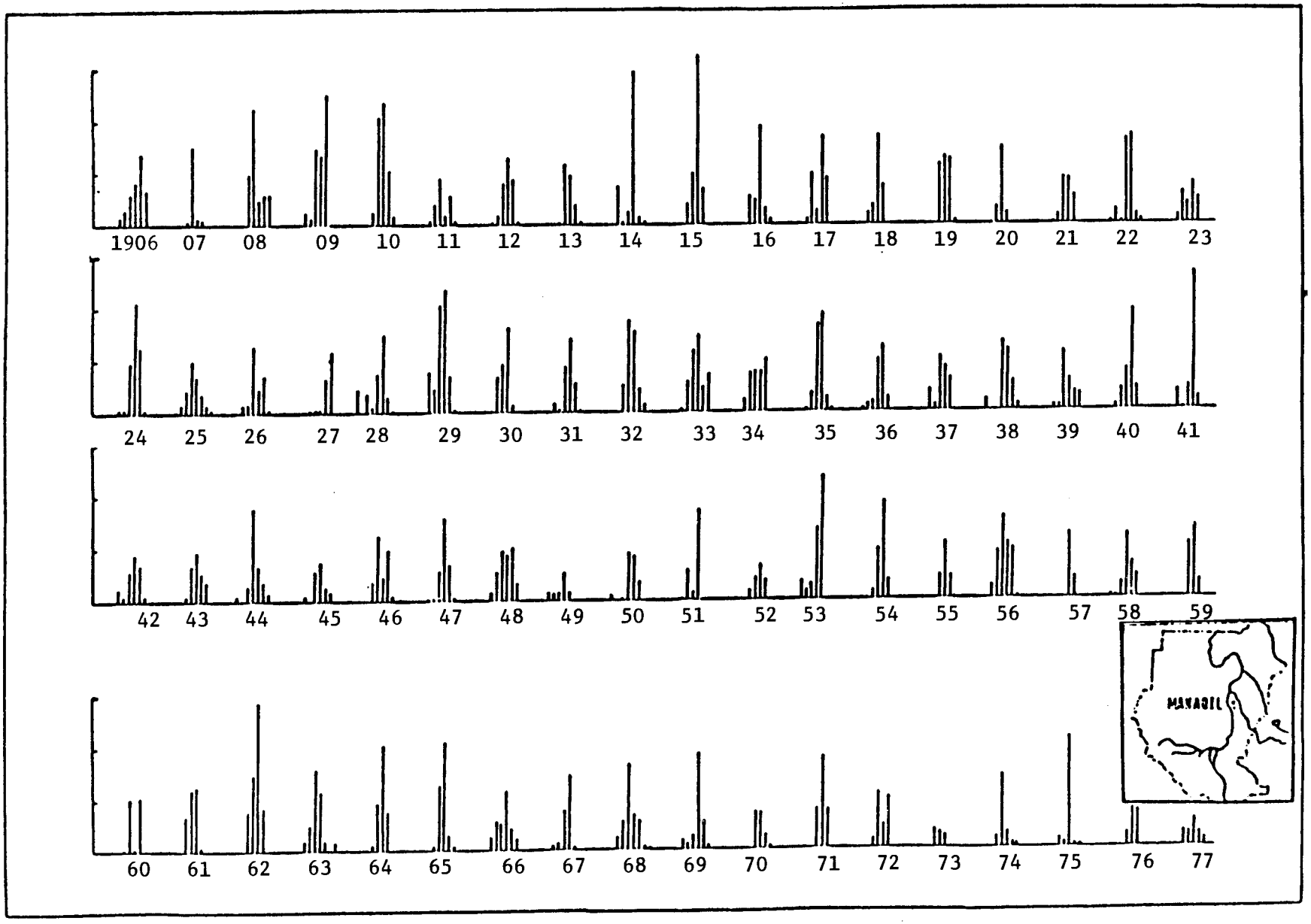


Based on WMO Adapted Indices

Table 1. Inter-station correlation of annual rainfall (Selected Stations)

	ZALINGEI	KADUGLI	KASSALA	EN-NAHUD	MALAKAL	KOSTI	GEDAREF	EL-OBEID	NYALA	WAU	EL-FASHER	W.MEDANI	GENEINA
ZALINGEI	1.0	.291	.196	.182	.136	.104	-.116	.475	.122	74	.274	-.093	.669
KADUGLI			.369	.669	.085	.087	.190	.392	.344	.196	.386	.100	.149
KASSALA				.479	.277	.483	.095	.570	.159	.002	.283	.486	.183
EN-NAHUD					.005	.140	.016	.423	.019	.275	.254	.083	.081
MALAKAL						.344	.113	.084	.088	.205	.192	.145	.041
KOSTI							.286	.336	.121	.073	.350	.616	.093
GEDAREF								.233	.520	-.060	.111	.300	.076
EL-OBEID									.391	-.047	.332	.313	.374
NYALA										.137	.384	.146	.314
WAU											-.072	.114	.113
EL-FASHER												.362	.507
W.MEDANI													.177
GENEINA													1.0

Figure 3. Monthly rainfall over Manaqil, Sudan 1906-1977 (in mm) showing the months April through October for each year



IMPACT OF DROUGHT

The impact of the drought from which Sudan is suffering at present has affected all categories of the population and their various economies. It has hit the rainfed sector most severely, especially the northern three belts lying in the 50-800 mm rainfall zone. Yet the irrigated lands and the urban centres have not been saved, as the displaced populations from the north have headed to them for refuge. Hence the impact of the drought, measured in food shortages, has placed stress on the existing administrative and service infrastructure, and caused urban upheaval, a rise in crime, delinquencies, and poverty. The 11.5 million people affected by the drought, once viewed in the above perspective, reveal the state of confusion the country has to face at present.

SHORT, MEDIUM, AND LONG-TERM DIFFICULTIES AND OPPORTUNITIES

The current drought in Sudan has had many repercussions, some of which have been directly felt and measured while others may be anticipated in the medium or long term judging from present trends.

Among the short-term difficulties faced by the country at present, the following seem to be the most prominent:

A Large Population is Affected

The estimated figures for population affected by drought, based on FAO Khartoum Office Statistics, are displayed in the following table by region:

Table 2. Number of people, by region, affected by drought.

Region	Receiving food aid	Population displaced
Darfur	2,870,000	500,000
Kordofan	2,830,000	425,000
Central	1,400,000	420,000
Eastern	1,500,000	400,000
Northern	-	25,000
Total	8,500,000	1,800,000

The figures clearly reveal the enormity of the problem arising from the current situation. Of all regions listed in the table, the two western ones, Darfur and Kordofan, account for 67 percent of the population suffering at present. Taking into consideration their remoteness and their limited opportunities to compensate for food losses from other land and water resources, gives clear evidence of the acute situation these regions face in the short run.

A Large Food Deficit

The official figures estimate a food consumption requirement of 3,485,000 tonnes of grain up to the next harvest in November 1985. Out of this amount, the shipments received at Port Sudan from the various sources of international aid are in the order of 1,028,000 tonnes, while domestic production is in the order of 1,471,000 tonnes, leaving a standing deficit of 986,000 tonnes. Grains are but one category of food. Other protein foods, especially milk, oil, and legumes, badly needed to curtail the high infant mortality rate, record large deficits too.

The Transportation Bottleneck

Food shipments arriving at Port Sudan, the main and only harbour of the country, need to be transported to the needy areas in the interior. Internal transport is handicapped by the long distances, the difficult road system, and the inefficiency of Sudan Railways. The distance between Port Sudan and El Fasher, the regional capital of Darfur, is 2200 km, and between the former and El Obeid, the regional capital of Kordofan, is 1500 km. The road system is only asphalted for a distance of 1200 km up to Kosti. For the rest of the way to the two capitals, trucks have to use earth roads which are difficult to traverse, especially during the rainy season - July to September. Sudan Railways which used to be one of the most efficient networks in Africa has deteriorated in the last decade. It presently performs at 30 percent of its capacity, carrying only 800,000 tonnes per month. Low as it stands, it is not fully devoted to the transportation of dura, with other commodities competing for space as well. Added to the low performance is the irregularity of the service, especially during the rains as rails are often washed away by torrents. Road transport, as a complement to rail transport, is interrupted by delays due to the high charges demanded by truck owners. Though the trucking capacity of the country is reasonable, the government finds difficulties in negotiating contracts with truck owners. Because of such handicaps, large amounts of dura are piled presently at Kosti, an internal terminal point of the national truck-road, awaiting transportation to the two western regions and the south. The southern region, apart from bad facilities for transportation suffers an insecure situation due to ongoing guerilla warfare which makes shipment of food supplies almost impossible.

Insecure Cropping Season

Regional governments, with the help of the national government and donor organizations, have exerted considerable effort toward rehabilitation of the affected population and the return of those uprooted from their home areas.

Great success has been achieved in this connection and the majority of the returnees went back with the early rains. The initiative was timed by the rural migrants themselves so that they might raise a crop on this year's rains. However, their plans have been undermined by a number of shortcomings, including the inadequacy of seeds for planting, particularly millet (the main staple food crop in the low-rainfall areas), the anticipated shortage in dura supplies to carry them through the rainy period up to harvest-time, their poverty in terms of cash needed for meeting other needs, and the unpredictable rainfall regime which might not suffice to produce a good harvest. All of these factors render the current cropping season in the drought-affected areas highly insecure until harvest-time comes and proves it otherwise.

Collapse of the Economic Bases

The drought impact on crop and livestock production systems of the affected areas has been complete degeneration of the economies of these areas. With the decline in production there occurred a collapse of the economic bases of the rural council units, followed by decay and disintegration of the government machinery and disfunctioning of services in those rural areas hit by the phenomenon. The explanation is simple. The rural council units used to generate their annual budgets for administration expenditures from sales taxes on crops and livestock. As the agricultural products failed to reach the local markets, no taxes were being collected. An evaluation of the budgetary situation of all local government districts in the drought-afflicted areas revealed without exception striking deficits in the current budgets of these districts. The deficits have been partially offset by central government resources but only to cover staff salaries and essential services, without any extras for the initiation of any development programs. Because of financial and food shortages none of the primary schools with boarding facilities in Kordofan region have opened yet, while the secondary schools in the same region suffer from acute shortages of teachers because salaries have not been paid in time.

Decline in Environmental Health

Many of the impoverished people who have lost their means of livelihood have fled to places of refuge, depending on the means available to them. Some have headed to nearby administrative or trade centres, others to regional towns, and many more to the national capital and the irrigated schemes. In all cases, the drive has been to make their presence known to the authorities and to be close to sources of food aid. This has led to the rise of temporary camp settlements in the outskirts of all these destinations. Most of these camps are quite sizeable, ranging from a few thousand persons to 65 thousand in the case of the one on the outskirts of Khartoum. (Some of these camps were evacuated on the initiative of the occupants when good rains were received, so that they could return to their places of origin to begin cultivation once more.) However, at many sites, including the one at Khartoum, people are still clinging to these camps. Being built out of necessity and by the occupants themselves, these camps lack the basics of human well-being. The shelters are poor, the amenities available are minimal, and environmental sanitation is completely lacking. The fact that these camps are overcrowded and that the occupants defecate in the

open is indicative of the dilapidated state of these shanty settlements. With the rainy season in progress, the outbreak of endemic diseases such as cholera is not a remote possibility.

Problems of Water Supply

Most of the rural areas in the rainfed sector suffer from shortages of drinking water for humans and livestock. The massive water-provision programs beginning in the mid 1960s, though alleviating the water-supply problem to a great degree, devoted little concern to the maintenance of the added water sources, mainly tube-wells. The situation has been seriously aggravated in the last 5 years with the result that rehabilitation programs of the regional water authorities are becoming a necessity. The recurrent droughts have strained the supply situation further. With the resultant crop failure and decline of living conditions in the villages, a sizeable portion of the uprooted population has moved to nearby small administrative centres which have also become centres for dura rationing. This development has led to a high congestion of villagers at these places and, consequently, to an acute water-supply shortage in many of them, most being equipped with sources only adequate to meet the needs of their original population.

Limited Employment Opportunities

As already stated, the drought has displaced large segments of the population. The highest priority for these individuals is to obtain food. But dura subsidies alone cannot sustain families and cash is also needed to satisfy other domestic needs. The migrants are without any cash in their hands and to earn money they take all kinds of jobs available to them. Since most of the places to which they head offer limited employment opportunities for migrants with poor skills, the majority end up unemployed. In sectors where no special skills are required such as cotton-picking in the irrigated schemes, the influx of huge numbers of migrants has diluted wages for those segments of the population who traditionally work on these schemes.

Devastation of the Tree Cover

Migrants who have headed to regional towns and small intermediate centres within regions affected by drought have resorted to the cutting of trees and the selling of fuel wood and charcoal to the town's people of these centres. This practice has led to immense devastation of the tree cover and recovery of such lost vegetation is not likely within the foreseeable future, especially if the drought continues and alternative sources of income are not provided.

Loss of Livestock

The livestock of the semi-arid areas have perished in large numbers due to pasture failure. In many areas, there have been adequate drinking water supplies for the animals but no natural forage around these sources. It is estimated that about 90 percent of the cattle population and about 25 percent of the sheep population of the semi-arid belt died last year. The failure of the

staple food crops, i.e. millet raised by the nomads and the semi-nomads, coupled with the scarcity of dura raised in other areas or imported and its inflated prices, forced the livestock-raisers to exchange many units of animals to obtain smaller amounts of grains. This diminished the value of livestock considerably during the dry months following the bad harvest and resulted in a general decline in the size of herds. The integration of livestock-raising and crop-production in the traditional sector, facilitated in normal years through the market exchange system, has been devastated by the drought. An important lesson to be drawn from this experience is that neither of the two economies can be maintained productively without being balanced by the other. Dura is not only needed for humans but as an essential feed for livestock. If the cost of obtaining dura to maintain human lives means the exchange value of so many units of animals, purchasing dura as feed for livestock is practically impossible.

Transferring the Adverse Effects South

The lands lying south of all three regions affected by drought are ecologically richer and of low human population density. They have attracted large communities of farmers and nomads in addition to most of the livestock raised in the northern parts. As a short-term alternative, these lands have provided refuge for migrating populations from the north. The focal points of concentration have been the places where water supplies exist. Since the water sources in these areas are very localized, the movement southward has resulted in a concentration of migrating elements around certain spots. This has prompted land misuse and an overstocking of animals at these places. Communities in the southern areas are already complaining of the bad practices introduced by the migrant elements from the north. Incidents of conflict between the two populations have been recorded. If this trend of heavy utilization of the southern areas continues, the ecological devastation which has taken place in the northern areas will expand southward.

These are some of the difficulties presently faced by Sudan. They present quite a spectrum of problems of varied nature and magnitude. Some of them relate to government policies and efforts to maintain communities affected by drought and rehabilitate the displaced populations. Others are specific and directly relate to ecosystem devastation originating from the misuse of the natural resources and the imbalances caused by the long-term effects of desertification which have been accelerated by the recent drought. However these difficulties are categorized, they have direct social and economic repercussions on the national economy, the country's priorities, the running of the government systems, and on the average citizen in both affected and non-affected areas.

To attempt classification of these difficulties into short, medium and long-term categories is not an easy undertaking because of the unpredictable nature of drought. Some of these difficulties such as the reduction in the size of population affected as a result of a successful crop this year, deficit in grain supplies, transportation bottlenecks, insecure cropping season, decline in environmental health, limited employment opportunities, and problems of water supply may be singled out as short or medium-term problems. Those relating to the collapse of the economic bases, devastation of the tree cover, loss of livestock, and the transfer of the adverse effects south may be referred to as medium and long-term effects.

OPPORTUNITIES

Opportunities arising from the drought situation include the following:

Increasing Awareness of the Problem

The rainfed lands and their economies have long been neglected. These lands have usually been looked upon as the traditional sector and have received little attention in terms of agricultural development. The kind of organized development which has been expanded on a large scale has been mechanized sorghum farming mostly carried out by big investors. The advancement of the indigenous economies and the traditional users of the land have received little attention. The provision of social services and community amenities has continued to be the only form of intervention in these traditional areas. The drought has drawn attention to the problems faced by this sector. This awareness is growing at all levels: the users of the land, the technical departments, the regional authorities, and the national government, as well as the international community. Ideas, plans, and policies addressing questions of the rational use of resources and balanced utilization of ecosystems are being revived and held up as national priorities. The line of action adopted by the government has been to aid the affected communities and rehabilitate the ecosystems for long-term sustained growth.

Development of Scientific Capabilities

The drought has always been an intrinsic feature of rainfed economies. However, it has usually been a localized phenomenon of short duration. The prolonged incidence of drought during the last five years has at last initiated the need for a scientific handling of the problem. The country's technical capabilities are not comparable to those of the advanced nations in research of the problem and creation of the necessary alarm systems for prediction of natural calamities and mobilization of resources for quick action. Yet stemming from the official awareness of the magnitude of the problem, there has been a definite shift in attitude towards a scientific solution. This is gaining momentum at present through seminars, workshops, revival of studies and plans, integration of ongoing and proposed projects, attempts at formulating regional and national plans for combating desertification, and the creation of a national authority to integrate programs of food aid and rehabilitation.

Support of the International Community

This aspect of the drought stands as one which holds hope for future action. The ordeal itself has been instrumental in eliciting a demonstration of world solidarity beyond political and ideological boundaries. Drought has proven that we are the children of one planet sharing the same fate, irrespective of poverty and wealth.

We in the Sudan at all levels strongly believe that the international community may not be able to help us forever. We need to help ourselves and build more stable economies by expanding our agricultural production to secure staple foods

for the rural masses. In our strategies, we need to give more attention to the small traditional farmers and livestock raisers. They are the ones hit hardest by drought, not the producers on our irrigated schemes. We want the world community to share our concern for the small producer who offers the only possible security against repetition of this sad phenomenon in the future. We advocate a revision of current agricultural policies and investment priorities in the Third World to reflect a shift in focus toward the small producers.

Optimism about a Good Agricultural Season

There are high hopes that this agricultural season will yield a good harvest. The incidence of rain has so far been satisfactory. Reports from different parts of the country are that rains have been adequate and that crops are well established. The prospects of a good crop increase as we move southward following the natural regime of the rains. Also, large areas of our irrigated schemes are under intensified dura cultivation to raise additional grain supplies. Both developments will increase the opportunities of the country to produce more grain. By how much is difficult to say; only after the harvest will we be able to answer that, but we remain optimistic.

NOTES

(1) Qoz-country means vast areas covered by stabilized dunes in Kordofan.

IMPACT OF DROUGHT IN WESTERN CANADA

R.C. McGinnis
and
D.F. Kraft

DROUGHT AND PRAIRIE CROP YIELDS

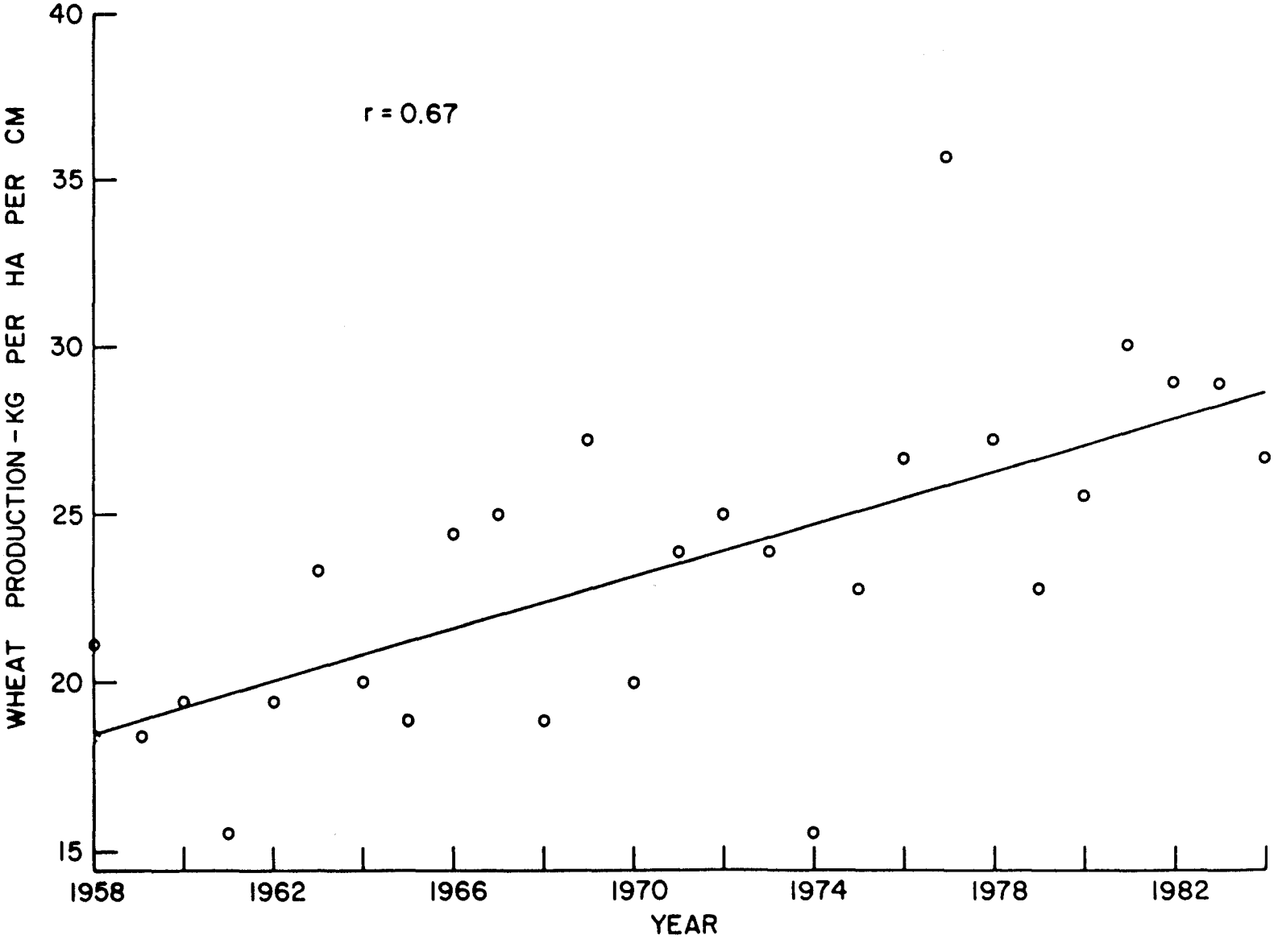
Drought conditions are normal events in western Canada. The prairie interior is a semi-arid region where evapotranspiration exceeds summer rainfall and soil moisture is replenished during the fall and winter months. During the twentieth century the recorded and estimated moisture shortages have ranged between 30 mm and 500 cm. Despite the risk of drought, prairie agriculture has expanded from minimal crop production at the turn of the century to the point where 33 million hectares, or 75 percent of area suitable for crop production, is cultivated today. The uncultivated soils suitable for crop production are not found in areas most subject to drought but where frost is a greater risk.

Cereal grains, oilseeds, and forage production expanded not only because more land was cultivated but because over the past 25 years crop yields have increased 1.5 percent annually. Hedlin and Tokarchuk (1985) assessed the change in water use efficiency for wheat and barley between 1958 and 1984. They estimated the annual yield increases per centimetre of precipitation ranged between 1 and 3 percent. Figure 1 illustrates that Saskatchewan wheat production was estimated to increase from 19 kilograms per hectare per centimetre of water in 1958 to 28 kilograms per hectare per centimetre of precipitation in 1984. Kraft and Fields (1983) assessed the influence of weather on crop production by explicitly accounting for soil moisture conditions, fertility, genetics, and crop rotations. Soil moisture shortfalls were defined to be the difference between the daily moisture required by the crop and the level provided by the soil. The daily shortfalls were added together for each stage of crop maturity. By isolating the year-to-year effects of weather on farm recorded yields, Kraft and Fields (1983) were able to estimate yields if farmers had used different technologies. An illustration of the Kraft and Fields (1983) measurements is shown in Table 1.

Table 1. Farm wheat yields in southwestern Manitoba for different technologies and weather conditions (tonne/hectare).

Seedbed	Normal weather 1980 technology	1961 weather		
		Actual	Forecast	Forecast 1980 technology
Stubble	2.03	0.50	0.59	1.12
Fallow	2.42	0.93	1.11	1.99

Figure 1. Wheat produced in Saskatchewan in kg per hectare per cm of precipitation for the years 1958 to 1984.



The southwestern region of Manitoba is illustrated because this area is subject to drought conditions more frequently than other areas in the province. The most severe drought recorded was in 1961. In 1961 the farm wheat yields averaged 0.5 tonnes per hectare for stubble seeded crops and 0.93 tonnes per hectare on fallow land. The corresponding yields estimated for the 1961 weather conditions, fertilizer applied, and varieties of wheat seeded by farmers were 0.59 tonnes per hectare and 1.11 tonnes per hectare. If farmers had seeded the same varieties in 1961 as they did in 1980 and followed the 1980 fertility and weed control practices, the estimated wheat yields under 1961 growing conditions would have been 1.12 tonnes per hectare on stubble and 1.99 tonnes per hectare on fallow. Wheat yields for stubble seeded crops would have been 90 percent higher if 1980 technology was available to farmers in 1961. Fallow seeded wheat would have increased by 80 percent. In 1984 severe drought conditions limited crop production and the average wheat yields were comparable to 1980 technology estimates shown in Table 1.

The effect of drought on crop yield is determined by comparing the yields estimated for 1961 weather conditions to normal weather conditions. Under normal weather conditions, wheat stubble yields are estimated to be 2.03 tonnes per hectare or 81 percent higher than the drought yields. Historically, summer fallow has been practised widely in areas more frequently subjected to drought conditions. Summer fallow has the potential of storing up to 50 mm more soil moisture than land cropped in consecutive years. Despite the moisture conserving advantages of summer fallow, the cost of not producing a crop has resulted in fewer and fewer hectares being fallowed in the prairies. In 1961, 34.5 percent crop land was summer fallowed in the prairies. By 1985, only 21 percent of the land base is fallow. Therefore, the trend to more intensive cropping has subjected farmers to greater year-to-year yield variability.

The main factors underlining the growth in cereal grains and oilseed yields include:

Variety Improvement

Plant breeders have been successful in incorporating genes - for higher yield and more stable yield, earlier maturity, disease resistance - and drought tolerance into crop varieties, all of which enhance water use efficiency.

Weed Control

With the advent of modern herbicides, farmers can produce crops under weed-free conditions. A wide choice of herbicides suited for the control of specific weed problems is available. This has led to a rapid increase in herbicide use with the concomitant increase in water use efficiency. Water that at one time supported a weed population is now going into crop production.

Fertilizer Use

An adequate nutrient supply results in increased crop growth per unit of time. Soil testing of farm fields to determine fertilizer requirements is a common and accepted practice by farmers today who recognize the importance of a good fertilizer regime.

Reduced tillage

More farmers are reducing tillage operations and although research data on the effect of reduced tillage is limited, the increase in trash cover would decrease water lost by evaporation. In addition, snow trapped by the stubble would be less subject to spring runoff and become available for crop production. The soil is also less susceptible to erosion. All of these factors should contribute to higher water use efficiency.

Timeliness of Farm Operations

With the advent of sophisticated mechanization, farmers can respond rapidly to take advantage of favourable weather conditions in their farm operations. There has been a trend to earlier planting to utilize the early spring moisture and to permit earlier harvest before threat of frost. Operations that used to take a week or two can now be done in a day and done better as well because of the improved implements. The importance of "timeliness" cannot be over emphasized.

DROUGHT AND THE AGRICULTURAL ECONOMY

The prairie agricultural economy is subjected to similar drought conditions as other semi-arid regions in the world. However, few areas export a larger share of total crop production. A drought in a nation importing some grains, oilseeds, and animal products increases the dependency upon international trade. An exporting region, like the prairies, transfers the drought-affected production levels directly into reduced supplies available to export. Customers normally importing grain from Canada must seek alternative sellers. All of the drought-reduced supply is withdrawn solely from the export market and minimal internal adjustments are required by domestic buyers. Regional shortages of feed grains often result in farmers buying grain from other areas in the prairies rather than imports. This section will outline the economic setting affected by a prairie drought.

Table 2. Supply and disposition of Prairie grains and oilseeds (million tonnes).

	Annual average 1980/81- 1984/85
Production	40
Shipments	29
Prairie processing	3
Prairie farm	8

Table 2 shows the combined supply and disposition of wheat, barley, oats, canola, and flaxseed. The five major grains represent 97 percent of total prairie crop production. Between 1980/81 and 1984/85 grains and oilseed production averaged 40 million tonnes, and 29 million tonnes or 72 percent of the average available supply was exported from the prairies. Domestic uses in the prairies consisted of some industrial processing of wheat, barley, and canola and on-farm use of livestock feed and seed. Domestic use remains unchanged essentially when total crop production is reduced. In the 1984/85 crop year production fell by six million tonnes and total shipments dropped by a comparable level. Importers had to turn to alternative sources of supply.

Whereas prairie users of grain and oilseeds are not forced to adjust to a reduced supply, the economy is affected indirectly as farmers adjust to lower income levels. The economic circumstances, prior to the drought-reduced supply of grain, are paramount in identifying how the economy will be affected. The wealth of the farm community measured in terms of the assets invested in grain and forage inventory, farm machinery, livestock, and savings, buffer the economic impact of reduced crop yields. Stocks of grain or forage represent a ready liquid asset which farmers may draw upon to offset drought-reduced production. Prior to 1981/82, prairie farmers frequently built up stocks of grain above levels they deemed to be desirable because either the transportation system was inadequate to export the available supplies or international sales failed to materialize. These forced savings of grain effectively buffered the prairie economy from fluctuations in supply during the 1960s and 1970s. However, an expanded grain handling and tansportation system will allow farmers to export more of their grain. The potential increased income variability introduced by the expansion has been realized in 1984 and 1985. In both years severe drought conditions in some prairie regions caused the reduction in exports.

Forage production consumes more soil moisture than cereal grains or oilseeds. Beef cattle production is most vulnerable to changes in forage production because half of their consumption is summer pasture and the remainder is hay harvested in the summer and fed during the winter. A shortage of pasture coincides with lower hay yields. Inventories of forage stored from one year to the next buffer the impact of drought. Since minimal amounts of forage are exported, the adjustment to the reduced supplies must be made by the domestic livestock industry.

Accelerated culling of the beef cattle breeding had often served two purposes, namely, reduced forage requirements and an infusion of money to offset lower grain sales. Selling some of the breeding herd can offset some of the immediate loss in income but the effects are transferred into the future as fewer cattle are available for sale.

Farm machinery replacement can be postponed if the equipment is relatively new and not subject to frequent repair. Many farmers are able to delay farm machinery purchases during drought conditions but eventually the equipment wears out. A farming economy with relatively new equipment can better withstand the immediate loss in income than one where the equipment has been allowed to depreciate with age and use.

Drought affects farm expenditures on variable inputs less than capital items. Because prairie drought conditions are not linked to a two or three year cycle, farmers anticipate crop yields will return to normal levels in years following a drought. Therefore, expenditures on fertilizers, seed, pesticides, and other variable inputs do not change unless operating credit is limited. Furthermore, crop insurance premiums guarantee that most variable crop production costs will be met by damage claims if the yields are reduced by drought. The only expenditures normally influenced by drought are lower payments to grain companies and railroads for handling less grain and higher outlays to the trucking industry for transporting hay between surplus and deficit regions.

A study by Kraft et al. (1985) measured the farm and off-farm impacts of drought on the Manitoba economy. It also developed a framework for analyzing policies to mitigate the effects of drought. The framework is set out in Figure 2. An economic model of the provincial agricultural economy esitmates farm income, variable crop and livestock expenditures, capital purchases, and farm debt. These estimates are linked to simulated decisions that farmers are likely to make given a set of economic and drought conditions. The economic setting was 1979 while the sequence of weather events represented conditions between 1936 and 1940. Farm purchases are linked to the rest of the provincial economy through input-output models which estimate regional income and employment levels.

Table 3. Economic impact of drought on the Manitoba economy.

	Normal weather ($ billion)	Drought (% of normal)	
		Year 1	Year 2
AGRICULTURAL INCOME			
Crop sales	1.2	0.94	0.88
Livestock sales	0.5	1.26	1.04
Crop expenses	0.8	0.98	0.96
Livestock expenses	0.2	1.10	0.88
Farm machinery	0.2	0.99	0.87
Debt	0.1	1.00	1.00
Farm income	0.4	1.03	0.69
AGRICULTURAL ASSETS			
Grain inventory	0.7	0.75	1.00
Forage inventory	0.1	0.61	0.97
Farm machinery	1.3	0.99	0.98
Livestock	0.9	0.87	0.77
PROVINCIAL ECONOMY			
Income sectors linked to agriculture	2.1	0.95	0.92
Unemployment (%)	4.7	1.13	1.15

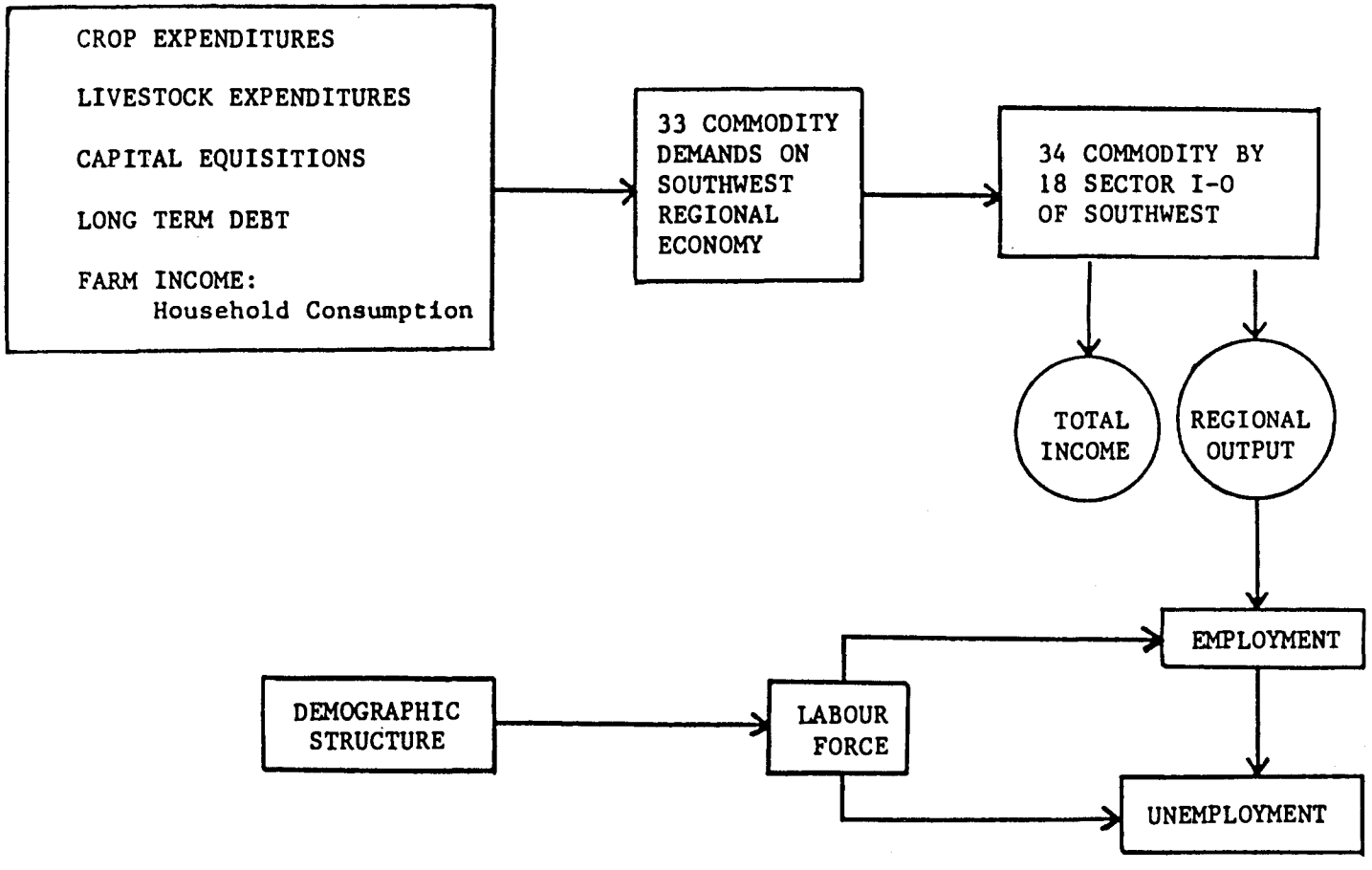


Figure 2. Framework for analyzing policies to mitigate the effects of drought.

Table 3 shows the simulated effects of the drought conditions in 1936 (Year 1) and 1937 (Year 2) relative to average weather conditions. The calendar vear rather than crop year is the point of reference. Under normal weather conditions farm income is expected to equal 0.4 billion dollars. The first year of the drought income was forecast to increase by 3 percent because an expansion of livestock sales (26 percent) offset lower crop sales (6 percent). The growth in livestock sales was at the expense of the beef herd as the total value of livestock on farm fell by 13 percent. Despite the herd reduction, livestock expenses grew by 10 percent in the first year of the drought because of higher ration costs. Crop sales fell to 94 percent of their normal level. Grain sales were maintained at normal levels from January inventories until the drought-reduced crop was harvested in August. The impact of the drought in Year 1 is reflected in the year-end inventory of grain and hay. On December 31 of the first year of the drought, grain stocks were at 75 percent of their normal level while hay supplies dropped to 61 percent. The lower grain stocks appear in the reduced sales (88 percent of normal) in the second year. Farm income plummeted to 69 percent of the normal level as continued herd dispersal was insufficient to counter reduced crop sales. Crop-related expenses dropped because less grain was sold while livestock expenditures declined to 80 percent of normal as fewer animals were available. By the end of the second year of drought, the livestock population had dropped to 77 percent of the level maintained in normal weather conditions. Grain and forage inventory returned to normal levels at the end of Year 2 because the drought in 1937 was limited to only the northwest region of the province.

Farm machinery purchases failed to keep pace with depreciation and the value of all equipment declined 2 percent by the end of Year 2. Whereas 2 percent appears to be a relatively small drop in farm machinery assets, it presents a catch-up of 24 percent in future years. Farmers normally buy 0.2 billion dollars of equipment each year but these purchases will have to exceed 0.2 billion by 50 million dollars to replace the equipment not purchased in the drought years.

Impact of the drought beyond primary agriculture occurs because farmers reduce expenditures for the farm and household. In Manitoba, 2.1 billion dollars of output is linked to the agricultural sector. Income levels for the wholesale and retail sectors are affected relatively more than manufacturing, utilities, and personal services. The transportation and storage sector is the main service industry adversely affected by reduced grain shipments. Unemployment levels increased from 4.7 percent to 5.4 percent because less nonfarm labour is required when farm output declines. Therefore, the absolute drop in nonfarm income is comparable to the loss in farm income. The victims of drought extend beyond the farm gate.

DROUGHT-TOLERANT CROPS: THEIR NATURE AND VALUE IN DROUGHT SITUATIONS

H. Doggett

The two most important factors influencing crop growth and therefore crop yield, are water and temperature. A measure of the efficiency of water use is the ratio of yield (generally total dry matter) to water loss. Water may be lost from the crop through ordinary evaporation from the plant surfaces and from the soil, and also through transpiration, the loss of moisture from the interior of the plant through the stomata. One measure of the relationship between crop yield and water use is Water Use Efficiency, or WUE. This is defined as the ratio

$$\frac{\text{Yield (dry weight)}}{\text{Evapotranspiration}} \text{ or } WUE = \frac{Y}{ET}$$

Temperature affects the rate of evapotranspiration, and also the rate of the plants' photosynthesis and respiration. Temperature effects are difficult to separate from water loss effects, so that drought, especially in the tropics, is the resultant of both water loss and temperature levels. A prolonged spell of sunshine results both in increased evapotranspiration and higher temperatures. When water gets short within the plant, the cooling effect of transpiration is lessened, the stomata usually close, and so the temperatures of the plant tissues rise.

Plants which can grow successfully in drought situations usually have mechanisms to diminish transpiration during dry spells. They also possess cytoplasm that can survive periods of high temperature, and recover their normal function quickly when the drought has ended. Root systems are also important, and must be able to scavenge efficiently for water. They are often well branched and occupy the soil volume rather fully. Some crop plants' roots may penetrate deeply and be able to take advantage of moisture at depth. Water loss that cannot be replaced from the dry soil results in very powerful tensions within the root tissues, and these may collapse irreversibly unless internal thickening is strong enough to withstand the forces. We expect plants adapted to drought situations to have special mechanisms to endure heat and to reduce water loss. They must possess a root system able to recover from drought when water is once more available in the soil.

We shall not look in detail at drought resistance mechanisms. However, it is important to emphasize that the ability to endure drought results from the integration of a whole series of morphological and physical characteristics, and is very complex. Plant breeding is sometimes credited with miraculous powers. "Breeding for drought resistance" to some laymen sounds just as straightforward as breeding for shorter plant height, or for resistance to a disease such as rust in wheat. The procedure is expected to result in substantial yield

increases. Nothing could be further from the truth: the dry matter yield potential is determined by the moisture available and the temperature regime, subject to satisfactory soil conditions and to nutrient requirements being met. It is indeed possible by breeding to bring about steady improvement in the performance of drought-resistant plant species; but there is nothing revolutionary in sight, no "drought revolution" from plant breeding.

CEREALS

All cereals are most vulnerable to drought damage during the period of inflorescence development and flowering and the timing of this growth period is of critical importance. In the Great Plains of the U.S.A., wheat grows during a cool part of the year and avoids the worst stress by maturing just as the hottest and driest period of the year begins. Sorghum, by contrast, is planted in the spring and grows through the hot summer. The optimum temperatures for wheats are about 5°C below those for sorghums. Further, the WUE for sorghum is about double that for wheat: sorghum can produce twice as much dry matter as can wheat for the same quantity of available moisture. This is shown in Table 1.

Table 1. Water use efficiency of wheat and sorghum

(Hays, Kansas, period 1966 - 1976)

	Irrigation water (ha-cm)	WUE (kg grain/ha per cm of water)
Wheat		
	42	44
	48	50
	51	50
Sorghum		
	36	75
	39	81

Other figures from the Great Plains show that sorghum has better WUE than does maize when the water supply is reduced. Measurements at Samaru, Nigeria, showed that pearl millet used 330 mm of water in 85 days, maize 486 mm in 117 days, and groundnuts 438 mm in 125 days. The millet produced 1 kg of dry matter for every 148 kg of water used, the maize used 353 kg of water, and the groundnuts used 518 kg of water to produce 1 kg of dry matter (Eastin et al. 1983; Elston and Bunting 1980).

Timing is the key factor for successful cropping in drought areas. Plant breeders can often develop crop types that match the period during the rainy season when the chances are highest that there will be enough rain. Usually this involves developing varieties with short maturity length. In this way, optimum dry matter production can be obtained in many seasons. Photoperiod sensitivity is the major factor in controlling the appropriate maturity length for many tropical crops. Flowering is triggered by appropriate night and day lengths, so on average takes place at the appropriate time before the rains have ended. Further, plant breeders can select varieties that partition the dry weight produced so that there is more grain and less straw, i.e. the harvest index is higher. That may not always match best the needs of the livestock owners, who need the straw as feed.

Maize can sometimes be adapted to fit the rainfall pattern of dry areas in this way. Thus, at Katumani in eastern Kenya, Dowker developed a short-term maize that could use the two months of reliable rain that fell, producing consistent, modest yields. However, maize is not able to withstand much water stress, especially during the reproductive phase. Maize tissues themselves appear to be more heat tolerant than are those of sorghum, but its stomata close tightly, shutting off transpiration, so there is no cooling. Sorghum stomata remain slightly open, and slow transpiration keeps the tissues cool enough to survive.

Plant breeding can do a great deal to correct weakenesses to minimize the losses from the yield-reducers. Resistance to diseases and pests can make a big contribution. In millet, downy mildew, ergot, and smut can take a heavy toll. Charcoal rot, bed rot, anthracnose and sooty-stripe can be damaging to sorghum. Millet is troubled by earhead caterpillars, and to some extent by stem-borers, although these are much more serious in sorghum, as are midge and shoot-flies. Plant breeding has already made good progress in helping to reduce crop losses from such causes. In cowpea, photoperiod insensitive types may show good adaptation to the drier areas: bruchid disease and striga resistance are being transferred to the best of the traditional photoperiod sensitive types. Dwarf Pigeon Pea developed in India has become a relatively short-term crop when planted for the rabi season (Rai and Witcombe 1985).

Witchweed (Striga) causes serious crop loss on sorghum, millet and cowpea in Africa, the extent of which has been overlooked for a long time. Plant breeding can do much to reduce this, but again, must not be isolated from the importance of improved inputs. Given the regular use of high inputs, Striga is a far less important parasite, but during the long period while input levels are increasing, Striga resistance has a key role to play.

Pearl millet is more efficient in water utilization than is sorghum, and also has higher heat tolerance. Some types have a very short duration of growth, as little as 70-80 days. Pearl millet spends less of its life cycle in the vulnerable reproductive stage - one quarter of its maturity length as compared with one third for sorghum. Also, the grain-filling period of pearl millet is some 15-20 percent shorter than in sorghum. Thus, the two major cereals best adapted to drought conditions in the tropics are pearl millet and sorghum, but grain production depends upon the amount of water available.

SORGHUM

More is known about genetic differences in drought response for sorghum than for pearl millet. The cv Shallu (a Guinea type) performs poorly under drought stress. Others, such as CK60 (a Kafir) and the hybrid RS610, continue to complete their life cycle fairly normally, in spite of the stress. Yet others are able to utilize stored soil moisture extensively, and some of these expend relatively little of their total water use during the pre-flowering period. Examples of these are Feteritas (Caudatums) and Durras, including the Indian type M35-1. Genotypes differ by as much as 20 percent in the amounts of stored soil moisture extracted (Blum 1974).

Hybrid sorghum deserves more attention in drought-prone areas. In 1969, I reported that hybrids show a constant yield increase compared to varieties over a wide range of yield levels. Results are shown in Table 2 and in Figure 1 (Doggett 1969).

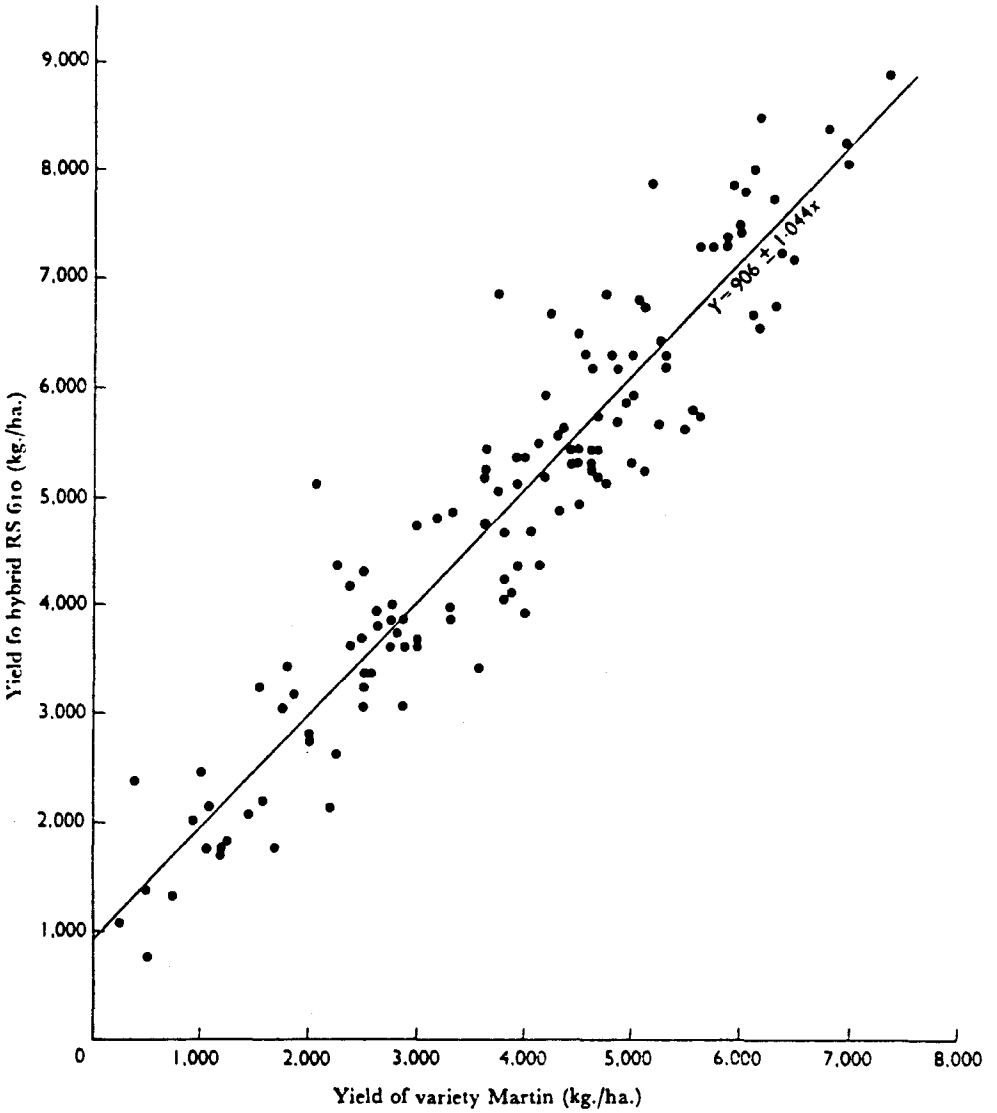


Fig. 1. Grain yield of the hybrid RS 610 plotted against the yield of variety Martin in the U.S.A. (based on data from Texas, Kansas, Nebraska, Illinois and Arizona in 1955, 1956, 1957, 1958, 1959, 1964 and 1965).

Table 2. The relationship between Sorghum Hybrid and variety grain yields(kg./ha.)

	COUNTRY					
	A	B	C	D	E	F
	East Africa[1]	U.S.A.[2]	Rhodesia[3]	Rhodesia[3]	East Africa[1]	India[4]
a. Hybrid	H×58	RS 610	NK300	NK300	H×57	CSH–1
b. Variety	Serena (pollinator parent)	Martin	Framida	Red Swazi	SB65 (pollinator parent)	Local check varieties
c. Mean variety yield	2095	3820	3925	3560	1475	1835
d. Lowest variety yield	475	250	180	940	370	120
e. Highest variety yield	5715	7400	9320	6860	4250	5330
f. Mean hybrid yield	2590	4895	5740	5740	2185	2460
g. Regression for yield of hybrid on variety, b=	1·034±0·086	1·044±0·034	1·036±0·118	0·926±0·297	1·253±0·082	0·663±0·108
h. Mean yield increase for hybrid over variety	495	1075	1815	2180	710	625
i. Number of trials in sample	42	128	32	32	81	76

1. Data from 'Record of Research', *Ann. Rep. E. Afr. Agric. & For. Res. Org.*, Kikuyu, Kenya, 1964 to 1966.
2. From trial reports available at Serere from Kansas, Illinois, Texas, Nebraska and Arizona, 1956 to 1965.
3. From *Ann. Rep. Matopos Res. Sta.*, Rhodesia, 1961–1966.
4. From *Progress Reports Accelerated Hybrid Sorghum Project*, 1961–62, 1962–63, 1963–64 (Indian Council of Agricultural Research and Cooperating Agencies).

It will be seen that even in East Africa and India 15 years ago, hybrids showed a constant yield advantage of 495, 710, and 625 kg/ha either over one parent or over a widely grown variety. In the U.S.A. and Zimbabwe, the yield advantage was greater, but so was the whole level of inputs and management. This deserves more study: the right hybrid might have a useful contribution to make towards yields in drought areas. Certainly the U.S.A. has gone over to hybrids, although much of the crop receives some irrigation (Doggett 1969).

The problem of hybrids in Africa is seed production, distribution, and sale to farmers, coupled with the need to educate the farmer to buy new seed every year. When I started the ICRISAT sorghum program in 1973, I chose the route of population improvement. The sorghum material from the populations would provide excellent hybrid parents, and when the national programs were in a position to develop such hybrids, they would also be in a position to undertake the necessary seed production and distribution without which hybrids could never be adopted. Meanwhile, farmers could use the varieties and synthetic varieties developed from the populations. ICRISAT is putting a lot of effort into this population improvement breeding in sorghum.

OTHER CROPS FOR DROUGHT AREAS IN AFRICA

Cowpea is a valuable crop for dry areas: again, a short duration of growth may be one valuable factor, although crop durations vary from 60 to over 140 days according to variety. There is a strong tap root, a well developed rootsystem, and excellent nitrogen fixation capacity. Tepary beans are also useful in very dry areas. Pigeon pea is grown in dry areas of eastern Africa, but has not yet caught on in West Africa. Its roots are able to follow the receding water table.

Cotton can be another valuable crop, but it is important to use a cultivar which can be so managed that the early flowering period of the crop coincides with low moisture stress.

Sesame (Simsim) is a drought-tolerant crop, once it has been established in the field. There may be scope for growing this crop more widely in the northern Sudan zone.

Groundnuts can produce well under moderately dry regimes, but WUE is lower than for maize.

Castor and safflower can crop under difficult conditions on rather deep soils, with good water-holding capacity. Their roots are able to follow the water table down. There is probably scope to use these more widely in some of the flood plain and fadama areas.

POLICY ISSUES

The most important factor determining the type and abundance of vegetation in Africa is the amount and distribution of rainfall. Table 3 shows the grain yield potentials of various rainfall zones in the tropics, assuming moderate phosphate and nitrogen fertilizers, and no serious yield loss from pests and diseases.

Moisture levels in the lowest rainfall zone shown in Table 3 impose an upper limit on yields. Perhaps we hope to make some progress in obtaining rather better yield stability by using drought-enduring or drought-avoiding crops: but even if a 20 percent mean yield increase were to be obtained by this means, that would be worth only 260 kg of grain per hectare. Further, such an improvement is likely to make little impact on the frequency of crop failures. Move to the next rainfall belt, and a 20 percent mean yield increase is worth 600 kg/ha of grain: that might well lead to a slight reduction in the frequency of crop failure. Taking the whole range of the table, an average yield increase of 20 percent in the lowest rainfall zone gives 260 kg/ha, with crop failure still in the order of one year in three. An increase of 20 percent in the highest rainfall zone is worth 1.6 t/ha, and crop failures are very rare. Clearly, the most profitable regions in which the invest the money available for the improvement of crop production lie in the higher rainfall zones. Larger increases in the amount of grain produced can be obtained more easily, and for lower research and development costs. Inputs will be better used and will very seldom be wasted through drought-induced crop failures.

A glance at a rainfall map of West Africa shows high, reliable rainfall in a belt along the Gulf of Guinea, and roughly parallel to it. The rainfall decreases in amount and duration as one moves northwards, until the desert is reached. The political map of Africa shows that many national boundaries run

Table 3. Grain yield potential for various rainfall zones.

Rainfall, mm/yr	Yield potential (t/ha)	Crop failure rate [a]
300- 500	1.3	1 in 3, or more frequently
500- 800	3.0	1 in 5
800-1,000	5.0	1 in 7
1,000-1,200	8.0	1 in 10 or less often

a "Failure" means less than 300 kg/ha of grain

Table 4. Present and projected populations compared with potential population supporting capacities in Africa.

Year	Population	People per hectare	Potential population supporting capacities - people per hectare		
			Low Inputs	Intermediate Inputs	High Inputs
1975	380	0.13	0.39	1.53	4.47
2000	780	0.27	0.44	1.56	4.47
2020	1542	0.54	?	?	?

East-West. The more northerly States may have no zone of ample, reliable rainfall; for example, Mauritannia, Mali and Niger. Most semi-arid countries in Africa have favoured rainfall zones or are adjacent to countries possessing such zones. The first need is the development of good communications between the two. In West Africa, that requires complete freedom of north-south movement for local produce and livestock. In all countries, better roads between wet and dry areas are essential.

Higgins and Kassam (1984) have calculated the potential population that can be supported in Africa based on three levels of inputs - low, medium and high, taking soils and climate into account. This is shown in Table 4.

This table is full of hope: but it does demand freedom of trade between all areas. It is based on rainfed agriculture, so irrigation may provide a bonus. Higgings and Kassam emphasize that for individual zones within a country attempting to attain food self-sufficiency from their own land resources, the situation is drastically different. Hope for the future lies in increased inputs only if there is freedom of trade in local produce. On a purely within-country level of food distribution, even with intermediate input levels, 12 countries totalling 110 million people would remain in a critical situation in 2000 A.D.

Kassam et al. (1978), in the FAO Agro-ecological Zones project, analyzed 10 crops. They estimated their potential yield range, and also suitable land areas for their cultivation, classified as very suitable, suitable and marginal. For each of these land classes, they estimated yield potential with low inputs and with high inputs. Averaging their estimates for 7 of the crops they chose (those belonging to the lowland tropics, but omitting cotton), the effect of high inputs was dramatic - a factor of approximately 5, regardless of the land-suitability class.

THE SAHEL ZONE

In the really dry areas with food crop failure rates of 1 in 3, the Sahel Zone, few people should be wholly dependent upon such crops. Crops should rather be regarded as supplementary food, or food for only a part of the population. The "crops" for the really dry and unreliable zones are grasses, legumes, and browse plants, grazed by livestock. The traditional African pastoralists have always known this - their main food resource was milk, or milk and blood from the living animal. Sorghum was grown by the African pastoralists in the lowlands, barley by the Galla. The young and able followed the livestock over their extensive grazing grounds and lived from them. The elderly and the younger children lived from the food crop harvests in the base camps. Increasing populations of people have resulted from better health care and lower mortality rates. Increasing cattle populations have resulted from disease control and the installation of increased numbers of watering points.

From the crop standpoint, priority goes to the improvement of pasture plants, and their management, in the 300-500 mm rainfall zone. Drought-tolerant crops, as generally understood, have a valuable part to play in this zone, but only as a supplementary food source. Cowpeas should receive more attention. Small irrigation schemes based on shallow wells and run by groups of farmers should be encouraged where appropriate.

The Northern Sudan Savanna (NSS), with a rainfall of around 600 mm, will repay more investment in millet and sorghum improvement, and this could result in a significant reduction in the crop failure rate. Hybrids may well pay off here. Millet should receive major attention. Cowpeas are important. The Sudan Savanna proper (SS, sometimes SSS for Southern Sudan Savanna), with a rainfall around 750 mm, should be the major focus of the sorghum work.

The Northern Guinea Savanna (NGS), rainfall around 1,000 mm, should be growing more maize. Root crops will also be important. Sorghum and millet will both still have a place, although using different genotypes from those further north.

The Southern Guinea Savanna (SGS), average rainfall about 1,100, should be growing maize, and root crops. Relay cropping should be explored, e.g. the short-term Katumani maize at the beginning of the rains, followed by another crop. Rice should receive attention. This is an area where multiple-cropping systems based on those developed in Asia need to be given support.
Evidently, there are no sharp boundaries, millet, sorghum, and maize will be found throughout the Sudan and Guinea zones.

SUMMARY

* The drought-prone areas of Africa should be producing livestock primarily, and the better rainfall areas crop products primarily. The first requirements to overcome the problems of feeding the growing population are greatly improved communications between dry and wet zones; improved trade and marketing systems; and unrestricted movement of local produce across national boundaries.

* Research inputs should be concentrated on the improvement of grasses, legumes and browse plants in the dry areas, with some emphasis on associated crop plants. The main emphasis should be on grazing management and livestock health. In the better rainfall zones, research inputs should concentrate on the most productive, paying crops: and on all aspects of multiple cropping.

* Plant breeding can do much to improve the yield stability of the crops in drier areas, by identifying drought-resistant strains and reducing their susceptibilities to pests, diseases and to Striga. Hybrids and synthetic varieties could provide a worth-while production increase. The most rewarding results from plant breeding will be obtained in the higher rainfall zones, both from improved varieties and hybrids, and from tailoring crops to match multiple-cropping systems.

* The biggest obstacle to the use of the improved varieties and hybrids in Africa is the absence of efficient, adequate seed multiplication systems - the seed industry is virtually non-existent for food crops.

* Greatly improved distribution and marketing systems, so that fertilizer and other inputs are available to farmers at the right places and the right time, are required.

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ANIMAL PRODUCTION IN DROUGHT-PRONE AREAS

M.L. Mokone

BACKGROUND

Drought occurs in different parts of the world with varying severity and frequency. When it occurs it affects a number of livestock production parameters, cattle lose weight, mortality increases particularly among calves and old cows, and calving rates decline. This is due primarily to effects of rainfall or lack of it, on rangeland pastures which have a major influence on cattle productivity. The ability of the livestock industry so affected to sustain production not only depends on the condition of the range before drought and the severity of the drought but also depends largely on the country's management capability as well as the intervention measures introduced to mitigate against the effects of drought. These vary by country and are also a function of the development and growth of the industry in particular and the economy of the country in general. If the livestock industry is well developed, breeding programs introduced would tend to emphasize the production of drought-resistant or resilient cattle. The research programs would have as major components range and livestock management. The grazing management practices would include supplementary feeding and rotational grazing. Consequently, the breeds so developed would be hardier than most exogenous breeds and better able to withstand stress. This is important as cattle may have to walk long distances to find water.

The significance of disease control cannot be overemphasized. A healthy animal will endure stress more than a sickly one. It is important, therefore, that animal disease control and prevention are practised effectively.

At the same time, adequate slaughter capacity should be provided to enable removal of cattle from the range to offset herd build-ups beyond the rangeland's biological carrying capacity. This would ensure that appropriate stocking rates are maintained lest range degradation is inadvertently introduced. To achieve all of this, resources need to be provided for continuous cattle breeding research, disease control outreach, animal production, management and marketing extension, and improvement of infrastructure required to enable smooth movement of cattle for slaughter.

During drought, relief measures such as the provision of stock-feed, nutrient supplementation, and culling are imperative if the rangelands are to be maintained and cattle death losses are to be reduced to a minimum.

Most of the people who depend on agriculture in Africa today are pastoralists. This is primarily due to inadequate rainfall such that arable production under rainfed conditions is risky and uncertain. Consequently, livestock production has a comparative advantage over crop production.

This is the situation in Botswana, an African country situated between 18° and 27° south of the equator and 20° and 27° east of Greenwich. The majority of the people in Botswana derive their livelihood either directly or indirectly from the livestock sector. Cattle sales often are the only source of cash income in the rural areas particularly for the non-wage earners. Death of cattle through drought deplete this source of income for the rural people. Stress, which often results from drought, inhibits production of milk from milking cows, depriving little children in the rural areas of nutritious milk products.

CATTLE PRODUCTION IN BOTSWANA

Due to Botswana's arid climate, livestock production has an advantage over crop farming. High temperatures and low, erratic rainfall result in low average yields in arable production which have stagnated over the last ten years. The national herd in contrast increased dramatically over the last two decades, from 1.4 million in 1965 to 2.6 million in 1984, having peaked at nearly 3.0 million before the current drought.

PRODUCTION SYSTEMS

There are basically two cattle production systems in Botswana, the commercial and the communal (traditional). Commerical farming takes place in freehold and leasehold land. Commerical farms accounted for only 0.4 percent of the total number of farms in 1983 but held 14.6 percent of all cattle. These farms specialize in cattle production. For instance, of the 360 commercial farms recorded in 1983, 345 held cattle with an average of 1190 head.

Traditional farms, on the other hand, are situated in communal areas and accounted for 99 percent of all farms in 1983. They held 85 percent of all cattle. Traditional cattle production is carried out at cattle posts. The vast majority of traditional farmers engage in some form of mixed production. In 1981, a non-drought year, 81 percent of all traditional farms planted crops and 68 percent held cattle.

Although the two systems are practised simultaneously government has, over the last decade, been actively encouraging commercial cattle production. The main vehicle for achieving this has been the Tribal Grazing Land Policy. The policy was formulated in 1975 in recognition of the need to ensure conservation of Botswana's range resources, to provide greater equality of income in the livestock sector, and to foster increases in the productivity and commercialization of the livestock industry. To meet these aims, tribal grazing land was divided into three zones: commercial farming areas, communal grazing areas, and reserved areas. In commercial areas, groups of individuals were given exclusive rights to specified grazing areas through 50-year leases. So far, 368 ranches have been demarcated with 218 already allocated and 80 under implementation. In the communal areas, the communal grazing system was maintained and livestock owners are encouraged to adopt improved management practices. Reserved areas were set aside for future use and for alternative uses such as wildlife utilization, conservation, and management.

The major support for the implementation of the Tribal Grazing Land Policy was provided through the Second Livestock Development Project, a World Bank assisted project. Under this project an Agricultural Credit Division was established within the National Development Bank, a statutory bank, through which loans were provided to potential ranch owners. Additionally five Regional National Development Bank offices and nine District Credit offices of the Agricultural Division were created. These offices, in conjunction with the Ministry of Agriculture, were able to increase interest in the development of ranches through the wider dissemination of information concerning Tribal Grazing Land Policy and the benefits of commercial livestock production.

Assistance to small livestock owners in the communal areas was provided mainly through the Services to Livestock Owners in Communal Areas (SLOCA) project. Demonstration facilities, handling facilities, fencing, firebreaks, water supply equipment, and kraals were established and funds provided by means of matching grants to groups of livestock owners registered as Agricultural Management Associations to develop these facilities themselves. As a result of these developments, total lending to agriculture from the National Development Bank and other financial institutions during the period 1979-83 increased from P17.8 million per annum to P43 million - an increase of about 18 percent per year in nominal terms, but a considerable increase in real terms. National Development Bank's share of total lending to agriculture increased from 16 percent in 1979 to 56 percent in 1983. This increase was made possible by the introduction of the Agricultural Charges Act - an Act which permitted the National Development Bank to accept cattle as security for loans. At the same time as there was an increase in demand for ranch loans, the deposit requirement prior to disbursement of loans was waived and the National Devlopment Bank decentralized its activities.

DISEASE CONTROL

Over the years Botswana has developed an effective animal disease control system. The Department of Veterinary Services of the Ministry of Agriculture is responsible for disease prevention and control, meat inspection, tsetse fly control, administration of livestock advisory services, trek routes, the operation of a diagnostic laboratory, and veterinary research. Foot and Mouth Disease vaccine is also produced locally by the Botswana Vaccine Institute, a wholly owned government company. In the event of a major disease outbreak, the Department assumes virtual control over the whole livestock industry. This control of a broad spectrum of animal diseases and the maintenance of animal health in general has allowed Botswana beef to maintain access to the EEC market. A network of cordon fences divides the country into disease control zones. Between disease zones quarantine camps have been established in which cattle moving from one zone are held at least two weeks before moving to the next zone. Cattle from each zone are classified as being either approved for sale to the EEC or for sale to the non-EEC.

CATTLE MARKETING

The Botswana Meat Commission (BMC) is the cornerstone of the cattle industry in Botswana. It has a statutory monopoly over exports of meat, by-products, processed meat, canned meat, and live cattle. It accounts for four-fifths of all cattle slaughtered in the country. It is the largest single market for the cattle industry. The Botswana Meat Commission's main aim is to maximize returns to the cattle producers.

The Commission has two abattoirs, the first (one of the largest in Africa), is situated in Lobatse in the south of the country and the other in Maun in the northwest. The Maun abattoir was opened in 1983. The Lobatse plant has an optimum daily capacity of about 1200 animals, while the Maun facility can slaughter and process up to 100 beasts per eight-hour shift. The Lobatse operation also includes a cannery that processes 300 tonnes of beef per week. A tannery, opened in 1978 as a wholly-owned subsidiary of the Botswana Meat Commission processes hides to the wet blue stage.

The Botswana Meat Commission owns a 4000-tonne cold storage facility at the main meat market in London. This arrangement allows for flexibility of beef marketing to the various EEC countries to which Botswana sells her beef. The main markets are the United Kingdom, the Netherlands, Germany, and South Africa. Botswana has an annual beef quota with the EEC of 19,816 tonnes of boneless beef under the ACP/EEC Lome Conventions of Association. Other markets to which Botswana beef is sold are South Africa, Reunion, Hong Kong, Mozambique, Mauritius, and Zaire. The Botswana Meat Commission can produce 30,000 tonnes of boneless beef per annum. The Botswana Meat Commission realized P119.9 million in 1984, paid P59.5 million to producers and over P10 million in tax revenues to the government.

Cattle producers can supply slaughter stock to the Botswana Meat Commission in one of three ways. They can sell direct, or through a private agent or middleman, and/or through cooperatives. Livestock producers in Botswana can also sell their cattle to the Botswana Livestock Development Corporation, a public sector buyer of cattle not yet ready for slaughter. Cattle purchased are usually grazed by the Corporation for a period and then sold to the Botswana Meat Commission. Cattle producers can also sell their livestock to traders, speculators, and butcheries.

THE IMPACT OF DROUGHT ON LIVESTOCK PRODUCTION IN BOTSWANA

Drought in Botswana occurs in 10-year cycles with frequencies of about one drought every five years. When it occurs, the livestock sector is affected adversely in several ways; the grazing land becomes depleted, drinking water becomes unavailable and cattle then have to walk long distances in search of water.

As a consequence, mortality rates increase, old cows and calves die in greater numbers, while calving rates decline. The condition of the national herd deteriorates as cattle lose weight. This not only affects the total production of meat at the abattoir but also affects the quality of meat available for sale as the grades of cattle used for slaughter are generally low.

During the drought years 1979/80, 1981/82, 1982/83, 1983/84, and 1984/85, the Botswana Meat Commission throughput increased to levels that had never been attained before: 229,000, 237,000, 234,000, and 239,000 head of cattle respectively. Following a drought however, Botswana Meat Commission throughput often declines as producers hold back their cattle for breeding purposes in order to build up their herds. During 1981, which was a normal year in Botswana, the Botswana Meat Commission slaughtered 141,000 head of cattle compared to 229,000 the previous year, which was a drought year.

During the four years, 1981/82 to 1984/85, there was an increase in the amounts realized and therefore in payments to producers but there was a corresponding decline in the average weight of cattle, reflected in cold dressed mass, from an average 217 kg in 1981 to a low of 185 kg in 1984, a loss of 32 kg per animal slaughtered per day. At a Grade 3 average price of P132 per 100 kg the loss is equivalent to P42.24 per beast or P10 million from 239,000 head of cattle slaughtered. In addition to this imputed loss of revenue due to loss of condition, Botswana cattle owners have suffered massive declines in the asset value of cattle on the hoof.

Losses have been proportionately more serious for the owners of smaller herds. Mortality rates have increased from an average of 13.8 percent in 1980 to 17.8 percent in 1983 for all traditional cattle owners. The small herd holders, with herds of one to ten, suffered more severely - their cattle mortality rates have increased from 31.6 percent in 1980 to 54.1 percent in 1983. The ratio of sales has increased from 7.7 percent to 8.5 percent for the traditional cattle holders compared to an increase in offtake for all commercial cattle holders from 21.3 percent to 39.9 percent. Additionally, cattle are marketed in poorer condition from the traditional sector.

The other costs imposed on the economy by the occurrence of drought include the cost of drought-relief measures, their administration costs, the opportunity costs of foregone development, and the additional feeding costs to the cattle producers. Botulism is prevalent every year in Botswana particularly in the Sandveld, when the lack of phosphates becomes a limiting factor to growth and general health. This limitation is especially severe during drought. As a result of this, the government is often forced to intervene and provide free botulism vaccines to reduce cattle death losses during drought. During the past four years of drought the Government of Botswana has spent over P6 million for this purpose, excluding transportation and administration costs.

As mentioned earlier, because of the very high dependence of Botswana on livestock for income generation, particularly by the non-wage earners, severe economic hardships have forced the government to incur heavy expenditures on direct-feeding programs and other disaster-relief projects. These relief programs are often distortionary as they divert limited resources from normal development programs, thus inhibiting economic growth and development.

RELATIONSHIPS BETWEEN DROUGHT, INFECTIONS, AND INFESTATIONS IN AFRICAN ANIMALS

Lars Karstad

The impacts of drought on animal populations are manifest in a variety of ways. At risk of pointing out what may seem obvious, I would like to emphasize that the predominant effect of drought is starvation, not the direct effect of water deprivation, per se. As temporary water sources dry up, animals are forced to congregate around fewer permanent water supplies. Overuse of the available forage in the vicinity of those watering points results in deaths from starvation, even in the presence of sufficient water. Other animals forced to trek long distances between pastures and water may succumb to exhaustion. To maintain optimum body condition, cattle must be watered daily. As distance between water and available pasture becomes greater, the strategy of the pastoralist is to drive his cattle and small stock to water only every second day. Livestock may be driven at night to minimize heat stress and dehydration. Thus we have the combined effects on the animals of water deprivation, undernutrition, and overwork. Among domesticated animals, all species suffer to a greater or lesser degree, camels the least, but even the camel has limits of tolerance. A wide spectrum of water dependence is seen also in wildlife. Some small desert animals have evolved the ability to satisfy all of their needs for water from the water released through metabolism. Among the ungulates, gazelles and certain of the antelopes, like domestic goats, are able to survive on the water available in leafy browse, while at the other extreme, buffalo must drink every day. The effects of water scarcity, therefore, vary widely among the species of wild animals. They too, experience the undernutrition and travel stresses which come with drought, although generally to a lesser degree.

Other, less generally appreciated, effects of drought are manifest through disease and parasitism (Thomas 1984). During times of drought, some of the major animal plagues obtain transmission advantages, while other infections and parasites which are normally of low pathogenicity may appear to become much more damaging. Disease escalation may come about either by increased transmission during the perturbations of drought, or because of the combined impact on animals of infections, infestations, starvation, dehydration, and exhaustion.

My remarks and examples will relate mainly to Africa, and mainly to the parts of East Africa where I have worked. A number of specific examples have been chosen to illustrate the ways in which drought can influence the manifestation of infectious diseases and parasitism, and vice versa. These are listed in Table 1.

EFFECTS OF DROUGHT ON DISEASE AND PARASITE TRANSMISSION

Drought can have either positive or negative effects on disease and parasite transmission and the direction of the change is determined by the biological nature of the parasite or pathogen and the mechanisms which have evolved for its survival in nature.

Rinderpest and contagious bovine pleuropneumonia are examples of diseases in which transmission is facilitated when animals are brought together in large herds around permanent water sources, or when they contact many other animals in being driven over long distances to find forage and water. They are diseases

Table 1. Influence of drought on disease transmission and disease impact on animals.

Disease	Agent	Influence of drought On transmission	On impact
Rinderpest	(Virus)	> *	>
Food-and-Mouth Disease	(Virus)	> or <	>
Rift Valley Fever	(Virus)	<	
Bovine Petechial Fever	(Rickettsia)	> or <	
Contagious Bovine pleuropneumonia	(Bacteria)	>	>
Botulism	(Bacterial toxin)	>	
Anthrax	(Bacteria)	>	
Trypansomiasis	(Protozoa)	<	>
East Coast Fever	(Protozoa)	<	>
Worm Parasitism	(Helminth)	<	>
Plant Poisoning	(Toxin)	> or <	>

* > = increased transmission or impact on animals.
< = decreased transmission.

spread by large droplet respiratory tract secretions, through direct contact or close proximity between animals. Drought, with the resultant increased movements of cattle southward to pastures and markets, is held responsible for the reintroduction of rinderpest into Nigeria and other West African countries in 1981, where it spread from persistent foci of the disease in Mali (Scott 1985). In 1982, during the dry season, rinderpest broke out in African buffalo in the Serengeti National Park of Tanzania, when buffalo herds concentrated along the permanent watercourses. Shortly thereafter, during the continuing dry period, rinderpest broke out in buffalo on the forested flanks of Ngorongoro Crater (Rossiter et al. 1983). The sources of infection in these outbreaks were not established but it is probably significant that there were unauthorized cattle movements through the Park around the time of the outbreak, and because of the drought at Ngorongoro, cattle had been allowed into forest areas from which they normally were excluded.

The re-emergence of rinderpest in Africa cannot be blamed entirely on animal movements related to drought. The worldwide recession has been particularly damaging to the economies of oil importing African countries, with the result that veterinary services, including vaccination, have declined. Also, civil

strife, such as occurred in Uganda and the Southern Sudan, has resulted in a breakdown of law and order, with cattle raids and illegal movements of livestock a prominent feature.

Foot and mouth disease (FMD) also is transmitted by respiratory droplets. In this case, however, the droplets are small and may be wind-borne over great distances (Donaldson et al. 1982). Since the virus is susceptible to destruction by drying and ultraviolet irradiation, climatic conditions in Africa are not conducive to wind-borne transmission. Transmission in Africa requires close contact between animals and herds of animals. While climates in Africa, therefore, limit the wind-borne spread of FMD, in periods of drought the increased movements of animals promotes FMD tranmission. As in the case of rinderpest, and also contagious bovine pleuropneumonia, outbreaks of FMD have been facilitated by the recession and by military and civilian conflicts.

Diseases spread by arthropod vectors are usually limited by periods of drought. Outbreaks of certain insect-borne diseases, such as trypanosomiasis (Ford 1971) and Rift Valley Fever are not seen in areas afflicted by drought, because the moist conditions necessary for the breeding of the vector insects are not available (Sellers 1980). The transmission of tick-borne diseases, such as East Coast Fever, may similarly be limited by drought. The mode of transmission of bovine petechial fever (BPF) is unknown (Davies 1981). The rickethsial nature of the causative agent, however, suggests that ticks or mites may be vectors. Drought may affect the transmission of BPF in two ways. At the beginning of a period of drought, presumably when the infected vectors are still available, cattle are at greater risk when shortage of pasture requires that they be herded into brushy hillside areas frequented by the BPF reservoir bushbuck. As the drought continues, however, the prevalence of BPF has been observed to decline, perhaps by reduction in vector populations. This is somewhat speculative but I mention it here just to illustrate the ways in which drought seems to affect the prevalence of certain diseases.

Diseases which have a soil reservoir may increase in prevalence during conditions of drought. Botulism and anthrax, diseases caused by spore-forming bacteria which can cause long-term, even permanent, contamination of soil may appear when drought causes animals to graze very close to the soil on scant vegetation (Choquette and Broughton 1981; Blood et al. 1979). At such times, undernutrition and the ready availability of the remains of carcasses of animals which have died may promote pica or bone chewing by the mineral-hungry animals. This osteophagia is one of the means of transmission of both botulism and anthrax. Anthrax transmission is also promoted when animals crowd around receding waterholes, which can become heavily contaminated with anthrax bacilli.

FENCES AND DISEASE TRANSMISSION

In many African countries, veterinary cordon fences have been constructed to prevent disease transmission, mainly because of the risk of disease transfer from wildlife to livestock. Such fences have been built to limit the spread of diseases such as trypanosomiasis and FMD. They have, at times, had devastating

impacts on migratory or semi-migratory wildlife populations because they have cut off or interfered with normal wildlife movements. In times of drought, the ability of wild animals to move long distances in search of food and water can become a matter of species survival. Veterinary cordon fences are believed to have contributed to the disappearance of several wild ungulate species from the Kalahari region in Botswana and the survival of even formerly abundant animals, such as the wildebeest, is threatened (Wiliamson and Williamson 1984). The cordon fences in Botswana have been erected for control of FMD, without any substantial evidence that wildlife is involved in the spread of FMD to cattle. So, while they are not direct causes of mortality, fences may have a profound influence on survival of animals during periods of drought.

EFFECTS OF DROUGHT ON PARASITISM

This is a broad topic but for simplicity we may consider it in two parts: (1) the effects of unusual dryness on the survival of parasites away from their vertebrate hosts, and (2) the effects of drought on the pathogenesis of parasitism.
Unusually dry conditions tend to suppress transmission of parasites, either through direct lethal effects of drying on parasites in their free-living existence, or through destruction of intermediate invertebrate hosts or vectors such as ticks, insects, snails, acquatic invertebrates, etc. Drought may cause the extra-host stages to be prolonged, for example when free-living nematode larvae go into drought-induced aestivation in cow dung on pasture while worm parasitism in the cattle declines.

The second category of drought effects on parasitism, its influence on the intensity or severity of the pathological effects of parasites, is more complicated. Parasitism becomes more prominent and more obvious when the host's resistence has been lowered by the undernutrition, thirst, and travel stress that accompanies the drought. Animals then may appear to be dying of parasitism, when actually the stresses of drought may be the major factors which allow parasites normally of low pathogenicity to overwhelm the weakened host. Ticks and other external parasites may be more numerous and more troublesome. During a drought, wild animals, for example those which normally tolerate blood protozoal infections, may appear to be killed by them. The precise ways in which the stresses of drought predispose to parasitism are several. Some of the predisposing effects may be adrenal mediated. Corticosteroids are known to lower body resistance to infections and parasites. Other mechanisms are competitive - parasites merely competing with the host for nutrients. It is probably sufficient to note that the general tendency is for drought to increase the damaging effects of parasites and, conversely, for the presence of parasites to reduce the ability of the host to survive under drought conditions - starvation, thirst, and travel stress.

PLANT POISONS AND DROUGHT

Some poisonous plants require adequate or abundant rainfall to flourish and be available for ingestion by livestock or wild animals. These, of course, are no problem during a drought. There are other plant species, however, which cause poisoning because they are able to tolerate conditions of drought, and though

they may be unpalatable to animals under normal conditions, in the absence of other forage, they may be eaten. Even certain fodder plants, the Sorghum spp., may cause prussic acid poisoning when stunted and wilted by drought.

RECENT AND CURRENT PROBLEMS IN PERSPECTIVE

The major disease problem facing both livestock and wildlife in Africa at this point in time is rinderpest. Other major diseases of livestock are FMD, contagious bovine pleuropneumonia, East Coast Fever, and trypanosomiasis. The recent drought has hampered disease control efforts, mainly because of the need, for humanitarian reasons, to relax restrictions on livestock movements. Losses of animals due to drought, either by mortality or forced marketing, has made any losses to disease the more serious. Overall, drought has had a lesser adverse impact on disease control than the economic recession and, in some countries, civil unrest. For economic recovery in most African countries, livestock disease control is essential.

In planning the aid responses required by African countries, control of diseases, both human and animal, must have high priority. Emergency food supplies are necessary from time to time, but in long-range plans for food self-sufficiency, aid should be directed toward improvements in production of both crops and animals. Choice of animals to be promoted must also be made with care. Species and breeds which have evolved together with the African environment are best able to survive the combined effects of drought and diseases (Murray et al. 1984). Exotic breeds of livestock are most susceptible. Whenever exotic breeds are introduced to up-grade production of the indigenous breeds, care should be taken to maintain much of the hardiness of the local breeds. Livestock improvement, therefore, must proceed slowly and with caution. Wildlife ranching may have a useful place in areas which are semi-arid (Hopcraft 1981).

At the present time there is need for a coordinated international effort to control rinderpest in Africa. Such an effort, coordinated by the OAU is being planned. FAO is cooperating in coordinating the international assistance required and the EEC promises to be a major donor. While major emphasis is on vaccination of cattle, I would put in a plea for research. Research is needed, in parallel with vaccination, to determine the role that wildlife may be playing in the perpetuation of rinderpest in some countries (Rossiter et al. 1983). Continuing to the present, Rossiter (unpublished) has obtained evidence of the persistence of rinderpest in African buffalo in Kenya. What does this portend for effective and lasting control of the disease? What is the nature of these strains of rinderpest virus in buffalo? Are they pathogenic for cattle? Are cattle protected by the vaccines in current use? All of these questions demand answers before a very expensive pan-African control program is instituted and its effectiveness placed at risk.

Disease control measures must be tailored to serve the needs of wildlife conservation as well as livestock production. What has happened to wildlife in Botswana is a sad example of failure by veterinarians to consider the effects of disease control measures on wildlife. The cordon fences were justified on the

basis of protecting the export of beef to Europe. However, it appears that the risk of FMD transmission from wildlife to cattle is not as great as it was assumed. Certainly, in Kenya, research has shown that the risk of wild animals acting as reservoirs for FMD transmission to cattle was negligible (Anderson et al. 1981). Wherever fences are constructed for any purpose, including disease control, careful planning must ensure that they do not interfere with migration routes essential to wildlife survival. Where errors have been made, corrective action should be taken. Wild animals are an important part of the natural resources of a country. Their conservation should not be neglected in planning to maximize production of crops and livestock.

SUMMARY

In total, the influence of drought on the occurrence and effects of infectious diseases and parasitism is most often accentuating. Drought makes diseases and parasites more prevalent or more devasting in their effects. Conversely, the occurrence of diseases and parasites reduces chances of survival of animals during drought. Specific examples have been given. Recent disease problems in Africa, complicated by drought, did not originate because of the drought. The stage for breakdowns in disease control was already set by the economic recession and by civil and regional warfare. International aid, which extends beyond provision of emergency food supplies, must be aimed toward increased food production of both crops and livestock. Aid for disease control, e.g. rinderpest, must form part of the overall plan.

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LAND AND RESOURCE MANAGEMENT IN SOUTHERN AFRICA

Malcolm J. Blackie

THE RESOURCE BASE

Southern Africa, in common with the continent as a whole, is a highly diverse region in terms of key characteristics such as natural resources, population densities, and political systems. The subregion is composed of Angola, Botswana, Lesotho, Malawi, Mozambique, Republic of South Africa, Swaziland, Zambia, and Zimbabwe. Tanzania, while a member of the southern Africa SADCC grouping, is more commonly grouped with the East Africa states. Aspects of the Tanzania agricultural experience are, however, considered in this paper. In view of the objectives of this symposium, discussion will be confined to the independent black states of southern Africa.

Rainfall

Drought has always been a failure of the southern African environment. In Zimbabwe, rainfall records indicate that a severe national drought is likely approximately once every seven years. However, in many of the lower rainfall areas which predominate in the eastern lower altitude parts of the southern Africa region, drought is even more frequent.

Rainfall is probably the major constraining natural resource throughout the region. Much of the region receives between 750 and 1,000 mm of rain annually although annual rainfall in parts of Botswana is less than 250 mm (Collinson, forthcoming; Devres 1983). The rainfall occurs during a monomodal rainy season of 4 to 7 months in duration. Typically, as the average rainfall decreases, the variability both within and between seasons increases. In Botswana, for example, seasonal variations range from 80 percent in the arid southeast to less than 25 percent in the higher rainfall northeast. In Siabua, in northern Zimbabwe, the mean annual rainfall for the last thirty years is 693.3 mm, representing a range of annual rainfall between 110 mm and 1,200 mm and a growing season length between 90 and 145 days (Hungwe 1985).

Thus mean annual rainfall, in the drier areas of the region, does not give an accurate indication of growing season reliability. The start and the end of the growing season are highly unpredictable and the probability of a devastating midseason drought period is high. Data from Zaka, Zimbabwe, illustrate this last phenomenon. In any 15-day period in January and February, there is a 20 percent probability that less than 45 mm of rain will fall. The average length of the growing season is five and a half months but 22 percent of the growing seasons are less than 120 days and 41 percent between 125 and 165 days (Bromley and Lang 1980). Thus the choice of both farming system and crop variety is highly risky. Overall, the region receives the world's highest solar energy input of 150 to 180 cals/cm^2 per year. However, water constraints

severely limit the potential for converting this radiation into plant growth (Cooper 1970). The high level of radiation and resultant evapotranspiration also restrict the usefulness of the rain that does fall. Collinson (forthcoming) notes, for example, that in southern Africa sugar requires 2,000 mm of moisture per annum to realize its full potential. This compares with 750 mm in the temperate zones of Europe and is largely a function of high radiation and consequent transpiration rates. Open water evaporation (E_0) varies from 1,400 mm per annum in the highlands to 2,600 mm per annum in the desert. Much of the region has E_0 between 1,800 and 2,200 mm (Collinson, forthcoming). Of particular significance is the recent observation by Collinson (forthcoming):

> Irrigation might seem to offer a potential of balancing the high solar energy resource with water. However, most precipitation is held within the top soil layers and used for plant growth. Because of the limited available surplus water in aquifers, irrigation does not offer a widely replicable strategy for development in the region.

While access to land has dominated political activity in much of southern Africa during this century, access to, and use of, water can be expected to become an increasingly controversial issue. For example, the Chavunduka (1982) report on Zimbabwean agriculture states:

> At the present rate of population growth, the country's demand for water can be expected to exceed the available internal resources in about 40 years' time. Although it may be possible to ensure the country's water supplies for a longer period by using the potential of the Zambezi River, the cost of this for the foreseeable future will remain prohibitively expensive.

The authors of the report noted that current per capita water use in Zimbabwe was less than half that of developed nations. Increasing industrialization, irrigation, and urbanization will all raise the demand for water.

Soils

Collinson (forthcoming) notes that it is the physical characteristics of the soils of the region that have negative effects on cropping potential rather than their fertility since fertility can be added. Physical soil characteristics are important at both the micro and the macro level. Over 70 percent of Botswana is covered by infertile Kalahari sands of low water-holding capacity. Impervious lateritic crusts inhibit exploitation of large well-watered areas of central and southeast Tanzania (Collinson, forthcoming). Fertile vertisols occur throughout the region but are only farmed succesfully to any significant extent on large-scale mechanized farms. Small-scale producers, with their limited draught power resources, make very limited use of these soils.

Traditionally, farmers have sought out and cultivated those soils that are most fertile. Farming systems of considerable ingenuity and complexity have evolved where local population pressure is heavy. Examples are: the "malapo" cropping

systems in northeastern Botswana, and the raised vegetable gardens in valley bottoms in Rwanda, Uganda, and Burundi.

Soil characteristics vary widely across the region with most countries having a significant proportion of fertile soils. Botswana is the worst endowed with only some 5 percent of the land being suitable for arable cropping (Devres 1983). However, consisently across the region, both fundamental and applied soils and agronomic research have typically been undertaken in the better arable areas and with levels of input appropriate for large-scale mechanized agriculture. Issues associated with the continuous cropping of the less fertile soils at low input levels have not been adequately addressed.

This last point is of major significance. Frequently it is asserted that there is technology available to increase arable production in the region. It is stated that the problem of low agricultural production levels is due to poor information transfer, inappropriate national policies, or perhaps inadequate input delivery systems. Delgado, Mellow, and Blackie (forthcoming) write:

> This view was widespread in Asia in the 1950s but major yield increases did not occur until agricultural research breakthroughs were achieved in the mid and late 1960s. By then it was widely recognized that while research station yields were higher than farmer averages, they were not above those of the best farmers. Experiment stations often have different physical and economic conditions than farmers. There was also a tendency to note experiment station plots with high yields and ignore those with low yields - a luxury not permitted the practical farmer.

As it was in Asia, so it is in Africa today. Underlying the stagnation in agricultural production, and the consequent vulnerability to drought of the region's burgeoning populations, is an inadequate technological base for agriculture.

Population and Land Resources

Population is growing rapidly throughout the region. Typically, population growth rate is in excess of 3 percent and may be as high as 4 percent in some countries. Land resources are unevenly distributed; Botswana has the lowest population density in the region at 1.6 persons per square kilometre compared with Malawi's 65. Only Zambia, Angola, and Mozambique have significant areas of unused but potentially productive land.

The past century has seen two major changes in human settlement. First, steady population growth has caused the rural population to move into increasingly arid and infertile areas. Thus an increasing proportion of the rural community is farming in a significantly more risky agricultural environment than in the past. Second, the past few decades have seen a substantial increase in the

urban population of most countries in the region. In Malawi, the urban population is increasing at the rate of 7.5 percent annually; in Botswana, the percentage of the population living in urban areas has increased from 8 percent in 1971 to 17 percent in 1981 (Devres 1983). In Zambia, the twenty years since independence have seen the urban population more than double to 45 percent (Marter and Honeybone 1984).

Numerically, the small-scale traditional farmer represents the majority of the rural population. At one extreme is Botswana where 99 percent of the rural population are engaged in traditional agriculture. They cultivate 96 percent of the land planted with the major food crops and account for 85 percent of food grain production and 53 percent of cash crop production. They own 84 percent of the cattle and 96 percent of smallstock. Similarly in Malawi, smallholders occupy 70 percent of the land and produce 81 percent of agricultural output (Devres 1983). Zambia and, to a lesser extent, Zimbabwe lie at the other extreme. At independence in Zimbabwe, large-scale farmers occupied half of the agricultural land, most of which was in the more favourable agricultural zones. This group produced 80 percent of total agricultural output and 95 percent of marketed agricultural output (Chavunduka 1982).

Interactions

Fundamental to understanding the agricultural systems of the region is a comprehension of the interactions of soils, rainfall, population, and altitude. Collinson (forthcoming) identifies relative land scarcity as the most important factor causing variation in farming systems in the region. This is directly related to population density and is closely linked to differences in rainfall. Population density is greatest in those areas most suitable for arable production. In the high potential arable farming areas, population density is as great as one hectare per family as compared to 50 hectares per family in some low and medium potential areas (Collinson, forthcoming).

Rising rural population densities mean shortened fallow periods and, in some areas, continuous cropping of soils. Soils not previously regarded as arable for reasons of rainfall, topography, or fertility are now being used for cropping. The risk of crop failure is higher in these areas and the rural families involved are thus more vulnerable to climatic variation. In southern Africa, the distress caused by the recent drought can be attributed to a considerable extent to this effect. Given the inevitability of further substantial population growth for the remainder of this century, southern African states are likely to be increasingly at risk from drought-related disruptions to food and agricultural production.

FARMING SYSTEMS

The Debate on Large-Scale versus Small-Scale Agriculture

Large-scale, mechanized agriculture, outside Zambia and Zimbabwe, is responsible for only a minor proportion of agricultural production in the regon. Yet, in spite of the importance of smallholders in the agricultural economies of the

region, effective support for smallholder agriculture, as opposed to rhetoric, is not widespread. Tanzania and Zambia, and increasingly Zimbabwe, favour large-scale state farms as a major component of agricultural development. The policy debate on the relative emphasis to be given to large-scale, as opposed to small-scale, agriculture is largely unresolved. Large-scale farms are typically well serviced by public and private institutions and thus appear more efficient than the less well-supported smallholder sector. The socialist penchant for state farms to provide a marketable surplus for urban areas also keeps the debate alive (Mellow, Delgado, and Blackie, forthcoming).

This contrasts strongly with the Asian experience where an emphasis on smallholder agriculture was generally accepted. Debate decisively favoured the smallholder sector prior to the green revolution except for a short-lived position by the Congress party of India in favour of cooperative farming (reminiscent of Tanzania's much more serious Ujamaa policy) and some discussion of plantation versus smallholder production and export crops such as rubber and oil palm (Mellor, Delgado, and Blackie, forthcoming).

The 1983 IFPRI/University of Zimbabwe conference on accelerating agricultural growth in sub-Saharan Africa came to a clear consensus that, despite the contribution made to the continent's food production by large-scale producers in eastern and southern Africa, large-scale agriculture could not make an expanded impact into the future. Regionally, the area in expansion is both technically difficult and politically impossible. The management and investment resources needed to support large-scale agriculture are scarce and their costs even higher than their nominal value would suggest (Mellor, Delgado, and Blackie, forthcoming). Assumptions based on Asian experience with smallholder farming appear valid for Africa. There is little scope for economies of scale in farm production (as distinct from research, input supply, marketing, and other support institutions). The agricultural, and especially the food, sector is already dominnated by the small farmer who, as elsewhere, is responsive to good support services. This point has been strikingly demonstrated where both improved technology and supporting services have been provided. Examples include the Kenya Tea Development authority, hybrid maize production in eastern and southern Africa, cocoa development in the Ivory Coast, and cotton in Mali and Zimbabwe (Mellow, Delgado, and Blackie, forthcoming).

Experience with maize production in Zimbabwe reinforces the view that smallholders can compete with large-scale producers and are quick to respond to production incentives. At independence in Zimbabwe, large-scale producers accounted for over 90 percent of marketed maize and 60 to 75 percent of total maize production (Chavunduka 1982). Yet smallholders were already beginning to benefit from the research, prices, and infrastructure that had been provided for large-scale producers. Access to markets, services, and infrastructure by smallholders has improved markedly since independence and the consequent marketed production of both food and export crops has expanded dramatically. Smallholder producers today grow more than half of Zimbabwe's cotton and smallholder cotton production has expanded from 60,419 tonnes in 1980 to an estimated 115,000 tonnes in 1984 (Gandiwa 1985). In the 1983/84 season, despite

three years of drought, marketed maize from the smallholder sector rose to over 30 percent of total deliveries. Projections for the 84/85 season, a relatively good cropping year, indicated that smallholders will deliver over half the marketed crop. This group is already the major purchaser of hyrid maize seed in the country (Mellor, Delgado, and Blackie, forthcoming).

Small-Scale Farming Systems

As noted under Interactions above, relative land scarcity is the most important factor causing variation amongst farming systems in the region. Other important factors are access to cash and to draught power. Typically, smallholders spend 10 to 15 percent of their gross cash revenue on fertilizer and insecticides. Total farm expenditures by most smallholders are in the range US $10-25 (Collinson, forthcoming). Thus cash requirements and the returns to cash are often key criteria in the selection or development of innovations. Draught power availability and source also interact with land availability in small farming systems in the region. Methods of seedbed preparation range from the handhoe, requiring more than 40 man-days per hectare, to oxen requiring up to 5 team-days per hectare. In some areas, tractors may be hired to supplement hand or ox power (Collinson, forthcoming). Collinson (forthcoming) observes that farmers often continue preparing and planting land well into the rainy season. He estimates that families working with handhoes are limited to some 3 hectares of cultivated land and those with a single ox team and plough to some 10 hectares.

The returns to cash influence farming systems in the region in another fundamental manner. Low (1984) writes that conventional models of the farm household are based on assumptions of diminishing returns to labour on the farm and of an institutional wage rate. Here the African situation differs significantly from that in Asia where the preceding assumptions would appear appropriate. Empirical evidence from southern Africa, where land is less of a constraint relative to labour, suggests that marginal returns to family labour do not tend to decrease as the size of farm household increases. Nor is it realistic to assume that the wages available to members of a household are the same for all members.

Migrant labour and off-farm work form an important component of rural productive systems throughout southern Africa. Low's work supports that of Hyden (1984) in defining three important characteristics of these systems: universal access to land by all members of society; a lack of agricultural surplus labour; and maintenance of strong rural links by urban migrants.

His analysis shows that these characteristics are closely linked and that universal access to land results in specialization within rather than between households. Low (1984) writes:

> Where wage employment opportunities exist, this means that farm households are often not primarily or solely farmers. Some members specialize in wage employment, while those who remain on the farm have other maintenance

activities to see to beside farming. As there are no landless families, and especially where other job opportunities exist, it is not possible to hire labour to substitute for alternatively occupied family labour. Farm production thus suffers from a lack of individuals who are able to devote most of their time to farming.

While this maximizes overall household welfare, household agricultural production is reduced due to out-migration and farm household labour shortages. Thus, under the traditional land tenure systems prevalent throughout the region, improved agricultural technology has to show substantially improved returns as compared to both traditional farming methods and off-farm earning opportunities.

Finally, in this analysis of farming systems of southern Africa, it is necessary to acknowledge the importance of livestock. There are three issues of significance.

- The role of cattle as draught power.
- The importance of livestock in the farming systems of arid and semi-arid areas.
- The relative neglect of the role of small ruminants.

Collinson (forthcoming) observes that in most of southern Africa a critical farmer decision variable is the size of area that can be cultivated by the household in a single growing season. Land in the region is generally not sufficiently plentiful to permit the maintenance of soil fertility by a fallow rotation but farmers are still unable to cultivate more than a proportion of the cultivable land each season. Hired tillage power is probably the most common purchased input amongst small farmers. This input, where land is not absolutely scarce, gives substantially higher returns to cash investment under present farming systems than land intensifying inputs such as fertilizer. Further, the delayed times of planting, the lower power availability, and the choice of seedbed preparation over early weeding inhibit the efficient use of intensifying inputs (Collinson, forthcoming).

Thus access to animal draught power and, in particular, the ownership of cattle are key variables in regional smallholder farming systems. Livestock owners obtain substantially higher crop yields and generally operate a more reliable and higher-income farming system than non-owners (see for example, CIMMYT 1982; Bendsen and Gelmroth 1983; Marten and Honeybone 1984). However, the trends noted by CIMMYT (1982) in Chibi, Zimbabwe are probably representative of the poorer, more land-hungry parts of the region. Cattle ownership is falling and the typical herd size is too small to replace oxen. In Chibi, 46 percent of households owned cattle as compared to 56 percent five years earlier. Increasingly, cows, rather than oxen, are used for ploughing (which further reduces the fecundity of the herd) and more farmers rely on borrowed or hired cattle for land preparation. Population growth causes arable cultivation to invade areas previously used for grazing; cattle owners thus find it steadily more difficult to ensure adequate grazing. As cattle ownership declines, so does agricultural productivity. As populations expand into areas of unreliable rainfall and poor soils, lack of access to adequate draught power exacerbates the risk of crop failure.

With increased cultivation in arid zones of the region and improved understanding of the importance of livestock, research interest has started to focus on the introduction of high protein forage crops into arable farming systems (Sandford, forthcoming). In more arid areas which are not cultivated, the use of phosphate fertilizers or forage legumes is currently uneconomical and Sandford (forthcoming) reports little prospect of finding economically viable techniques for significant increases in the primary productivity of these areas.

Arid and semi-arid zones account for over half the land area of sub-Saharan Africa and contain the majority of the region's ruminant livestock. Sandford (forthcoming) reports that animal health is no longer a major constraint.

Although in southern Africa, there has been significant work on the genetic improvement of both indigenous and exotic stock, this has not led to substantial increases of yield per unit of scarce feed resources. Thus improved feed utilization must form a major research priority for improved livestock systems. Interestingly, there is evidence to suggest that, on an output per hectare basis, traditional livestock systems outperform large-scale ranches (de Ridder and Wagenaar 1984). The debate on appropriate range management systems continues inconclusively but confidence in low-cost range management technology based on U.S. research has eroded in recent years (Sandford, forthcoming).

Recent ILCA work (as reported by Sandford (forthcoming)) does suggest that substantial improvements in production based on improved animal husbandry practices are possible. Enormous differences have been identified in productivity between herds which apparently have access to the same water feed resources. Further research is being conducted to identify those practices most responsible for these productivity differences and the kinds of farmers who tend to adopt them.

In southern Africa, there is a longer history of livestock-oriented research than in other areas of the continent, largely as a result of European settlement. However, the settler influence has meant that much of this research is not well suited to small-farmer circumstances. The small ruminants, which are ubiquitous throughout the region, have been largely neglected. Goats and sheep play an important role in small farmers' food security strategies. Sales of these stock are made both to defray periodic expenses such as school fees and also to provide an income during periods of economic crises such as occur after a crop failure. Unlike cattle, goats and sheep are owned by even the poorest members of the rural community. Thus improvement in small ruminant production and markets can be expected to have an important impact on the rural poor.

IMPROVING LAND AND RESOURCE MANAGEMENT

The debate on priorities in African agriculture remains unresolved. Some commentators are pessimistic regarding the potential for improved productivity in the absence of major policy and structural change. Low (1984), for example, writes:

> In recent years, increasing attention has been given to the role of agricultural technology in rural development. However, the lessons of the past decade of rural development efforts in southern Africa teach us not to place too much hope on the impact of 'green revolution' technology by itself...In order to devise strategies for substantially increasing agricultural production per capita from the traditionally farmed areas, we need to go beyond the generation and dissemination of yield increasing technology. We need to consider more fundamental changes in land tenure and in relative pricing structures. However, it is clear that any such changes will involve substantial trade-offs: between industrial development versus the commercialisation of the small farm section on the one hand and the social security benefits that traditional tenure currently provides on the other.

The development problems of southern Africa are complex and only poorly understood. Progress can be expected to be slow and painful; the debate on agrarian policy can be expected to continue, unresolved, well into the future. That this should be so is unsurprising. Independence has come late in southern Africa and history shows that the evolution of appropriate agricultural policy has everywhere been a lengthy and difficult process. Recent reviews by Collinson (forthcoming), Delgado (1984), Eicher (1985), and Mellor, Delgado, and Blackie (forthcoming) deal at length with African research priorities and agendas. The consensus which emerges is of an urgent need for agricultural research. While both national and international investment in agricultural research have been substantial, the effectiveness of this research has been limited by two major factors. First, much of the research has relied on the services of expatriate scientists. While not denigrating the work done by such scientists, they come at a considerable cost (particularly in scarce foreign exchange) and all too often are engaged for relatively short-term project-type activities. Secondly, too little of the research has been conducted specifically for smallholder agriculture. Pioneering work by Collinson and others has shown conclusively that technology needs to be designed and adapted to the distinct requirements of the African smallholder. Smallholder technology is not just scaled down technology developed for large farms.

To a considerable extent, these two factors are closely interrelated. The development and adaptation of technology for smallholder needs require an intimate knowledge of rural households and communities. Personal experience over the past few years as project leader of several smallholder-oriented agricultural research projects has convinced me that there is no substitute for indigenous scientists. While the scarcity of appropriately trained nationals may well mean that, for the next decade, research direction and supervision will require a significant component of expatriate support, the development of a cadre of national researchers trained and experienced in African farming systems and on-farm research must be a major component of regional agricultural research policy. This approach contrasts strongly with the conventional method of relying on expatriates to staff the agricultural support services while national staff train overseas.

There are three components necessary for the implementation of a research agenda of value to land and resource management in Africa: staff stability, researcher mobility, and agricultural university and college development.

Agricultural research and development needs long-term commitment. Where both national and expatriate staff are changing frequently, little progress can be expected. In the long run, national governments will need to come to terms with the market value of their agricultural scientists. For the immediate future, research directors will need technical support, probably from external sources, to enable them to hold their most promising staff. This is a highly controversial issue which rarely fails to provoke debate. Yet the difficulties are more perceived than real and in my own faculty we have had some very promising experience in obtaining and using this kind of support to hold together various research teams.

Second, mobility is essential for smallholder-oriented research. Researchers need to spend extended periods in the field; they need to be able to visit the field in a timely and expeditious manner. Again, drawing from my own experience, two vehicles between three researchers is probably the minimum requirement. Just as farming in many of the smallholder farming areas is a risky activity, so too is on-farm research. The probability of losing trials and data is high even with the best of management. If a researcher cannot reliably visit his trials at the critical periods, the risk of failure is unacceptably high. Professional advancement rarely comes to those who have tried but failed.

Finally, the disappointing standard of many of the agricultural colleges and universities in the region needs to be redressed. Typically these are treated largely as undergraduate training institutions and have only a minor research and extension role. The reasons for this lie in the colonial history of the countries concerned and is reinforced in the post-independence period by the continuing reliance on expatriate staff and training. The integration of the colleges and universities of agriculture into the national research and extension system must be a key component of agricultural development policy in Africa. This does not mean attempting to replicate a land-grant system in Africa; the institutional framework for southern African countries is unlikely to tolerate such an imposition. However, these nations could do well to model their agricultural training systems on those of such countries as Australia and New Zealand which have a comparable settlement history and a successful record of agricultural development. Zimbabwe has, in recent years, moved in this direction and, in consequence, has one of the more lively faculties of agriculture in the region.

CONCLUSION

Drought is a recurrent feature of the African environment and drought-related crises in southern Africa can be expected to increase in severity in the medium term. While this outlook is depressing, it reflects the very difficult environment in which countries in the region operate. However, with innovative, carefully designed programs aimed at the smallholder and with a substantial input from national scientists, considerable progress in turning around the agricultural production trends of recent decades can be expected. The resilience and productivity of the Zimbabwean farmers since independence lends some empirical evidence in support of this view.

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PROVISION OF WATER FOR DRINKING AND SANITATION IN SEMI-ARID RURAL AREAS

Donald S. Sharp

For several decades now, donor agencies have been providing developing countries with financial and technical assistance for the development of needed water resources. Unfortunately, the construction of dams, water distribution systems, and wells in semi-arid Third World countries has been accompanied by a host of unanticipated problems, some technical in nature but most involving complex socio-economic factors. The failure to compensate for social, cultural, economic, political, and bureaucratic constraints is probably a key factor in every unsuccessful project.

In the case of wells, when the water delivered is used for drinking purposes, once constructed the well must be sealed to prevent it from contamination and a pump installed. These pumps can be powered by diesel engines or electric motors and in some areas the wind can be harnessed. But in most developing countries the energy required for raising water to the surface comes from people - primarily women and children. Unfortunately, diesel-powered pumping devices require fuel which is expensive and often difficult to obtain. Maintenance requirements can be substantive requiring skilled technicians and imported spare parts. And we often hear about windpumps being installed in places where there is no wind.

Handpumps, therefore, are still the best option for use in rural areas. However, there are numerous problems inhibiting their use which remain to be solved. In many remote communities, as many as 200 people a day may use the same handpump. Under such conditions of use and abuse, breakdowns are frequent. To keep pumps in service requires trained maintenance teams equipped with vehicles, adequate spare parts, and special equipment for removing the below-ground components. If a malfunctioning pump is not repaired quickly (say within 3 days), the user population becomes frustrated and in retaliation may vandalize the pump and well resulting in a loss of investment thus undermining efforts by the government or aid agencies to respond to the needs of the people. When this happens the technical intervention that was intended to be the solution to a problem has created a problem. The population is forced to return to its traditional, highly polluted sources of water. Situations such as this cause rural dwellers to lose faith in the government and to refuse to accept other offers to help.

The training of selected community members to repair handpumps within their own villages has also met with varied results. It is often expected that the community should pay for the services of the village mechanic or caretaker. However, if he or she is not adequately paid and on a regular basis, enthusiasm for repairing the pump quickly dissipates.

As for the problem of spare parts, because most pumps in use today are manufactured in industrialized countries, parts must be imported, creating a procurement problem and negatively affecting the country's balance of payments. Once imported, to be useful the parts must be warehoused within easy access to the pump sites. To keep track of the ordering, distribution, and inventory requires a finely tuned management system. Unfortunately, few developing countries have either the capability to operate such a system or the capacity to maintain it once put into operation.

It is understandable that due to these problems many water resources development projects have met with failure. Nevertheless, numerous new solutions to the present situation are still being proposed. For example, in an announcement published in "The Groundwater Newsletter," June 17 (1985), it is reported that the U.S. Government and the National Aeronautics and Space Administration (NASA) are being urged by several consultants and manufacturers to place a large format camera on a future space shuttle flight. The camera, which can photograph 60,000 km^2 in a single shot, can provide detailed data which, after analysis, might indicate areas with good groundwater potential. Although this approach could provide important hydrological information, governments and donor agencies must translate the results into concrete programs of action. The question is, who will exploit these new water resources once identified and who will pay for their development, operation, and maintenance?

What is needed is not more technology but the application of more "appropriate technology". What is needed is not more research but more "relevant research" into the development of durable, low-cost technologies and the software needed to put them in place.

One such option is rainwater harvesting. Although people have been collecting rainwater for domestic purposes for centuries, the practice is not widespread in many areas of the developing world where potable water is not easily accessible. Rainwater costs little to collect, is relatively uncontaminated, and does not involve large capital outlays for pumps, treatment facilities, or distribution systems. Research sponsored by IDRC is currently being carried out in Thailand, Malaysia, and the Philippines on low-cost tank designs, using indigenous construction materials, and on determining optimal tank sizes for given climatic conditions.* Various collection systems and construction techniques that can be easily carried out by unskilled villagers are being examined. Financing and maintenance schemes, which can be implemented at the village level, are also being investigated as well as the development and introduction of water-rationing schemes for dry zones.

In the case of groundwater extraction, research is being undertaken by the Sarvodaya Movement, a grassroots non-governmental organization in Sri Lanka, on the development of low-cost, well-drilling techniques which, again, can be carried out by relatively unskilled village labourers.

To address the question of handpumps, the United Nations Development Program (UNDP) and the World Bank has established a project for the testing and technological development of handpumps for rural water supplies. A total of

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* It should be pointed out that references to projects being carried out outside of the Africa region are made due to their relevance to the situation and the fact that the research results have global applicability.

2860 pumps, among 76 pump types, are currently being field tested in 17 countries. Laboratory endurance tests are being carried out by the Consumers' Association laboratory in the United Kingdom. Emphasis has been placed on encouraging the development of pumps suitable for village-level operation and maintenance (Arlosoroff et al. 1985).

To meet this criterion, researchers in several countries are systematically examining the implications of new materials and improved designs. In view of the widespread introduction of plastics in developing countries, particular attention has been focused on the polymer resins, specifically polyvinyl chloride and polyethylene. Design work has centred on developing simple, low-cost piston and foot-valve assemblies. By simplifying the technology and using materials that are readily available in developing countries, it is possible for these countries eventually to become self-reliant in the manufacture of handpumps.

Simply "parachuting" a technology into a rural community and expecting households immediately to use it is no longer considered appropriate strategy. Communities must be involved in the planning and implementation of programs designed to introduce these technologies at the village level. Communities are also more apt to accept, use, and maintain technologies such as handpumps if they feel that they are their own. Therefore, more attention must be focused on research aimed at examining important social, cultural, and economic aspects such as community acceptance schemes, financing arrangements, and community participation strategies among others. The users must be supplied with easy-to-understand information about the benefits of change in order to be convinced to adopt new behavioural patterns and accept new ideas (Sharp and Graham 1983).

Research is currently under way to demonstrate that appropriate technologies can be transferred to the village level and that the villagers themselves can ensure the continued functioning of a pump, for example, if given sufficient training, experience, and resources. In addition, research projects in Ethiopia and Sri Lanka are focusing full attention on demonstrating the capacity of village women to manufacture, assemble, monitor, and maintain handpumps at the village level.

In Ethiopia, the Ethiopian Waterworks Construction Authority, in cooperation with the Mechanical Engineering Department of Addis Ababa University, is intent on addressing the maintenance issue. One hundred and twenty locally manufactured pumps are being installed and evaluated for their technical performance. In addition, women from the villages where the pumps are being installed will be trained to carry out routine maintenance procedures. Given the fact that women are the primary collectors of water, it follows that they will have a higher appreciation of the need for reliable handpumps. Therefore, women should be encouraged to participate actively in all phases of water supply development, including the decision-making process.

Interest in the utilization of solar energy has led to the development of solar engines and photovoltaics to drive mechanical pumps for irrigation and water storage. As nature would have it, the drought-prone Sahelian countries have an

abundant supply of solar energy. Recent technological developments are making it possible to produce photovoltaic cells at a much lower cost than previously assumed. Eventually, this technology may prove to be a viable solution to the delivery of water from groundwater reserves.

Another interesting pumping device utilizing solar energy is the solar liquid piston pump (Murphy and Brew-Hammond 1984). The first such pump was patented in England by Thomas Savory in 1698 and was used to pump water out of coal mines until it was replaced by mechanical pumps. Since then several other designs of liquid piston pumps have been tried but not widely used because of low efficiencies, critical operating conditions, and the superior performance of mechanical pumps (Murphy 1979). However, at McGill University a solar liquid piston pump has been developed which holds considerable promise as a simple, low-cost water pumping device. Plans are under way to field test this pump at the University of Science and Technology, Kumasi, Ghana.

The quality of drinking water is a major concern for people living in remote rural areas. If the health status of a community is to be protected against water-borne diseases, potable water sources must be routinely monitored and assessed for the presence of faecal coliform bacteria, the accepted indicator of faecal pollution. To do this requires skilled technicians with access to well-equipped laboratories. More important, it requires that any drinking water source found contaminated be disinfected and the cause of the problem corrected as soon as possible. Most developing countries do not have this capability.

There are two important considerations when monitoring water supplies. These are realistic standards and practical laboratory techniques for assessing water quality. However, in most, if not all developing countries, it is nearly impossible for rural water sources to meet internationally recognized WHO standards. To overcome the factors that limit the effectiveness and practicality of water quality control programs in developing countries, simpler, inexpensive bacteriological tests are needed that can give rapid results in the field. In addition, a system is needed for categorizing water sources according to levels of contamination or "relative risk." This scheme could be based on the microbiological content of the water being tested and on the degree of sanitary protection at the source. This would permit developing countries to routinely monitor and classify their drinking water sources and set bench marks for maintaining and improving water quality with a minimal amount of expertise and resources.

Research is currently under way in Asia and Latin America, and is being proposed for Egypt, Tunisia, and Morocco, on evaluating the use of coliphage organisms as indicators of faecal pollution. Coliphage is the general name given to a certain group of bacteriophages, viruses that attack bateria of the coliform group. They can be easily detected without the use of sophisticated laboratory equipment and at a much lower cost than conventional tests. The techniques used are relatively simple and results can be obtained rapidly. In addition, because coliphage organisms are more resistant to chlorine disinfectants than coliform organisms, they may be more useful as indicators of disinfection efficiency than the standard coliform indicators.

Another group of tests, known as the presence/absence (P/A) test, routinely used by Ontario Government laboratories to screen drinking water samples for bacteriological hazards, is also being examined for use in developing countries. Such tests indicate the presence of enteric organisms or possibly a pathogen, making it possible to screen large numbers of water sources without having to rely upon a laboratory. If positives are found they are confirmed by the more sophisticated conventional tests. If found practical for developing country conditions, this procedure will greatly reduce costs and speed up monitoring activities.

Even if a water source is adequately protected and maintained, users must sometimes travel considerable distances to reach it. Under these conditions, it is likely that clean water will become contaminated in transit or while in storage at home. Efforts to protect well water from contamination at the source is often negated through its mishandling before consumption. Therefore, disinfection at the household level is an important consideration.

There are a few methods commonly advocated for disinfecting drinking water. These include boiling water for a minimum of 10 minutes and the use of chlorine compounds available in liquid or tablet form. Iodine can also be used. However, to most people not accustomed to the taste of these compounds, their use is unacceptable. In addition, their relatively short shelf-life often limits their viability as disinfectants. Complicated by procurement and distribution problems, their application is extremely limited in the developing regions of the world where water-borne diseases are most prevalent. However, these difficulties are only part of the problem. For instance, about 1 kg of firewood is required to boil 1 litre of water for a sufficient period of time to kill the pathogens which might be present. In drought prone areas, this energy consumption is unjustifiable and likely impossible.

In view of the above constraints and difficulties, alternative methods of disinfecting water are being examined. One such method is the use of direct sunlight, in particular ultraviolet radiation and/or heat from solar energy. Laboratory research has shown that UV radiation from UV lamps can significantly reduce harmful micro-organisms found in drinking water. However, very few experiments have been conducted on the effect of natural UV and/or heat from solar energy as a means of disinfecting drinking water at the household level. Research is currently being carried out at Chiangmai University in Thailand and at the American University of Beirut in Lebanon on the feasibility of using solar energy for disinfecting drinking water in small volumes (on a batch scale) and in continuous-flow systems. In these experiments, local materials are being used to minimize construction and maintenance costs.

A recent survey conducted in a village in Tamil Nadu State in India documented that an extract derived from the seeds of the Theythancottai tree has been used for centuries to treat water for drinking purposes. By rubbing the seeds on the inner surface of earthen pots or by crushing them to form a suspension, which is allowed to settle, a high percentage of suspended solids and bacteria are mechanically removed thereby reducing the risk of water-borne disease

transmission. Research is about to begin to assess the efficacity of this method. However, more research needs to be carried out on identifying and examining other traditional water-treatment methods.

Poor drainage at the well site too can create public health problems if stagnant water is allowed to become a breeding site for mosquitoes and other insects that may carry diseases such as malaria or dengue fever.

Another public health concern is the potential adverse health effects of small-scale irrigation projects. Schistosomiasis, a debilitating parasitic disease caused by a blood fluke which uses a freshwater snail as an intermediate host, is on the increase in many areas where such projects have been introduced (Mott 1984).

It has often been said that a project will not succeed unless the community is involved. Unfortunately, not enough attention is paid to assessing social, cultural, and economic constraints which inhibit meaningful involvement when implementing water development projects. To do so requires a multidisciplinary approach by a team of professionals which may be difficult to control and co-ordinate, and is time consuming. Community participation, therefore, often takes the form of free labour as it is easiest to organize. In other words, "we'll provide the pipes if you dig the ditches." Unfortunately, it isn't until after the facility is installed that the problems of ownership and responsibility for maintenance begin to surface. Often, the attitude expressed is: if the government installed it, then the government should maintain it - no matter what previous arrangements have been made with the community.

In some arid areas, natural sub-surface reservoirs fed by infrequent rains are the only source of water for remote rural populations. However, sometimes this water is too salty or brackish for human consumption. In Botswana, research is being conducted by the Rural Industries Innovation Centre on the development of simple, solar desalination devices. While the designs vary with respect to construction materials, volume of distillate produced, portability, and expected lifetime, all models share an important characteristic - they are designed to be relatively inexpensive and easy to operate and maintain and can provide potable water under harsh environmental conditions. The intent of the research is to provide remote rural dwellers with the means to become self-sufficient in the provision of potable water. The development of an appropriate training program for the operation and maintenance of these stills and an assessment of their technical performance, their social acceptability, user preferences, and utilization patterns are important components of the research.

Generally, the primary purpose of water supply programs is to deliver water that is safe to drink, adequate in quantity, and accessible to all. Limited resources must be directed toward finding the optimum balance between these three characteristics.

It must be pointed out, however, that an increased supply of safe water must be accompanied by certain behavioural changes that affect personal hygiene and sanitation practices before enteric diseases can be significantly reduced.

These changes are complex and are not likely to occur spontaneously. The entire population must be supplied with easy-to-understand information about the benefits of change and convinced to adopt new habits and accept new technologies. Furthermore, consumer acceptance of water and sanitation technology depends on the use of devices that hold up to abuse, function for long periods, and can be purchased and maintained by the villagers themselves. Not only must the users understand the technology and its limitations, but they must test it, and adapt and modify it to their own needs and perceptions.

As demands on developing countries' meagre resources grow, and as more and more pressures are being imposed upon the urban centres due to rural-urban migration, it is unlikely that governments will be able to provide adequate long-term services to those who need them most, the rural poor. Therefore, if positive change is to take place, these communities must become self-reliant. In the drought torn regions of the African Sahel, promoting self-reliance and self-sufficiency in improving food production, developing necessary water resources, and installing sanitation facilities, while still paying attention to the fragile ecology, will reduce the impact of future disasters. According to David Negus (1985), many of the mistakes made during previous drought relief operations are being repeated creating new and reinforcing old patterns of dependency. He states:

> As the cycles of disaster and dependency continue, it becomes harder and less feasible for countries or people to break the cycle. What is needed, if we can find it, is a way to build a cycle of increased self-sufficiency, capacity to cope with disasters that will come, and movement beyond to further confidence and indigenous capacity for development (Negus 1985, p. 17).

Non-governmental organizations (NGOs) are increasingly assuming responsibility for water supply and sanitation in rural areas. Most NGOs are action-oriented and have vast experience in community participation strategies. They, therefore, hold considerable promise in being able to help solve local water problems by providing the necessary technical expertise and training to villagers in how to handle various water-supply technologies. They are less bureaucratic, closer to their target audiences, and are the most familiar with the social and cultural factors that inhibit the effective adoption of new technologies and are therefore most effective as agents of change. In an article in the journal "World Health" Mechai Viravaidya, Secretary General of the Population and Community Development Association and Governor of the Provincial Water Works Authority, Bangkok, Thailand, states: "Now is the time for government bodies - both national and international - to acknowledge the role of NGOs in bringing health services to hundreds and millions of poor people and to follow up that acknowledgement with concrete backing and support" (Viravaidya 1985, p.2). Governments and donor agencies should therefore focus financial resources on developing networks of small, indigenous NGOs. They must provide them with access to the wealth of scientific information already

available. They must also provide the NGOs with the research skills needed to examine and modify technologies to suit a given circumstance and to carry out studies aimed at solving the many problems associated with project planning and implementation. Knowledge of health education techniques and of how best to deliver public health messages to the villagers so that they can be understood and accepted is also important. Training in how to apply for financial assistance from donor agencies and in how to manage projects once funded is another consideration. With a relatively small amount of money, the potential impact NGOs have in creating positive change can be significant.

Finding solutions to the problems of drought-prone areas is a global responsibility. We must carefully reassess our position as modifiers of the environment and group together to share our knowledge and resources for the responsible management of limited renewable and nonrenewable resources.

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DROUGHT IN AFRICA: ACTION WITH RESPECT TO CLIMATE

by

F. Kenneth Hare

ABSTRACT

The monitoring of climatic and hydrological parameters is essential if drought and desertification are to be combated. The World Meteorological Organization (WMO) is helping member countries to restore observing systems that have suffered from financial stringency. New satellite technologies could be more widely used to provide Africa with current data on surface conditions and climate. Climatological services and research are important for both food production and desertification control. AGRHYMET, a CILSS venture operated by WMO, provides good current information on early warnings of crop production losses and climatic behaviour, and also helps train personnel, as do 35 technical assistance programs in 25 African countries. A new African Centre of Meteorological Applications for Development is planned (under ECA auspices), probably in Nairobi. World Climate Programme activities under WMO leadership (with ICSU collaboration) involve modeling exercises aimed at investigation of feedback processes and climatic change, to see whether drought in Africa is ultimately predictable, and when the present dry phase will end.

INTRODUCTION

I have been preceded in this program by several African specialists to whom drought has a direct personal relevance. My own life has largely been spent in countries with a large surplus of water. I apologize for the incongruity. Nevertheless, I have been chosen by the World Meteorological Organization (WMO) to serve as its spokesman and will do my best to present its views objectively.

In parenthesis I should point to two good reasons why I could not refuse. First, I believe that the African situation is one of the world's most crucial dilemmas and one where natural processes play an unusually big rôle in strategic questions. My first exposure to the problems of the Sahel was over forty years ago, in the midst of another drought, when for military purposes I had to take a close interest in both flanks of the Sahara. In 1977, I was fascinated to see the paper I wrote then on the Sahelian climate republished in a modern journal (Hare 1977a). And second, I had the honour to help train, when he was an undergraduate at McGill University in the 1950s, the present Secretary-General of WMO, Dr. G.O.P. Obasi. I have been lucky enough to have had many graduate students from Africa, especially from Nigeria. One of them was recently President of the General Assembly of the United Nations.

WMO is not a large or rich body. In Geneva it is one of the least conspicuous and most humbly-disposed of the UN agencies. Its strength lies in the extent to which it can mobilize the voluntary collaboration of its numerous member governments. It succeeds to a remarkable degree (and I speak as an independent

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* Submitted on behalf of the World Meteorological Organization

observer). Over its long existence it has participated in or sponsored many major scientific programs, in nearly all cases by persuading its members to mount the programs and to get their own governments to pay for them. In recent years the Global Atmospheric Research Programme and the World Climate Programme have been organized in this way, with the active partnership of the International Council of Scientific Unions (ICSU). The latter fact demonstrates another reality about WMO - that it has been able to commmand the willing help of the scientific community outside government.

WMO has done as much as it can to alleviate the problems raised by drought in Africa, and will go on doing so. I have been involved in some of these ventures, and would have done more had I not been an academic administrator. In my own view the solutions to Africa's problems - for example in food and fuel supply, and in the control of desertification - lie more in the socio-economic domain than in that of the climatologist. Nevertheless my field tends to be undervalued. It may be that an ability to predict drought, or its ending, would not alone solve Africa's problems. But it is also true that they will not be solved if the present scale of drought continues. That seems unlikely, but not impossible.

I shall report on WMO's activities in what follows on the basis of the Organization's own responsibilities. The Secretary-General would wish me to say, however, that help from other UN agencies has been indispensable to its work - and in some cases leadership. WMO maintains especially close relationships with FAO and UNEP. I have myself been closely involved with UNEP in some of these enterprises. In addition UNDP and UNSO (UN Sahelian Office) have had much to do with funding these activities. Finally the Economic Commission for Africa has taken many initiatives in which WMO has been in effect the lead agency. I had the honour to chair a special expert meeting of WMO on the drought situation in Africa. The report of this meeting was used in the ECA Scientific Round Table.

MONITORING CLIMATE

Effective scientific and economic action in Africa is handicapped by a lack of reliable and accessible data about climate. The same is true, of course, about most other things; but the situation is especially severe in the matter of climate. As African governments have become poorer, they have tended to close down weather stations, abandon record-keeping, and reduce services to relay information to their publics. It is imperative that this decay be reversed. WMO cannot do this from its own resources. But it can and does urge all governments to support their own national meteorological and hydrological services. I quote verbatim and selectively from the recent report of the UN Economic Commission for Africa on a regional plan of action to combat the impact of drought in Africa:

> African countries should take prompt action to
>
> a) strengthen national meteorological and hydrological services ... so that they can provide the necessary services to the nation in combating drought ...

b) upgrade ... data-gathering networks, including the reopening of observing stations that, for one reason or another, have been closed down; provide necessary maintenance for instruments at all stations; and increase the number of upper air observing stations to the point where drought processes can be analyzed and better predicted;

c) ensure that the necessary meteorological and hydrological data are observed regularly, collected, processed and disseminated promptly by improving transmission and data-handling capabilities; the data should also be properly stored for use in the future (UN Economic Commission for Africa, 1984).

Given the urgency of the drought problem it is amazing that governments should need such advice, or that some of them should have allowed such a decay to proceed. The fact remains that in many parts of Africa the observation of climate is less effective than it was two decades ago (S. Nicholson, personal communication).

There is still, to my knowledge, no publicly-organized centre for the collection and dissemination of climatic data for all Africa. The reports emanating from other bodies concerned with the continent's problems show that this is a serious gap. WMO used to attempt this collection, but no longer does so. Instead it has been left to individual scientists in various countries to keep watch on the overall progress of African rainfall. Of these, the work of Winstanley (1974) was influential in raising world consciousness of the problems of predicting drought in the Sahel. It has been Sharon Nicholson, of Florida State University (1983), who has done the most thorough analysis of rainfall variation on the continental scale. It was her work that demonstrated the high degree of spatial coherence in the occurrence of drought. In other continents it is not common for prolonged drought to affect very large areas simultaneously. In Africa she has shown it to be a common feature - a fact that has high economic and political importance.

I would not want this expert body to assume that climatic monitoring is confined to the analysis of surface observation done once or twice per day. On the contrary we now have in orbit a variety of remote sensing devices that have transformed our knowledge of world distributions. The European geostationary satellite METEOSAT is, for example, permanently placed over the equator just off the west coast of Africa. Every observation that it takes, in its several frequency bands, "sees" all Africa. For the first time we can accurately plot the development and displacement of the cloud masses and storm systems of the African monsoon and other rainbelts.

In addition, it is now possible to use LANDSAT or NOAA advanced very-high-resolution radiometer imagery to record the greenness of Africa's surface (Tucker, Townshend, and Goff 1985), and thereby to watch the seasonal migration of the growing season in pursuit of the rains. Using the second of these

sensors the authors have shown that it is indeed possible to watch the migration of the zone of most vigorous growth, and to record its retardation by drought. So far this has been a research enterprise, but it clearly has much to offer those who must monitor drought for political and economic reasons. I should add that the direct ecological use of these sensors has been a special interest of the research staff of the Global Environmental Monitoring System (GEMS) in UNEP. It is pleasant to see climatological applications emerge from similar work.

In a nutshell, we now possess the means whereby Africa might, if so inclined, monitor climate and ecological response with amazing detail. What is lacking is the money needed, and the skills and institutional strength to do so. What also needs to be explored is the use to which such information might be put. A psychological and economic light-year separates the information potential from the realities of life for the ordinary African farmer or herdsman.

Let me, however, make a point that is apt to be overlooked by those with European or North American backgrounds, though never by Africans themselves. The African droughts of the past two decades have been appalling in their intensity, extent, and persistence. It is probable that there have been several historic episodes of similar or even greater intensity; but never before has Africa or any other continent had to confront such conditions at a time when populations and expectations were rising so rapidly. And never have new political states, freshly liberated from colonial rule, had to face such grimly hostile conditions. This coincidence in time has been literally tragic.

DESERTIFICATION CONTROL

WMO has done what it can to help African countries control desertification. In 1978 its Executive Committee adopted a plan of action in support of the Plan of Action to Combat Desertification (PACD). Since then it has attempted to follow up the proposals. It has commissioned periodic reviews of the problem, some of which I have conducted and written (Hare 1977b, 1983). Its major contribution has been, however, its coordination and management of the AGRHYMET Programme, aimed as much at food production as at desertification control. AGRHYMET will be dealt with in a later section.

The major thrusts of WMO's work against desertification are as follows:

a) attempts to persuade all interests that the major remedial measures are concerned with land use control, and that such control is also the most effective form of local climate control.

Climate can be seen from two quite different perspectives, revealing respectively the microclimate and the macroclimate. The former is what the farmer, herder, ecologist, and soil scientist deal with. It is the effective, on-the-spot reality for those who want to use or protect the land, or just understand how its productivity can be maintained. Macroclimate, on the other hand, is the large-scale weather and climate of common experience, the flow past

the observer of those things that clearly depend on large-scale atmospheric transport and behaviour. The incidence of widespread rain depends mainly on the general circulation of the atmosphere, and hence on world-wide processes.

The fight against desertification clearly aims to restore productivity to damaged land. Damage includes removal of tree and shrub cover, which allows sunlight to heat up the soil hence increasing the rate of oxidation of organic material. It also reduces aerodynamic surface roughness and increases albedo (reflectivity with respect to sunlight). So does exposure to bare soil, which is also subject to wind and water erosion of fine materials, including nutrients. Exhaustion of shallow groundwater, stored soil water, and salinization of irrigated land are also vital concerns.

Actions taken to reverse these processes are beneficial in that they do not merely work directly towards better surface conditions able to support more cultivation, herding, and wildlife; they also help restore a healthy microclimate, which may be defined as a climate with low albedo, relatively low soil temperatures, high soil moisture holding capacity, high nutrient and organic content, and high surface roughness.

b) attempts to encourage better use of climatological data, to raise consciousness of the importance of climatic processes, to predict and monitor drought, and to educate observers in the use of appropriate instruments and techniques.

At all levels, from the individual farmer to the world development organizations, there is a failure to make the best use of available information - and the same must be true in other technical and political fields. WMO tries to ensure that official meteorological agencies make such information available in usable and statistically defensible terms. It also tries to help in the extremely difficult monitoring and prediction problems, the latter particularly at the research level. And it is active in training programs of many kinds.

In Africa as in most other parts of the less developed world it is difficult to realize these objectives. In part this is because national meteorological services are starved of people and resources, at a time when maximum pressure is being put upon them. But there is also a need to focus research and training programs upon these special needs.

This objective permeates the proposals for an African Centre of Meteorological Applications for Development (ACMAD) put forward by the Economic Commission for Africa in collaboration with WMO. The planning report of November 30, 1984 emphasized that "the main purpose of the Centre [must be] to produce useful applications of meteorology... Resources required must include the communication of processed information to users..." A joint meeting of the two agencies agreed, inter alia, that Nairobi is the best potential site for such a Centre, though others were considered; that "ECA should organize a separate consultative meeting of users and experts to clearly state user needs so as to permit a useful activity programme to be developed...." Governments should be involved from the beginning, and user evaluation should be carried out from the outset.

The ECA Conference of Ministers, at its meeting in April 1985, resolved that such a Centre be established. It authorized extensive planning. It decided that

> the role of the African Centre of Meteorological Applications for Development is to improve the understanding of atmospheric and climatic process over the continent; collect, analyse and disseminate meteorological and hydrological information to serve as a watch or early warning system over Africa and faciliate the training of African scientists and technicians in the applications of meteorology for development (UN ECA 1985).

The proposal is expensive. Among other things a much-needed Cray-II computer is included. Between 1980 and 1990 total expenditures of $7,232,000 were predicted by the Technical Preparatory Committee. In relation to the difficult situation confronting the entire continent and the potentially large returns, the sum is quite modest. It will be very difficult, though not impossible, to staff the Centre even if it is fully funded.

No distinction is made in this proposal between desertification control and food production. Good land use practice is the key to both. The aim of applied meteorology is to help land use practice maximize the potential returns from the climatic resource and to minimize the hazards to food production, water supply, and long-term biological productivity.

An actual experiment aimed at much more immediate results has been AGRHYMET, a regional project set up to combat the drastic effects of the earlier phases of the Sahelian drought. Carried out by WMO in cooperation with the CILSS countries, it has regional headquaters at Niamey, Niger, national centres in member countries, and a series of field study areas. Its main thrust is to maximize food production in the light of annual rainfall conditions and to incorporate the early warning systems of FAO and the U.S. NOAA into a specific warning system for African countries. Measures to control desertification are within its scope.

Other WMO measures under way or planned in Africa include 35 technical assistance projects in 25 countries, chiefly involved with strengthening national meteorological services, and especially with agrometeorological and hydrometeorological skills. WMO is involved with the Niger Basin Authority in hydrological forecasting on the Niger River. It is also preparing to implement this year (1985) a new regional project for assistance to stricken countries in Southern Africa, where drought has been severe in recent years. The Secretary-General has proposed that a meteorologist be included in the management group of the Office for Emergency Operations in Africa, essentially to feed into that group the most current information about climate and the annual progress of the rains.

Clearly we do not know enough about the African climates. New insights into the mechanics of monsoon and intertropical climates are now being gained almost daily. But these have not yet crystallized into a coherent picture, much

less a predictive framework. Research of three different kinds is needed, and must necessarily be internationally coordinated. These are

a) research into surface microclimates, and their relation to ecological change, land use practice and physical characteristics (e.g., albedo, aerodynamic roughness, water holding capacity, and groundwater behaviour);

b) research into those aspects of the general circulation of the atmosphere and oceans that bear on intertropical rainfall and its erratic distribution in time and space; and

c) research into questions of climatic change over decades and centuries.

Research of the first kind can and should be a major thrust today in the universities and research institutes of the arid zone, including Africa. Several U.S., Australian and South African universities are active in this field, as are several bodies in the Soviet Union. Microclimate research should be an immediate priority of ACMAD. Costs are relatively low.

Research of the second and third kind are at the core of the World Climate Research Programme being jointly pressed forward by WMO and ICSU. Major stress is now being placed in particular on two major themes. One is the nature of the remarkable el Niño-Southern Oscillation (ENSO) phenomenon made so topical by the great event of 1982-83 (which did untold damage to Australia's arid land and agriculture and to many other locations in South America and South-East Asia), and the probable links of all such intertropical events with other aspects of the general circulation, including ocean surface temperatures. African rainfall displays aperiodic but inevitable swings between great excess and extreme deficit, on time-scales that are clearly not random. The challenge is to determine the causes and interactions of these massive fluctuations and how they relate to the general circulation.

The relevance of carbon dioxide heating of the atmosphere (and that of other trace gases) to African rainfall needs to be elucidated. Long-term planning, beyond the next one or two decades, will demand an assessment of this influence. The few modeling results available so far suggest small increases in monsoon rainfall, but with significantly higher radiation incomes and air temperatures. No adequate experiment has yet been mounted to test the validity of these estimates.

Clearly ACMAD will have to gain the competence (and have the computing capacity) to enter these two fields. This will be a very large job. In the meantime Africa will remain dependent on those external centres that devote attention to the continent's needs.

WEATHER AND CLIMATE MODIFICATION

I have said nothing specific about cloud seeding, the artificial modification of climate by flooding desert basins, planting greenbelts, or the large-scale

alteration of the world's geography, such as blocking the Bering Straits. These approaches are difficult, expensive and of value only when their results can be shown with considerable assurance to be cost-effective - which is rarely the case. The points emphasized in this paper are the currently acceptable thrusts of my profession. But that does not mean that geotechnical intervention will never be possible. It just does not look like a good bet today, given the realities of Africa's situation.

A PERSONAL ASSESSMENT

I began by admitting that WMO is a modest organization, depending largely on the coordinated work of its many members. It has been fortunate enough to receive the willing help of many national meteorological services and has escaped the influence of power bloc differences. Nevertheless the Organization is small, and can only do what its tiny and overworked staff can cope with.

My own relationships with WMO go back over 30 years. They have been close and harmonious. Always I have worked, not as a national delegate, but as an invited expert, a working scientist who has served sometimes voluntarily, sometimes as a paid consultant. Such arrangements are quite common. In my opinion they are highly productive.

Speaking from this detached perspective I should say that the Organization's greatest need is for more contact with those who guide the social, economic, and political affairs of the United Nations, so that the usefulness of its ideas in the development process might be more obvious. I am not sure who is the more dangerous, the natural scientist who knows too little about the realities of the world system or the economist who knows too little about the world's natural limitations. This meeting is an excellent example of contacts that have been needed for years, but were all too rare in the days when there was enough rain. La cigale, ayant chanté tout l'été, se trouva fort dépourvue, quand la bise fut venue!

Let me close by quoting some words from Dr. G.O.P. Obasi, WMO's Secretary-General, in his May 1984 statement to the ECA Conference of Ministers:

> The drought in Africa is a terrible affliction which has caused suffering among hundreds of thousands of African people. This drought is among the most important natural disasters in this century and at the same time is an extremely challenging scientific problem. It is true that we cannot yet accurately predict the cessation of the drought in Africa, nor when it will recur. It is also true that we cannot at the present time alleviate the drought by rainmaking .... However, WMO firmly believes that practical and useful steps can be taken now to help African countries make better use of existing weather and climatic data and techniques. It is intended to work with national meteorological services, with regional organizations such as the ECA, and with other international organizations to help African nations try to cope with the scourge of drought (Obasi 1984).

I would only add that for us to progress along the lines that Dr. Obasi suggests, the rains must return, and in abundance. And the lessons learned in this terrible present catastrophe must not be forgotten.

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EMERGENCY FOOD AID AND THE REHABILITATION OF AGRICULTURE IN AFRICA

J.H. Monyo

INRODUCTION

Food and agricultural production in Africa, particularly in sub-Saharan Africa, is very risky. Traditional peasant agriculture has adapted itself reasonably well to the uncertainties of the agro-ecosystems, brought about by droughts, pests, and diseases.

Over the past two decades food production in sub-Saharan Africa has not changed much; the growth rate for area expansion has gone down and the production growth rate has declined. Since the late 1960s much of Africa has experienced widespread and in some countries a chronic situation of diminishing levels of per capita food production, rising food imports, and increasing incidence of food emergencies (1).

On a global basis Africa is currently the region in which the need for growth of food and agricultural production is most compelling. During the period 1974-1983 Africa achieved only 1.9 percent food production increase against the region's goal of 3.8 percent discussed by the World Food conference in 1974. Population during the same period increased at a rate of 3.0 percent per annum. This compares to a global average food production increase of 3.4 percent and an average population growth of 2.1 percent for all developing countries (2). Only eight African countries had a food production increase in excess of population growth rate (Figure 1). In three African countries, namely Malawi, Nigeria, and Tanzania, increase in food production was equal to population growth rate. However, averages can be misleading; the data showing overall performance in food production in developing countries also conceal widely differing rates of production gains by country in relation to population growth.

A number of diagnostic and prescriptive studies of the African food situation were released in the early 1980s by FAO(3), the World Bank(4), and USDA(5). African governments have become alarmed by the widespread deterioration in the performance of their agricultural sectors and have made declarations, at various fora, of intent to overcome the situation. They have also agreed in principle on a set of programs for implementation (6,7). In recent years the FAO Committee on World Food Security has given special consideration to constraints to food production in the low-income food deficit countries of Africa and possible measures to overcome them(8).

Africa is currently facing a serious economic and social crisis. A large part of the continent has been affected by drought in successive years. The food situation in many, if not most, African countries is alarming, and disturbing reports of famine pervade the news media. Twenty-five countries in Africa have been affectd by calamities in 1983-85; their food and agricluture situation is currently being monitored by the FAO/World Food Programme Special Task Force on

FIGURE 1 - ANNUAL RATE CHANGE OF FOOD (CROPS AND LIVESTOCK) PRODUCTION IN RELATION TO POPULATION GROWTH FOR 105 DEVELOPING COUNTRIES 1974-83

Rate of change of total output %	POPULATION GROWTH (%)						1983 on Population (millions)
	1.5% and below	1.6 to 2%	2.1 to 2.5%	2.6 to 3%	3.1 to 3.5%	3.6% and above	
-3.0 and below	TRINIDAD AND TOBAGO				GHANA	SAUDI ARABIA	24.2
-2.9 to -2.0				GAMBIA			0.7
-1.9 to -0.1	KAMPUCHEA	DOMINICA GUINEA-BISSAU YEMEN	LESOTHO	BOTSWANA MOZAMBIQUE PERU SENEGAL	NICARAGUA ZIMBABWE ZAMBIA PUERTO RICO		74.8
0.0 to 0.9	JAMAICA	MAURITIUS	ANGOLA CAMEROON HAITI GUYANA YEMEN	BOLIVIA GUINEA	ALGERIA		68.5
1.0 to 1.5	GABON URUGUAY SAMOA		BURUNDI CENTRAL AFRICAN REP. COSTA RICA NEPAL	EL SALVADOR MADAGASCAR NAMIBIA SIERRA LEONE			48.0
1.6 to 2.0		CHILI	EGYPT	AFGHANISTAN CONGO DOMINICAN REP. SUDAN ZAIRE	MOROCCO UGANDA VENEZUELA	KENYA LIBERIA SOMALIA	213.1
2.1 to 2.5	CYPRUS	CAPE VERDE CHAD	PANAMA	BENIN MALI PAPUA NEW GUINEA TOGO UPPER VOLTA	EQUADOR IRAN	LYBYA	86.9
2.6 to 3.0	BARBADOS	INDIA N. KOREA REUNION	BHUTAN TURKEY	BANGLADESH			912.7
3.1 to 3.5	ARGENTINA	ETHIOPIA	COLOMBIA	GUATEMALA MAURITANIA	MALAWI NIGERIA TANZANIA	JORDAN	214.4
3.6 and above	CHINA CUBA LEBANON	SRI LANKA INDONESIA SURINAM	BRAZIL BURMA S. KOREA LAOS MALAYSIA THAILAND VIETNAM	MEXICO NIGER PAKISTAN PHILIPPINES SWAZILAND	IRAQ IVORY COAST PARAGUAY RWANDA	BRUNEI HONDURAS SYRIA	1 791.6

SOURCE: FAO, ESS

Prod > Population Prod = Population Prod < Population

Africa and their total 1985/86 population is estimated at 229 million people. Thirteen of these countries, with a total population of 129 million, are expected to be in need of exceptional food aid in 1985/86. Amongst this latter group of countries, Chad, Mali, Ethiopia, Mozambique, and the Sudan have indicated that 24 million people are exposed presently to hunger and malnutrition.

The FAO/UN World Food Programme is also presenting its activities in relation to the drought in Africa. In order to avoid unnecessary duplication this paper will concentrate on three major aspects of the food crisis: monitoring and assessment of food aid needs; sensitization of the international community, both bilateral and multilateral donor agencies, on the urgency of the situation; mobilization of resources to meet the immediate food aid requirements and to rehabilitate the agricultural sectors of the affected countries. It should be noted that close cooperation exists between FAO and the World Food Programme in this endeavour.

CAUSES OF DROUGHT IN AFRICA

In a broad sense there are three types of drought: hydrological or water resources drought, agricultural drought, and meteorological drought(9). Changes in both rainfall and evaporation may result in the first two. The third type of drought is usually a function of rainfall deficit. Crop yields in much of rural Africa are by far more dependent on rainfall than temperature. As such, the terms agricultural and meteorological drought are for all practical purposes synonymous.

There is no precise definition of drought. However, a drought situation can be presumed whenever rainfall falls significantly below expectations. Rainfall in many African countries varies considerably from year to year. In regions where average rainfall is close to the limit for prevailing agricultural activity, drought tends to be a recurring phenomenon. A large land mass of Africa is subject to recurrent drought interspersed by periods of adequate rainfall.

Specific causes of drought are difficult to determine, particularly on a regional scale and the causes of the recent drought in sub-Saharan Africa are not known. A number of hypotheses have been advanced but none has been conclusively proven. However, although precise causes are unknown, the long-term nature of the rainfall decline in sub-Saharan Africa coupled with the large area affected by the resulting drought are said to be indicative of some large-scale causal factor(9).

Possible causes that have been advanced relate to the position of the Inter-Tropical Convergence Zone, cross equatorial energy transport, sea-surface temperatures, land surface boundary conditions, atmospheric humidity, atmospheric dust, increasing atmospheric carbon dioxide concentration, the location and intensity of Hadly-type and Walker-type circulation, and/or to upper air flow patterns and associated atmospheric energetics. Nobody knows for sure whether one, two, three, etc., or a combination of all the above factors is responsible.

STEPS BEING TAKEN BY FAO TO MEET THE CHALLENGE

The Global Information and Early Warning System on Food and Agriculture

The system has been in operation since 1975 and almost 100 countries now participate in it. It is operated through a central unit located in the Commodities and Trade Division of FAO in Rome. Participation in the System is open to all member countries of the United Nations and its specialized agencies. The cooperating countries and organizations provide information to FAO on a voluntary basis and have access to the analyses and forecasts issued by the System, and upon request to unpublished information as well.

The System monitors on a global basis the supply and demand of the major cereals, oilseeds, oils and fats, milk and milk products, meats, sugar, cassava, pulses, feedstuffs, and fertilizers. In monitoring the situation in individual countries, emphasis is still placed in cereals, partly for lack of adequate information on other products. However, attempts are currently underway to improve the monitoring of non-cereal staples where these make an important contribution to the staple diet of the population.

Information flows into the System from a variety of sources. Reports and other data are received from participating governments; FAO representatives, FAO missions, and technical experts; units in FAO headquarters including the Office for Special Relief Operations (OSRO), the Agro-Meteorological Group and Grassland Service (AGPC), the Remote Sensing Centre (AGRT), the Fertilizer and Plant Nutrition Service (AGLF), and the Locusts, other Migratory Pests and Emergency Operations Group (AGPP); other UN agencies such as the UN/FAO World Food Programme (WFP), Office of the United Nations Disaster Relief Coordinator (UNDRO), United Nations High Commission for Refugees (UNHCR), and World Meteorological Organization (WMO), and intergovernmental organizations such as the International Wheat Council (IWC); non-governmental organizations (NGOs); private trade and industry; wire services and other news media. Information is collected on all aspects of the commodities covered, including agro-meteorological conditions, production, trade, food aid, stocks, and prices as well as on government policies which are likely to influence the supply/demand position for basic foods.

The System uses rainfall and other environmental data provided by the existing meteorological station network as indicators of prevailing weather conditions influencing crop development in drought-prone areas in order to spot likely crop damage at an early stage. The main advantage of this method is that it can be started using the present infrastructure and does not require any sophisticated equipment. For the past ten years, a model based on the cumulative water balance has been employed to monitor crop yields in the drought-prone Sahelian countries, using ten-day rainfall summaries and other already available data. During the 1983/84 crop season, this method was also employed on an experimental basis to monitor crop prospects in southern Africa. Similarly, the System also keeps a special watch on agro-meteorological conditions in Asia during the monsoon season. However, the usefulness of the available ground observations is

limited by a number of factors. In many drought-prone areas, rainfall reporting stations are too few, their location is such that the data collected are not sufficiently representative for the weather conditions in the main growing areas, and the information collected is not always sufficiently reliable.

FAO is employing, on an experimental basis, two methods using remote sensing data in its crop monitoring. Work covering the Sahel and southern Africa has now shown that the interpretation of METEOSAT imagery of cloud formations can significantly improve the existing capabilities for reporting adverse weather conditions, particularly agricultural drought, which influence negatively crop and rangeland production. Furthermore, it has been shown that the vegetation greenness index based on NOAA/AVHRR data has the potential to provide uniform and objective information on interannual variations in seasonal vegetation development. These data can significantly strengthen the agro-meteorological forecasting techniques and allow for more detailed quantitative projections of crop and rangeland conditions for extensive areas at low cost. The services of the Remote Sensing Centre serve a dual purpose: to help the GIEWS staff to better meet its mandate of giving early warning of likely food production shortfalls in vulnerable areas; and to develop techniques of crop monitoring which in due course could be used by governments within the framework of their national or regional early warning systems.
To further improve the System's capacity for assessing the food supply situation, crop assessment missions have been sent to a number of countries where production shortfalls were reported. These missions visited the main cereal growing areas, inspected crops, and met with field staff as well as with donor representatives who were familiar with crop conditions.

In its assessment of the prospects for domestic food production the System relies mainly on the analysis of factors which directly affect output, such as planted area, the availability of inputs, crop conditions, and meteorological data. In addition, for certain countries other indicators which can provide early warning of an impending food supply problem are also monitored. These include free market prices in rural areas; cattle prices and slaughter rates; the pattern of procurement, sales, and stock-holding by national grain marketing agencies; and population movements.

Despite several improvements made over the past ten years there remain a number of important constraints to the operations of the System. While some of these are unavoidable, at least over the short term, others could be reduced or eliminated. Priority continues to be accorded to the improvement of the quality and timeliness of the inflow of data into the System. Efforts to improve the data base focused on those developing countries where the gaps in the information are largest, and where the need for better information is most urgent. Toward this end, efforts will continue to be made to establish national early warning systems in countries which are vulnerable to crop failures.

In order to improve the information on weather and crop conditions in critical areas over the short term, the System intends to make greater use of direct monitoring from Rome using satellite remote sensing data. Following the good results achieved in 1984 with the pilot programs mentioned above, a project proposal for an international trust fund to establish an operational satellite

remote sensing system to support agricultural production and desert locust monitoring and forecasting is now under consideration. This project proposal envisages the establishment in the Remote Sensing Centre of an operational capability for the acquisition, processing, and analysis of METEOSAT data and for processing and analysis of NOAA/AVHRR data. By supplementing the existing FAO facilities for the processing and interpretation of these data, this will allow better use to be made of the experience already gained by FAO staff in their analysis. These actions will be coupled with an expansion to all vulnerable countries of ground observation of agro-meteorological crop conditions.

Where crop conditions are recognized to be critical in a country or region, it may be necessary to provide an early estimate of the likely extent of the damage. This is of particular importance for countries which require outside assistance to avoid food shortages. In the preparation of these estimates, field visits to the affected countries for on-the-spot assessment of crop conditions are planned as early as feasible, usually in the immediate pre-harvest period. The early estimates thus made will subsequently be revised, as the situation develops and more information becomes available.

Despite the efforts made so far, the information available for basic foods other than cereals is still inadequate for the monitoring of the food situation at both the global and country level. Further efforts are being made to strengthen the data base for these foods.

In its monitoring of potentially critical food supply situations, greater attention is now being given by the System to other indicators of prefamine conditions. A number of these indicators are already being monitored on an ad hoc basis, including unusual migration, high prices for basic foodstuffs, and unusual sales of assets in rural areas, including livestock sales by nomadic populations. However, a more systematic approach is being developed for the collection and analysis of these data. In the course of the envisaged improvements in the identification of the affected populations at risk and the monitoring of the magnitude and composition of their needs, various techniques are being explored to improve the flow of this type of information to the System, either through national information-gathering projects or other means.

In order that the System is able to meet its objectives, it not only has to speedily collect, process, and analyze the relevant information, but also must communicate the results to governments and other users as quickly as possible and in a suitable form. For this purpose, the Global Information and Early Warning System on Food and Agriculture produces a number of reports. These reports are issued in different formats depending on their purpose and the confidentiality of the information. The Food Outlook report is issued monthly and is published in the five official languages of FAO for distribution to governments and the public. A special Report on the Food Situation in African Countries Affected by Emergencies is also issued monthly for general distribution. Other reports with restricted distribution include Foodcrops and Shortages issued monthly, and Cereal Import Requirements issued quarterly.

Special Alert reports are issued for specific countries or regions to give warning of impending food shortages. The alerts are telexed to potential donors on a confidential basis. A number of other special reports are prepared for a variety of reasons.

There is also a quarterly Food Aid Bulletin which contains detailed data by source and destination on food aid availabilities, allocations, and shipments provided by governments, WFP, and other agencies including the International Wheat Commission. Quarterly briefings on world food security are organized for Permanent Representatives of Governments to FAO in Rome. These briefings provide an opportunity to keep member governments informed of current developments and to obtain advice on action required.

The Office for Special Relief Operations (OSRO)

The Office for Sahelian Relief Operations (OSRO) was established in 1973 as the focal point for the evaluation, mobilization, and coordination of relief assistance for the Sahelian countries in West Africa, and its mandate was broadened on 1 October 1975 to respond to requests for emergency assistance from any part of the world. The Office maintained its previous acronym but was then designated as the Office for Special Relief Operations. The Office, however, retained the precious experience gained in the evaluation of immediate needs, the mobilization of emergency relief assistance, and its coordination, transport, and distribution in the Sahelian countries during the 1973/74 crisis. In addition, OSRO's location within the Office for Inter-Agency Affairs in the Office of the Director-General of FAO has allowed and favoured a closer relationship with other UN bodies active in the field of disaster mitigation, prevention, and preparedness.

The Office for Special Relief Operations responds to requests for emergency assistance in the agricultural, livestock, and fisheries sectors submitted by developing countries affected by natural or man-made calamities. OSRO's interventions cover a number of aspects of urgent relief and rehabilitation in the agricultural and livestock sectors in disaster-sticken areas and assist countries in the establishment of prepardeness and post-emergency measures.

In addition, the activities undertaken by OSRO include the evaluation of requests for emergency food assistance addressed to the Director-General, the issuance of periodic reports on the food, agricultural, and livestock situation in African countries affected by natural and/or man-made calamities, the dissemination amongst the international donor community of the reports of Evaluation Missions fielded by the Director-General to individual disaster-stricken countries, the representation of the Organization in international fora concerned with disaster relief and preparedness.

When an emergency occurs affecting the food supply and/or agricultural and animal production so seriously as to cause human suffering and economic distress, the FAO representative is expected to make an initial appraisal of the situation and to eventually participate in the work of the committees which are set up locally to identify, coordinate, and conduct relief operations. If the

government of a disaster-stricken country requests international support, the FAO representative assists the local authorities in drawing up the request in conformity with the established procedures. Depending on the magnitude of the disaster, the evaluation is carried out through one of the following types of assessments (listed according to the increasing order of magnitude of the calamity): FAO representative's evaluation on the spot; OSRO mission; FAO/WFP mission, multidonor mission; United Nations Inter-Agency mission. The mission's conclusions and recommendations enable the Director-General of FAO to decide whether emergency aid is justified and whether it is necessary to appeal to the international donor community.

The African Food Crisis

The rainy season failed again in many parts of the Sahel in 1983. Drought still gripped several countries of southern Africa and spread northwards into countries of eastern Africa. In early 1983 FAO initiated the alarm on the need to recognize the dimensions of and take measures to deal with the crisis situation in Africa. In April of the same year the Director-General of FAO established a joint FAO/World Food Programme Task Force to monitor the situation in 24 African countries that were facing food emergencies because of the drought. So far eight Task Force reports have been published. The eighth was released at the end of June 1985. Each of the situation reports identifies resources needed to meet relief and rehabilitation requirements in the food and agricultural sector.

While food aid, including emergency food assistance from FAO/WFP sources is necessary to respond to immediate needs, FAO is fully convinced that it should not be used as a perpetual cushion against hunger and malnutrition in Africa. A lasting solution can only be achieved by taking the necessary steps to rehabilitate the agricultural sectors of the affected countries.

In the past, governments and donors have supported some recovery projects side by side with emergency relief operations. But these are not adequate to arrest the declining production trends in the affected countries. Such measures need to be strengthened by a coherent and well conceived agricultural rehabilitation program designed to yield results within a given time-frame.

Food Situation in African Countries Affected by Drought and Other Emergencies

In 1984/85, FAO considered 21 countries to be facing exceptional food supply problems. There were seven countries in West Africa (Burkina Faso, Cape Verde, Chad, Mali, Mauritania, Niger, Senegal); seven in East Africa (Burundi, Ethiopia, Kenya, Rwanda, Somalia, Sudan, Tanzania); six in Southern Africa (Angola, Botswana, Lesotho, Mozambique, Zambia, Zimbabwe); and one in North Africa (Morocco).

This list includes 11 countries in southern, eastern, and northern Africa where the marketing year has already ended. In the four countries of eastern Africa where the 1984/85 marketing year has ended or is about to end, crop prospects are favourable and the food supply position is back to normal. Thus, in Tanzania the harvesting of a good main season maize crop is well under way. In

Burundi and Rwanda the weather has generally favoured the second season crops now being harvested. In Kenya, the food supply position has improved as a result of an above-average short rains crop and a timely import program; abundant and well distributed rains have favoured the main season maize crop to be harvested in August.

In southern Africa, the marketing year has already ended in all of the six affected countries of the subregion. FAO crop assessment missions have confirmed that the weather generally favoured the development of the crops. Thus in Zimbabwe an exportable surplus of some .91 million tonnes is anticipated. In Lesotho and Zambia above average harvests are expected to result in a sharp fall in import and food aid requirements. However, exceptional emergency assistance will continue to be required in Angola, Botswana, and Mozambique, where harvests have again been reduced by civil strife and/or drought.

In Morocco, rains in April and early May favoured winter grain crops in the late filling stage, largely offsetting the adverse effects of an earlier dry spell. The output from the wheat and barley crops now being harvested is officially estimated at 3.9 million tonnes, an increase of .82 million tonnes from last year and some 28 percent above the average for the previous five years. Maize production is estimated at 0.25 million tonnes against 0.21 million in 1984.

In several of the 10 affected countries for which the 1984/85 marketing year has not yet ended, the distribution of food to the needy populations is being impeded by port congestion and internal distribution difficulties, leading to a further deterioration of the food supply position. Widespread malnutrition and deaths from starvation continue to be reported in Ethiopia and Sudan. Logistic constraints are causing severe congestion at ports and preventing the supply of food to the needy populations. Recent widespread rains have favoured the planting and early development of crops, but have exacerbated the already serious difficulties being encountered with the movement of food to remote areas.

The food situation is also deteriorating in several of the seven drought-affected Sahelian countries as they enter the "lean season" leading up to the next harvest. In several countries port congestion and internal logistic constraints are becoming a cause for serious concern, particularly in Chad, Mali, and Niger. Crops have already been planted in southern parts of Burkina Faso, Chad, Mali, and Niger. Elsewhere in the subregion the rains have not yet started properly and planting is scheduled to start from July. Thus, it is not yet possible to make even a preliminary assessment of crop prospects. However, even if the weather is favourable in the months ahead, production will be reduced by severe shortages of seeds and other inputs, particularly in Burkina Faso, Chad, Mali, and Niger.

Rehabilitation of Agriculture

As already stated above, FAO has been monitoring and assessing the drought situation and the resulting food crisis on a routine basis. At the 13th FAO Regional Conference for Africa, held in Harare, Zimbabwe, in July 1984, a general debate was organized on the Food and Agricultural Situation in Africa, resulting in the "Harare Declaration on the Food Crisis in Africa." The Conference also adopted a resolution on the Emergency Food Situation in Africa. The declaration and the resolution, inter alia, reaffirmed the determination of African governments to become self-reliant in food, and to give highest priority to their agricultural sector. They supported FAO's efforts to establish a Food Security Action Programme, and urged the international and donor communities to respond generously to the appeals of the Director-General of FAO for additional food aid and support for the rehabilitation of agriculture and animal husbandry in the countries affected by the drought.

The FAO Council in November 1984 also discussed the African Food Situation and adopted a resolution and identified a number of measures for priority action which included: manpower training, agricultural research, soil management and conservation, improved varieties of crops, appropriate technologies, better links between research and extension, reforestation, small-scale irrigation programs, livestock disease control, pest eradication, improved storage, prevention of food losses, and improvement of distribution and transport facilities. The need to pay special attention to structural problems and the problems of small farmers was emphasized. The Council approved the Director-General's proposal to refocus regular program resources to the tune of US$5 million within the present biennal budget, for rehabilitation as well as mobilization of assistance from the international community (10).

By deliberate rephasing and careful reformulation of regular program activities for 1985 the Council directive to refocus at least US$5 million worth of activities on agricultural rehabilitation in Africa has been achieved. This has and will involve direct technical assistance and advice through the sending of staff and consultants; formulating national program activities; providing training materials; organizing training courses; assisting programs in seed production centres and promoting measures to increase the use of fetilizers and other production inputs; carrying out demonstration activities and convening special purpose meetings and seminars for decision makers in affected countries.

Complexities of Agricultural Rehabilitation

In formulating the proposed rehabiliation program FAO is fully aware of the fact that agricultural rehabilitation is relatively complex. Each country presents a unique situation and even in an individual country the nature of the problem and requirements could vary greatly between regions. A number of technical considerations including the priorities of the governments were taken into account.

Project Formulation

Of the 21 African countries seriously hit by recent droughts, Ethiopia was the most affected. A separate rehabilitation program for Ethiopia was presented at a donors meeting in Rome on 30 January 1985(11). The proposed program for Ethiopia involves 21 emergency projects with an estimated cost of approximately US$94.7 million and 28 medium term projects with an estimated cost of about US$31 million. These emergency project proposals covered immediate rehabilitation requirements, oriented particularly toward the annual calendar in Ethiopia. The medium-term proposals dealt with longer-term measures required to probe into the fundamental causes of the present situation. FAO's technical assistance to Ethiopia in 1984 involved some 55 projects with a total budgetary value of US$27.5 million from external assistance of which the estimated expenditure by the end of 1984 was US$10.2 million. These figures do not include a number of ongoing FAO and WFP development projects. There were 15 FAO/Technical Cooperation Programme Projects worth US$1.3 million; 11 FAO/UNDP projects worth US$18.0 million; 5 FAO/Trust Fund projects worth US$2.7 million and 3 World Food Programme projects worth US$106.2 million.

A set of immediate agricultural rehabilitation projects for implementation in the 20 other seriously affected countries within a time-frame of 3 years (1985-87) were also identified and quantified by FAO. One hundred and ninety four projects have been identified. The estimated total cost of the proposed projects was about US$107 million. These projects were also presented at a donors meeting in Rome on 29 March 1985(12). The project proposals and their estimated costs are summarized in Table 1. Current FAO activities in these 20 African countries include 131 FAO/UNDP projects valued at approximately US$143.5 million; 225 Trust Fund Projects worth some US$257.7 million; and 219 TCP projects with a total expenditure of US$16.7 million.

The total number of project proposals for all 21 seriously affected African countries (including Ethiopia) were 243 with an estimated cost of approximately US$233 million. By mid-June donor interest had been expressed for 23 projects worth about US$108.5 million with approved funding for 13 projects worth US$59.6 million for Ethiopia. For the other 20 countries interest had been expressed for 149 projects worth US$73.9 million, of which funding had been approved for 43 projects worth about $10 million. Table 2 shows the population, cereal production and imports in a normal year, as well as the main growing seasons, and types of food consumed in the 21 African countries that have been seriously affected by drought and other emergencies in recent years.

TABLE 1: Proposed Rehabilitation Projects for 20 Drought-Affected Countries[1]

Country	Crop Production & Protection		Irrigation and Water Supply		Storage and Processing		Extension and Training	
	No	Cost	No	Cost	No	Cost	No	Cost
1. Angola	2	1 643 000						
2. Botswana	2	282 500	1	38 000				
3. Burundi	5	3 383 930					1	1 237 150
4. Burkina Faso	3	1 042 900	1	1 317 000	1	237 500		
5. Cape Verde	1	550 000	2	2 635 000			1	80 000
6. Chad	4	2 675 000	2	2 911 500				
7. Kenya	2	1 516 610						
8. Lesotho	4	2 504 500	2	300 000				
9. Mali	2	410 000	3	2 143 000			1	252 000
10. Mauritania	5	2 499 000	2	80 500	1	697 000	2	1 162 000
11. Morocco			9	2 870 000				
12. Mozambique	3	2 755 000	2	11 074 000	1	520 000	6	2 547 000
13. Niger	2	2 285 000	2	690 000				
14. Rwanda	6	4 488 000						
15. Senegal	4	2 365 500			1	95 200	1	199 350
16. Somalia	1	545 000	1	213 250	2	377 000		
17. Sudan	6	3 575 000	2	882 000				
18. Tanzania	5	6 302 400	2	1 534 480	4	5 113 100	1	31 020
19. Zambia	1	6 027 000	1	347 000			1	420 000
20. Zimbabwe	2	2 194 000	6	1 203 000			2	380 000
TOTAL	60	47 044 340	38	18 238 730	10	7 039 800	16	4 308 520

Cost given in US $

Source: FAO

[1] This table does not include Ethiopia

Livestock and Pastures		Fisheries		Forestry		Others		Total Cost	
No	Cost	No	Cost	No	Cost	No	Cost	No	Cost
3	2 002 000	1	1 000 000					6	4 643 000
2	829 000							5	1 149 500
4	2 217 130							10	6 838 210
3	665 000	1	546 600					9	3 809 000
		1	718 600					5	3 983 600
2	312 000	1	1 013 000					9	6 911 500
3	1 090 000							5	2 606 610
2	478 400	1	20 000					9	3 302 900
2	342 000	1	500 000	1	931 000			10	6 578 000
3	881 500	2	978 714					15	6 298 714
								9	2 870 000
		3	1 270 000					15	8 166 000
3	1 562 000			2	1 371 150			9	5 908 150
4	891 800							10	5 379 800
4	483 400							10	3 163 450
6	3 427 000	2	1 103 000					12	5 665 250
8	2 968 000							16	7 425 000
								12	12 981 000
2	1 010 000							5	7 804 000
3	481 500							13	4 758 500
54	19 640 730	13	7 149 914	3	2 302 150			194	107 724 184

A set of criteria designed to ensure the success of the projects was used in the project formulation, namely:

* The project should preferably be complementary to ongoing or future government action and/or other assistance, including present FAO programs and projects operating in the country;

* It should be possible to start most of the projects within a few months, and to achieve a significant impact in less than three years;

* The project should concern a large number of food producers and benefit populations recently affected by calamities;

* The project should normally include a technical assistance and training component, especially for in-service training;

* The logistic and institutional infrastructure, and the delivery/support services available at the project site should be sufficient to guarantee reasonable prospects for impact. If necessary, the project may help strengthen these infrastructures and services.

On the basis of these criteria, FAO representatives in the countries concerned were asked to consult the government and to forward project proposals and ideas in line with government priorities. A large number of proposals made by the governments, as well as those submitted by the FAO Technical Divisions in the light of their experience of ongoing programs, were examined by twenty task forces at headquarters set up for the purpose. The task forces in which all the relevant FAO Technical Divisions were represented, sifted a large number of proposals and selected those considered most likely to have immediate impact on production. Large projects, notably for the supply of inputs, considered to be out of proportion to the absorptive capacity of the governments, were scaled down. All the proposals were presented in such a manner as to conform with certain guidelines concerning format and cost. By and large, the rehabilitation projects have been kept sufficiently compact and small for speedy implementation and evaluation of results.

The FAO representatives in the countries concerned played an important part in identifying projects in line with government priorities, in assisting the task forces at headquarters and in obtaining the active involvement of governments in the proposals. In one or two cases senior government officials visited headquarters and actively assisted the task forces. The project proposals placed before the donors for consideration have thus the assurance of active involvement of the concerned governments and the full technical backstopping by FAO, where necessary.

Many of the rehabilitation proposals are condensed versions of detailed project documents which are ready for implementation. In other cases, detailed project documents will need to be prepared when donor expression of support is made known. But, in all cases the essential elements necessary to judge their suitability from the point of view of increasing food production are given.

TABLE 2 - POPULATION, CEREAL PRODUCTION AND IMPORTS IN A NORMAL YEAR MAIN GROWING SEASONS AND TYPES OF GRAINS CONSUMED

Country	Sowing Month	Supplies to reach one month before sowing	Cereal production in normal year (tons)	Cereal import in normal year (tons)	Share of Calorie Intake
1. Angola (8.2m)	Oct.-Nov.	September	360 000	280 000	Coarse grains, 26%; Wheat, 7%; Rice 3%; Root crops 34%
2. Botswana (1.1m)	Nov.-Dec.	October	50 000	130 000	Coarse grains, 39%; Wheat, 11%; Pulses, 8%; Meat/Milk, 15%
3. Burkina Faso (6.9m)	June-July	May	1 200 000	160 000	Millet/Sorghum, 63%; Maize, 5%; Wheat, 2%; Rice 3%
4. Burundi (4.5m)	Sept.-Oct. February	August January	410 000	25 000	Sorghum/Maize, 24%; Wheat, 21%; Rice 1%;Root crops, 35%; Pulses,17%
5. Cape Verde (0.32m)	May-June	April	5 000	60 000	Maize, 44%; Rice 4%; Wheat, 4%; Root crops 7%
6. Chad (6.02m)	May-July	April	580 000	30 000	Millet/Sorghum, 53%; Wheat, 2%, Rice 3%
7. Ethiopia (42.02m)	May-June	April	6 230 000	250 000	Coarse grains, 59%; Wheat, 12%; Pulses, 8%
8. Kenya (21.5m)	March-May	February	2 500 000	100 000	Maize, 41%; Beans 5%; Sorghum, 4%; Rice, 1%; Wheat, 6%
9. Lesotho (1.5m)	Oct.-Dec.	September	190 000	155 000	Sorghum, 12%; Maize, 42% Wheat, 23%
10. Mali (0.1m)	May-July	April	96 000	150 000	Millet/Sorghum/Maize, 60%; Wheat, 2%; Rice 10%
11. Mauritania (1.9m)	May-July	April	60 000	200 000	Millet/Sorghum/Maize, 27%; Rice, 13%;Wheat 11%
12. Morocco (24.4m)	Nov.-Dec.	October	4 100 000	1 800 000	Wheat, 43%; Barley, 16% Maize, 4%; Meat/Milk 4%
13. Mozambique (11.5m)	Nov.-Jan.	October	500 000	300 000	Coarse grains, 22%; Wheat, 6%; Root crops, 40%; Rice, 6%
14. Niger (6.3m)	June-July	May	1 500 000	60 000	Millet/Sorghum, 67%; Pulses, 11%; Rice, 5%; Roots/Tubers, 4%
15. Rwanda (6.3m)	Sept.-Oct. Jan.-Feb.	August December	300 000	25 000	Sorghum/Maize, 10%; Root crops, 42%; Pulses 17%; plantations, 10%
16. Senegal (6.6m)	May-July	April	740 000	450 000	Millet/Sorghum, 33%; Wheat, 7%; Rice 21%;
17. Somalia (5.6m)	March-April	February	360 000	333 000	Millet/Sorghum, 15%; Wheat, 10%; Maize, 17%; Rice, 9%; Meat/Milk, 27%
18. Sudan (22.0m)	June-July	May	3 000 000	500 000	Sorghum/Millet, 43%; Wheat, 8%; Pulses, 2%; Roots & Tubers, 2%;
19. Tanzania (25.3m)	Dec.-Jan.	November	2 600 000	350 000	Millet/Sorghum, 5%; Wheat, 3%; Maize, 22%; Rice, 5%; Root crop, 32%
20. Zambia (6.9m)	Nov.-Dec.	October	970 000	268 000	Millet/Sorghum, 3%; Maize, 59%; Wheat 10%;
21. Zimbabwe (9.1m)	Nov.-Dec.	October	2 500 000	70 000	Millet/Sorghum/Maize, 56%; Wheat, 9%

Note:

(i) Pouplation shown within brackets in millions.
(ii) In a few countries there may be more than one sowing season but the main sowing season is indicated. In Burundi and Rwanda there are two main season crops.

SOURCE: FAO

By far the largest number of crop production proposals are for the supply of production inputs, such as seeds, fertilizers, and other means of production together with technical assistance for the training of farmers and field workers in the application of the inputs. Such projects merit priority attention as the supplies should reach the countries concerned sufficiently in advance of the main planting seasons.

Fertilizer input proposals are based on proven experience and take account of foreign exchange constraints which have inhibited the use of additional fertilizers. In a few cases, where fertilizer input programs which have given good results are coming to an end, new programs have been suggested for their continuance and expansion. Seed multiplication proposals give priority to production of seeds on a large scale where research and pilot experiments have identified improved varieties of seed for large-scale multiplication. Expansion of village storage facilities to be undertaken with counterpart funds generated in fertilizer input programs are based on designs which have given good results. Feasibility studies in respect of some projects have already been carried out under earlier technical assistance programs, and the projects are ready for speedy implementation. Institutional support projects are aimed at overcoming constraints in existing institutions and laboratories and improving their immediate capacity to contribute to the production effort.

In-Depth Study on the Food and Agriculture Problem in Africa

Many of the African countries affected by the drought have great potential for increasing agricultural and livestock production. Although agricultural productivity in most of these countries has been known to be well below expected yield levels, even in normal years, there is some evidence to indicate that production of many crops in most agro-ecological zones could be increased by 50-100 percent or more during the remainder of this century through the use of available technologies (13).

Despite the impressive technological advances in the agricultural sector in recent years, tropical Africa has not made much progress in food and agricultural production. Most of the improved technologies have either been too expensive for small farmers or are inaccessible to them or are still in the pipeline! Unfortunately the available information provides only a qualitative picture of the extent to which the existing technologies are already applied. Low priority for agriculture and current inadequacies in input supply, delivery systems, credit facilities, marketing, and price policy are considered to have been largely reponsible for the slow adoption of improved technology and inadequate utilization of traditional technology. Even before FAO embarked on the formulation of the proposed short-term (including medium-term for Ethiopia) agricultural rehabilitation projects, the Director-General of FAO had decided to launch an in-depth study on the underlying factors of food and agriculture problems in Africa. The principal objective is to identify key practical measures that could reverse the trend of declining per capita food production.

The emphasis is being placed on staples but consideration is also being given to livestock and export crops. The study will concentrate on physical and economic sustainability and will therefore look closely at measures to avoid land degradation, ensure regular supply of production inputs, and define viable infrastructures.

The FAO Study will involve a re-assessment of the "agro-ecological zones" information at the national and subregional levels and will use a new set of demand projections that takes into account changes in consumption patterns and locations. A small number of high priority action programs will be proposed. Some will be for immediate consideration and/or implementation by the governments, others will be for the medium and longer terms within a time-frame to 2010. It is expected that the study will indicate the needs for immediate assistance in the organization and supply of inputs (fertilizers, pesticides, seeds, and removal of foreign exchange constraints), in the medium term for farm services of low recurrent costs (such as extension and irrigation), and in the long term for areas that require increased research effort.

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STATEMENT ON BEHALF OF THE WORLD FOOD PROGRAMME

A.N. Ngongi

It is a great pleasure and privilege for me to participate in this Seminar on Drought in Africa on behalf of the World Food Programme.

The current food crisis in Africa has been so well covered by the international news media that drought and starvation have become almost synonymous with Africa. The faces of listless children, of mothers so weak that they seem unconcerned about their children, and old persons lying down knowing all too well that they would not be able to get up again are just the grim manifestation of the ravaging effects of the current food crisis in Africa.

Over the last two to three years, between twenty and twenty-four African countries have been listed at any given time as facing abnormal food shortages (FAO).

In some of the affected countries, food crop production decreased by 50 percent or more while in most of them production shortfalls were in the order of 20 to 30 percent compared to "normal" harvests. The situation is made worse when it is realized that in many of the afffected countries, "normal" harvests do not cover more than 80 percent of the energy requirements of the population and that food reserves are almost non-existent. This, the second major drought in Africa in the last 10 years has been more widespread and more devastating in its toll on human lives, livestock, and the environment. It is perhaps the most serious drought the African continent has suffered in a century or two.

The drought and the resultant or accompanying social and economic crisis have been analyzed by specialists the world over. Many hypotheses have been advanced regarding the root causes of both the social and economic crisis and the drought. The conclusions reached are not always in agreement.

It is, however, clear from available evidence that since 1960 food production has not kept pace with population increase in Africa. Whereas population was growing at between 2.5 and 3 percent per annum in the seventies, food production grew at only 1.0 percent per annum. It was therefore a matter of time before a food crisis gripped sub-Saharan Africa (SSA) since the region was not exporting enough to be able to import the food it needed to cover its production deficits. The drought has just hastened the day of reckoning.

Even if the weather improved and production returned to normal, Africa would be unable to feed itself for many years to come and would need substantial amounts of food aid since the import capacity of the region is severely limited by foreign exchange constraints.

FACTORS RESPONSIBLE FOR THE CURRENT FOOD CRISIS

Many factors are responsible for the stagnation in Africa's food production. Among those frequently cited are:

- poor, old, and eroded soils;
- low level of technological inputs;
- almost non-existent irrigation (2% arable land);
- weak supporting and servicing institutions (research extension, training, marketing, credit);
- weak planning and implementation capacity;
- low priority to food crops compared to cash crops;
- poor infrastructure which limits access to markets and inputs;
- poor pricing policies (favouring urban consumers); and
- artificial exchange rates which encourage importation of "cheap" food.

All of these factors or a great many of them are indeed present in most SSA countries. To this already formidable list of negatives, one has to add the current drought.

Drought is, to put it figuratively, the last straw that broke the camel's back. It is not surprising that with so many weak points, many African countries were unable to cope with the effects of the drought.

EFFECTS OF THE DROUGHT

The immediate effects of the drought have been traumatic. Many thousands of lives have been lost, hundreds of thousands of children have been stunted physically and perhaps mentally, tens of millions of persons have become displaced and more than 10 million are still in danger of starvation. The experience has been a nightmare for some countries; 7.9 million were in danger of starvation in Ethiopia at the peak of the crisis and 2.5 million in Mozambique. The figure in Sudan is yet unknown. In Chad the effects of the drought have been made worse by the continuing civil strife. In Mauritania and Botswana, most persons are on relief. Even countries such as Kenya and Zimbabawe which have both made great strides in food crop production had to receive huge quantities of food aid (385,000 and 181,000 tonnes respectively). In addition Kenya purchased some 454,000 tonnes of food commercially in 1984/85.

In the face of such massive suffering, the international community responded generously, pledging some 5.7 million tonnes, 90 percent of the estimated food aid requirements in 1984/85. However, deliveries have been slow and only 55 percent of pledged assistance for the period July 1984 to June 1985 had been delivered by the end of May. At the ports the situation has been bad. Backlogs have been accumulating owing to inadequate internal transportation and handling facilities. During the second week in June over 145,200 tonnes of food was stockpiled at Ethiopian ports (WFP). For many persons the food will arrive too late and for many isolated communities food cannot get there by road under the

best of circumstances, and certainly not during the rains. The international community has been forced to use aircraft to lift food to remote areas, a very expensive operation.

WHAT IS TO BE DONE?

The immediate humanitarian response to the food crisis was necessary and only right, but it cannot be an end to itself. Rather, it should be seen as a means of saving lives and gaining time for the implementation of measures needed to reverse the negative trends in food production in SSA countries.

The search for long-term solutions to the food problems of Africa has been going on for some time now. The great drought of 1970/73 set in motion the forces responsible for the convening of the World Food Conference in 1974. From the World Food Conference emerged the World Food Council, the Committee on World Food Security, the International Fund for Agricultural Development, and the Committee on Food Aid Policies and Programmes.

The World Food Council has since 1979 called for the preparation and adoption of food sector strategies which are integrated into the national plans of developing countries, and has recently asked for a special fund to be set up to finance agricultural development in Africa (WFC). The Committee on World Food Security, under the aegis of FAO, asked in 1982 for a study on the constraints to food production in Africa, and on the basis of a report prepared by FAO in 1983, identified areas which could constitute a special long-term program for Africa. This was endorsed by the FAO Council and Conference in 1983 (FAO). Since its founding in 1977, the International Fund for Agricultural Development (IFAD) has given priority status to Africa in its funding of agricultural development projects with a strong emphasis on food crops and now wants to set up a special three-year $300 million fund for Africa. The Committee on Food Aid Policies and Programmes (CFA) of the World Food Programme since its creation in 1975 in replacement of the Intergovernmental Committee has laid emphasis on the need to go beyond emergency food aid. It has called for a full integration of food aid with other forms of development assistance at the planning stage and urged developing countries to adopt emergency preparedness measures so that emergency assistance can reach victims as fast as possible and reduce any disincentive to production to the minimum. The CFA has also paid particular attention to the needs of SSA countries. The World Bank has succeeded in obtaining about $1.0 billion for a special fund for Africa. A donor's meeting organized in Geneva early this year by the Secretary-General of the United Nations produced substantial pledges for emergency assistance to the twenty affected SSA countries. Many bilateral donors have also indicated a shift of resources in favour of Africa and Africa is now receiving over 50 percent of all food aid.

It is absolutely clear that the present drought and the resulting food crisis have placed Africa once more in the centre of world attention. It is an opportunity not to be lost if such experiences are to be avoided in the future.

In response to a question on what Ethiopia would do in order to avoid suffering from continued drought, Commissioner Dawit Wolde-Giorgis of the Ethiopian Relief and Rehabilitation Commission said, "We have to start over again with the afforestation program. We have to start irrigation, soil, and water conservation projects. If we had the know-how, the technology, and the capability to properly utilize existing water, we would not face shortages in coming years. But we do not have the technology, the manpower, the money."

This, in addition to the need for policy reform favouring incentives to small farmers, constitutes an adequate agenda for action in Ethiopia and many of the affected countries. It is a challenge which the international donor community and governments of affected countries must take up. Progress will be long in coming and difficult to attain but patience and fortitude would be needed.

WFP ACTION IN SUB-SAHARA AFRICA

The World Food Programme has been actively engaged in Africa since the early sixties assisting African countries to meet their emergency and development needs. WFP's activities in Africa south of the Sahara have increased dramatically and now Africa south of the Sahara accounts for 35 percent of the Programme's resources. WFP has invested $1.7 billion in development projects and emergency operations in SSA countries since 1960. In 1984, WFP commitments to SSA countries were $450 million for both emergency operations and development projects. This was, on a per capita basis, eight times the resources committed by the Programme to other developing regions.

EMERGENCIES

During the current drought situation, the Programme has increased its emergency assistance to the region. In 1984, WFP shipped 545,000 tonnes from its resources and 680,000 tonnes on behalf of bilateral donors. WFP's emergency food aid reached 10 million drought victims in 21 countries and refugees in seven countries. WFP had committed by the end of May 1985 222,000 tonnes of emergency food aid to SSA countries. This represents two thirds of global commitments made so far this year.

There has not been a great shortage of emergency food aid. Almost 6.35 million tonnes have been pledged but only some 55 percent has reached the affected countries and of this amount a significant quantity is stranded in ports for lack of adequate transport capacity. WFP has endeavoured to coordinate logistics aspects of food assistance with financial resources from bilateral donors, the World Bank, and its own resources. In this way donors are kept well informed not only of food requirements but also of scheduling of arrivals, transport requirements, and requirements for inland storage. Nothing is more frustrating than to know that people are in dire need of food, that the food is shipped but cannot reach those who need it most for lack of transport. Unfortunately, the rains have already reduced accessibility to many parts of SSA while food is stocked at the ports.

DEVELOPMENT

The greater part of WFP's resources is devoted to development activities. As already indicated, sub-Saharan Africa currently accounts for over 35 percent of the resources of the Programme. This amounted to $325 million in resource commitments in 1984. WFP's development activities can be divided into post-emergency rehabilitation and longer term development.

Post-Emergency Rehabilitation

WFP endeavours to act rapidly during an emergency situation to get food to those who need it. It is however recognized by everyone that people should not be made dependent on food handouts when they can work. WFP thus moves as soon as possible from emergency to rehabilitation activities in order to create employment and also construct or repair those rural infrastructures needed to boost food production. Two examples may suffice.

In view of a serious drought in Turkana in 1979/80 which reached famine proportions, the Kenyan Government approached several donors including the World Food Programme for emergency food aid. As soon as food aid was provided and famine conditions were contained, a second phase was launched to rehabilitate the productive capacity of Turkana district through a five-year food-for-work project to which WFP committed $7 million under project Kenya 2669. The main activities of the project are in water management through the development of micro and macro-catchments, small-scale irrigation for food crop production (mostly sorghum), road building, tree planting, construction of wells for drinking water, and construction of food stores. The project has made impressive progress.

A similar rehabilitation project was started as an emergency operation in Karamoja, Uganda, in 1980. WFP has committed $15.4 million to this project in emergency and rehabilitation resources to support food-for-work activities aimed at road building, tree planting, water management, and settlements.

Longer-Term Development

WFP's development activities can be divided essentially into three types:

- restoration of the environment;
- rural infrastructure;
- policy reform.

Restoration of the Environment

One of the major consequences of drought and perhaps one of its principal causes is environmental degradation (chicken and egg!). Population pressure has increased the need for fuelwood and building materials which currently results in the destruction of some 4.0 million hectares each year in sub-Saharan Africa. Shifting cultivation, which is the dominant farming system in Africa

south of the Sahara, destroys another 11 million hectares of forests a year. In addition, the fallow period is growing shorter and shorter thus leading to increased soil erosion. Over-grazing has damaged millions upon millions of hectares of land particularly on the fringes of the Sahara and thus the desert is fast moving south. When trees have been cut and soils eroded, water penetration into soils and the water retention capacity of soils are drastically reduced and lead to high run off. Thus the amount of rainfall which under stable natural conditions used to be enough to grow a decent crop is no longer adequate. Evapotranspiration from forests which used to build up the clouds which then fell as rain is no longer sufficient. The process of drought and desertification is accelerated leading in the long-term to an ecological crisis as is now the case in sub-Saharan Africa.

To address this problem, the World Food Programme is supporting several reafforestation and soil conservation projects in Africa in which food aid is effectively used to mobilize the human resources needed to carry out such labour-intensive works as tree planting and the construction of terraces.

An example of this type of activity is project Ethiopia 2488. WFP has been providing food to farmers since 1980, to support them while they terrace the badly degraded hillsides and plant trees for soil protection and fuelwood and grass for fodder. Livestock no longer graze on the hills in the project area, but are fed with fodder cut from grasses planted on the terraces. WFP has committed to date $160 million to this project, involving 453,000 tonnes of wheat and 14,500 tonnes of vegetable oil and edible fats. More than 300,000 kilometres of terraces have been constructed and are being maintained and trees and grasses are now growing on hillsides which were bare only a few years ago. Similar projects, although on a smaller scale, are being carried out in Rwanda, Burundi, and Lesotho.

Rural Infrastructure

A second example to illustrate the effective use of food aid in sub-Saharan Africa is in the area of labour-intensive public works. WFP has assisted projects in many countries involving the construction and maintenance of a wide range of infrastructural works that are essential for agricultural and rural development (roads, irrigation systems, food stores, settlements, etc.). These works are undertaken by low-income workers who would normally spend a high proportion of any additional income on food. Food aid thus represents to them a significant transfer of income. These labour-intensive activities are undertaken outside periods of peak demand for agricultural labour, thus avoiding competition for this relatively scarce resource in sub-Saharan Africa. In sub-Saharan Africa, which is food deficit, and where infrastructure deficiencies are pronounced compared with other developing regions and are recognized as a severely limiting factor in increasing food production, food aid can play a vital role in building and maintaining badly needed rural infrastructure.

Policy Reform

A third example of how food aid can best assist African countries is in the area of policy reform. There is need to resolve the dilemma of a food pricing policy in developing countries that fosters both higher producer prices to levels which

encourage increased production while maintaining access of poor consumers to food. Unfortunately, if food prices are raised abruptly the result is often public disorder leading even to political instability. Food aid and its couterpart funds can be used to resolve smoothly and gradually this dilemma over time.

WFP, together with other donors, is assisting Mali to enhance food security through price stabilization measures and a restructuring of the cereal marketing systems. WFP food is sold in Mali, the proceeds deposited in a common counterpart fund and used in support of an agreed program for gradually changing current cereals pricing policy and marketing arrangements, and thereby stimulating increased food production. In Senegal, a similar approach is being developed by a group of donor countries and WFP under which funds generated from the sale of food aid commodities will be used to support the government's policy decision to shift consumption from imported wheat and rice towards locally produced cereals.

In addition to the developmental types of projects, WFP is supporting many institutional feeding and human resources development projects in sub-Saharan Africa.

WFP is aware that its assistance to Africa has not had the same degree of impact on food production as similar assistance given to other developing regions. This is to a large degree due to the weak institutions found in most sub-Saharan African countries in the field of research, extension, and training. The program is currently exploring, in consultation with other funding agencies, ways and means by which WFP could support training, research, and extension programs in Africa countries, especially in meeting some of the local costs. This will help resolve a major problem encountered in the execution of externally funded projects and programs aimed at increasing food crop production. In addition, better programing of the utilization of food aid is needed if the impact of this resource is to be improved.

FOOD AID PROGRAMING

The current drought and its accompanying food crisis have provoked the rethinking of aid, and especially food aid, by the international community. The World Food Programme is in the process of reviewing its assistance to Africa South of the Sahara, with a view to improving the effectiveness of food aid. A major review of WFP's response to the current crisis in Africa has just been completed and will be presented to the governing body of the Programme in October this year. WFP and the African Development Bank will be holding a major seminar on food aid in Africa next year as a means of continuing the search for ways to increase the effectiveness of food aid. The current review of WFP's project cycle, although not specifically directed towards sub-Saharan Africa, will have an impact on the programing of WFP food aid to the region.

Even the most ardent advocate of food aid has to admit that this form of assistance has a serious limitation in that it is fairly inflexible. Since food aid now represents a high percentage of ODA to Africa South of the Sahara, and is likely to do so for some time in the future, serious efforts should be made

to integrate food aid within the development plans of recipient countries. Indeed food aid deliveries to the twenty SSA drought-affected countries from July 1984 to June 1985 amounted to 4.9 billion tonnes, with a CIF value of $1.45 billion. In 1983, the latest year for which data are available, net ODA receipts by this group of countries totalled $5.5 billion. Thus, for this group of countries, food aid represents approximately 25 percent of economic development assistance and resource transfers.

Food aid should therefore not be just an appendage to projects which have been planned but lack adequate levels of resources. WFP and World Bank collaboration in Ghana and coordination between WFP and other donors in Mali and Senegal are few examples of proper planning and integration of food aid with other resources in development projects and programs.

FUTURE ACTION

The time for pious pronouncements and declarations of intentions is over. It is now time to work out the details of a concrete Programme of Action for sub-Saharan Africa which embraces as much as possible the activities of the various donor agencies and countries involved in Africa. Such a program could have three principal components.

Environmental Protection

A massive regional project is needed for the reafforestation of sub-Saharan Africa. The major objective will be to establish a massive forest stretching from Senegal and Mauritania on the Atlantic to Ethiopia and Somalia on the Red Sea. A forest which will provide the fuelwood and wood for building materials needed by the population. The efforts being made by WFP in the area of reafforestation and soil conservation have been described earlier, but one hectare of forest here and one hectare there will not suffice in holding back the Sahara. A concerted effort is needed. Intensive reafforestation activities are also needed in other countries not within the Sahel belt but where the forest cover has been almost completely removed. The World Food Programme will be willing and ready to support such a regionally coordinated reafforestation effort.

Intensification of Agricultural Production

This component would include sub components on:

- soil conservation;
- small scale irrigation (including drinking water);
- training;
- research;
- extension;
- animal production (health, dairy, pastures);
- rural institutions (cooperatives, etc.).

It is evident that sub-Saharan agriculture is very unproductive partly because the soils are old, eroded, and poor and because of the low level of utilization of improved technology. As a result shifting cultivation, which has now become so destructive, is the dominant agricultural system while uncontrolled grazing by unnecessarily large herds of inefficient animals is the predominant livestock production system. Both shifting cultivation and over-grazing have contributed immensely to the process of environmental degradation in Africa, and these cannot be dissociated from the frequency and severity of droughts in sub-Saharan Africa and the current food crisis. Intensification of agricultural and livestock production through soil conservation and small-scale irrigation with the support of training, research, and extension programs will greatly reduce environmental degradation and provide Africa with the food it needs. Many of these sub-components are already being supported by WFP and other donors but much more needs to be done. WFP will be willing to do more in this regard and to coordinate its efforts with those of other donors.

Policy Reform

A third major component would be in the area of policy reform. It is generally agreed that African governments should take bold and courageous decisions to shift resources to the agricultural and rural sectors, shift emphasis from export crops to food crops, adopt price policies which are attractive to farmers, make available necessary inputs at affordable but unsubsidized prices, support research and training institutions, and at the same time protect the purchasing power of the poor and also take care of vulnerable groups. To expect that African governments will be able to do all of this within the space of a few years would be asking for miracles.

In many SSA countries there were hardly any qualified or experienced persons at the time of independence to draw up policy guidelines and administer them. The situation has improved in some countries but in many others the forces of instability have not provided a climate congenial for the formulation and execution of policies and programs aimed at long-term development. Such long-term development planning has been particularly lacking in the agricultural sector. It is, however, heartening to note that some thirty sub-Saharan African countries have now adopted food sector strategies in accordance with the recommendation of the World Food Council. Donor nations and agencies should support these countries, to the maximum extent possible, in the implementation of their strategies. WFP is happy to participate in the area of policy reform and restructuring of the economy as in the cases of Mali, Senegal, and Ghana mentioned earlier, and would be willing to do so in many more countries in partnership with other donors.

PRESENTATION BY THE INTERNATIONAL FUND FOR AGRICULTURE AND DEVELOPMENT

M.C. Mensah

The deteriorating performance of the agricultural sector in sub-Saharan Africa has been a matter of major concern for more than a decade for those involved with agricultural and rural development. The Sahel drought of the early 1970s left in its wake an enduring, widespread, and chronic situation of declining levels of per capita food production, rising food imports, increasing incidence of food emergencies, deteriorating nutritional status, and a weak agricultural export performance. The recent drought of 1983/84 has had further devastating effects on African agriculture.

Even though total food production in sub-Saharan Africa has, on the whole, demonstrated an upward trend since the mid-1970s, the annual average rate of growth has been far from satisfactory, not only in the context of the food requirements of the region but also when compared with the production performance of Asia and Latin America. Some 80 million people, or 20 percent of the region's population, live in countries in which total food production has either declined or remained stagnant in the decade ending in 1984. The problem is further compounded by the population growth outpacing agricultural growth. At a projected average population growth rate of 3.2 percent per annum between 1980 and the year 2000, the total population of African developing countries will rise from 440 million to 839 million, according to the UN Economic Commission for Africa - a 400 million increase in population in twenty years. It is estimated that since 1970 African agricultural output per capita has declined at an annual rate of 1.3 percent, and food output per capita has declined at a rate variously estimated from 1.1 to 1.3 percent a year. Thus, unless urgent steps are taken to reconcile the food production level and population growth, the present trend of declining per capita food availability could assume disastrous proportions.

As a result of the above, food imports have continued to increase for the sub-Saharan region. In a number of countries, the food imports' share is around one-quarter or more of the total merchandise imports. Futhermore, the share of cereal in total food imports increased from 20 percent to 30 percent between 1970 and 1982. The volume of commercial cereal imports almost quadrupled during the same period and reached 8.39 million tonnes in 1982. In the 21 countries identified, 1984-1985 cereal production is estimated at 20.8 million tonnes, 14 percent lower than the 1983 drought-affected output, or 23 percent below the average of 1981 and 1982. The total import requirement is estimated at 9.26 million tonnes.

It is important to emphasize here that the rural poor are likely to have benefited only marginally from the increase in commercial food imports while the displacement impact of food aid in certain cases may have had depressing effects on domestic food markets. Food imports have largely been directed toward the urban centres and geared to urban consumers' tastes. The combined share of

commercial cereal imports and food aid correspond to just over 20 percent of total consumption, which is very much in line with the share of urban population in the total population of the region. This fact, combined with the observed decrease in per capita food production, is an important factor in explaining the low nutritional status of the rural population.

The situation is made worse by long-term declines in the volume and value of exports by African countries as well as a deterioration in the terms of trade. These unfavourable trends have considerably limited foreign exchange earnings and the import capacity of many African countries. The already gloomy prospect in this context is further aggravated by the recent drought. Consequently, the sub-Saharan region has become increasingly dependent on food aid and external borrowing to finance current food needs. Undoubtedly, the region can significantly ease pressure on its external transactions by relying more on domestically produced food.

Over the years the combination of adverse domestic and international factors have led to a substantial increase in accumulated external debts. The external public and publicly guaranteed debts increased from US$5.4 billion in 1970 to US$48 billion in 1982, an average increase of 20 percent per annum. The majority of such debts for sub-Saharan Africa as a whole are on non-concessional terms. Consequently the debt service payments increased from US$0.45 billion to US $5.5 billion over the same period (average annual increase of 23 percent). Projections by the World Bank point to a doubling of the debt service payments in the near future to an average annual level of US$11 billion during 1985-87. This will aggravate foreign exchange shortages and impose additional limitations on import capacity which further emphasizes the importance of strengthening African countries' capacity to increase domestic food production.

The current crisis in Africa, summarily described above, has many dimensions but that which is of central concern to IFAD is the impact of the unbroken African drought and desertification process on the status of IFAD's target group, i.e. the rural poor consisting of small farmers, herders, fishermen, and landless rural workers. As the 1984 O.E.C.D. Review of Development Cooperation pointed out: "In 1983-84, drought drove millions of Africans deeper into poverty and further handicapped economic recovery efforts...Especially vulnerable are poor, chronically under-nourished rural labourers, marginal farmers and herders, and families headed by women, and their many children." It is this group of rural poor that IFAD would seek to reach through its current and expanded operations.

However, drought is only a part of the wider environmental crisis that has gripped the continent. Within the last thirty years, the natural environment, especially in the arid and semi-arid regions of Africa has been deteriorating significantly and from the 1970s the economic and social environments also began to decline and continue to do so. A large number of factors have been responsible for this development and those who are suffering most in this general decline are undoubtedly the rural poor.

With increasing numbers of working-age men leaving the land in the hope of securing urban employment, food production is becoming more dependent upon the labour of the very young, the elderly, and women. Women's share in subsistence agricultural activity is already 50 percent and in many cases it is exceeding 60 percent. Their contribution varies from 5 percent in land clearing to 90 percent in processing foodstuffs. In tasks like moving and storing the harvest, they contribute 80 percent of labour inputs. Their labour contribution in fetching water and fuel is as high as 90 percent. The drought has further increased women's workload. Scarcity of inputs, unavailability of tools and implements, destruction of water supply sources, and shrinking fuel wood supply have added a disastrous dimension to their predicament.

An analysis of the agricultural GDP per capita for 39 sub-Saharan countries, to estimate the size of IFAD's target group, reveals that by 1982, already 77 percent of the rural population (230 million people) were considered "absolute poor" as their annual income fell below the poverty line(1). A study of the available data on per capita daily calorie supply as a percentage of requirements for 1981, however, shows a larger size of IFAD's target group. It is estimated that 87 percent of the rural population (260 million) are undernourished, of whom 41 percent are severely undernourished(2). Based on current trends, it is fairly obvious that the scope and degree of deprivation in sub-Saharan Africa could well worsen and the size of IFAD's target group would continue to increase much more so if one bears in mind the added demand for food due to the growing number of refugees and returnees who essentially come from rural communities, and move from a status of net food producers to that of net consumers.

Bilateral and multilateral efforts currently under way to assist the countries of sub-Saharan Africa in rehabilitating and reconstructing their shattered drought-stricken economies have rightly stressed the central importance of bringing about a rapid growth in domestic food production. However, the strategies being considered to achieve this objective do not adequately focus on the important role of the small producers. There is also a broad consensus amongst the major donors on the need for a global approach which links the inflow of aid essentially to a package of policy reforms at the macro-economic level. However, in making most strategies and plans operational, it is necessary to provide an underpinning to the policy dialogue to ensure that the perceived national macro-objectives are properly linked with micro-decisions of smallholders and their needs. Fiscal policies, investment plans and transformation of marketing approaches, for example, need further articulation based on the extent they actually affect the rural area and traditional agricultural sector.

In the past, African development strategies have not accorded adequate priority to agriculture. Even where agriculture received sufficient attention, the bulk of investment and research tended to bypass the needs of smallholders. At various stages many African countries have adopted development strategies that favoured industrialization, exports, and the urban sector, while agriculture has often been viewed as a surplus sector to be tapped for labour and government revenues. Industrialization has typically been concentrated in the large towns and cities. The resulting jobs and relatively high wages have led to

expectations that standards of living would be improved by moving from rural areas to urban centres.

Furthermore, governments' investment patterns and policy frameworks have often fallen short of fully appreciating the primacy of the traditional agricultural sector and the potential role of the smallholders as the backbone of the African economy. This has naturally inhibited the smallholders in realizing a productivity level commensurate with their potential. Socio-economic pressures have driven small farmers and herders to greater use of marginal and drought-prone lands, further exacerbating the problem. Hence rural poverty, or rather impoverishment, has been a continuous process and not only the result of the droughts. As the majority of people suffering from poverty and chronic food insecurity in Africa are subsisting on land or livestock, it is IFAD's view that programs and policies aimed at development of the traditional agricultural sector would improve the productivity and incomes of smallholders and thus contribute to the food security of the majority of the rural poor.

In the short and medium term there is, however, a limited prospect for any significant deployment of capital, skilled manpower or a radical change in agricultural technology which could induce a fundamental transformation in the management of the small and scattered farm enterprises in sub-Saharan Africa. The orientation of development efforts in the agricultural sector should therefore derive from: (a) the wealth of experiences accumulated within the traditional systems of production; (b) the comparative advantages of the traditional farmer/pastoralist in producing a wide range of products; (c) the dominant role of the traditional system in the economy of the region, in particular in food production; and (d) the dynamism and flexibility inherent in the traditional sector for change and adaptability.

IFAD is particularly suited to play a significant role in the above context. The underlying strategy of IFAD's current operations in Africa has been directed towards demonstrating the importance of the smallholder in the agricultural development process, and at revitalizing his productive potential. This strategy has been found to be basically sound and appropriate. The translation of this strategy into concrete projects, however, has not been easy and their ultimate impacts cannot yet be fully assessed. Nevertheless, these projects have provided a useful stock of practical and operationally-relevant experiences. As a result, IFAD today is better equipped than before to respond in an effective and meaningful way to the additional demands imposed by the present crisis in Africa.

Because of the special focus of its mandate, IFAD has approached the analysis of the drought situation in Africa in terms of the implications for its target group, with particular emphasis on those domestic issues related to policies and production systems to which IFAD's resources can effectively be addressed. That means concentration on the traditional agricultural sector.

The development of the traditional agricultural sector in drought-affected sub-Saharan Africa is constrained by a number of factors which could be summarized as follows:

- a deteriorating physical production capacity, because of a fragile natural resource base and extreme fluctuations in climatic conditions;

- inadequate delivery systems (inputs, credit, extension) and technical packages not geared to the needs of the traditional sector;

- inappropriate development strategies and resource allocation policies, which do not offer proper incentives to smallholder farmers; and

- deficient institutions, support mechanisms, and management capabilities.

How does IFAD address those constraints? An attempt to answer this question can be found in "Special Programme for Sub-Saharan African countries affected by drought and desertification" which was approved by IFAD's Executive Board in May 1985.

Let us consider for instance the fragility of the natural resource base. It is due primarily to the prevalence of soil with low fertility under local ecosystems being exploited beyond its carrying capacity. For example, in the West African region - i.e. the group of countries from Mauritania to Nigeria - high fertility soils capable of sustaining high yields of both cash and subsistence crops cover approximately 10.5 million ha, while low fertility soils, some of which can hardly produce arable crops because of shallow depth, cover about 243 million ha and the medium to low fertility soils amount to about 180 million ha. Over-exploitation, due to extreme cultivation, overgrazing, or deforestration, added to the vagaries of the climate, have increased the fragility of the existing ecosystems to the extent that large tracts of land have been and are still being lost to the desert.

We, in IFAD, believe that the restoration of the natural resource base can be achieved only if approached from three main angles: technical, economic, and socio-political. It is very difficult indeed to request farming, cattle raising, or fishermen's communities to accept the discipline involved in the restoration of a degraded natural resource base unless alternative technologies are offered to provide an acceptable level of output in a way which is less taxing to the physical environment, thereby allowing the ecosystems to regenerate. A thorough inventory must be carried out of potentially suitable technologies existing in the regions concerned, as well as in other geographical areas offering similar ecological conditions. In developing the final technological packages, account must be taken of the target group's perception of production risks which it is not prepared to bear. For example, one of the main reasons behind low productivity in the traditional agricultural sector in Africa is that research has for too long focused on commodities and not enough on farming systems. As a result, extension workers have not been able to pass on effectively high yielding crop varieties to small farmers because the technical messages delivered did not fit into those farmers' risk-averting production systems.

Besides the risk-averting aspect, another important dimension relates to economics. The restoration of the natural resource base may require a long time-span, during which traditional sources of income to the communities concerned may dry up. Alternate sources must be found. Food aid can be a

valid and readily available solution, provided the food basket is carefully chosen to avoid any persistently negative impact on local consumption patterns. With respect to the socio-political dimension in restoring the natural resource base, a number of issues must be addressed. If, as is likely, soil restoration efforts call for a collective and not an individual approach, group discipline in planning and implementation of the restoration program would be essential. Problems related to future land allocation, tenure, and land use must be identified at an early stage and solved. In connection with land use, there may be a conflict at the community level between demand for food and demand for energy (firewood) and, as far as food is concerned, a conflict between livestock and crop production. The central government may even intervene with its own suggestions on land use which could be in direct opposition to local needs (e.g. high value export crops instead of traditional staple food). Therefore, it is of paramount importance that local communities be organized to develop a program which takes care of the concerns of all major parties involved and ensures its smooth execution.

In that connection, IFAD sees agroforestry as an important tool for natural resource base restoration and environmental rehabilitation in drought-affected sub-Saharan Africa. In fact, agroforestry is an old African tradition that needs to be rehabilitated. In most traditional production systems, certain trees, shrubs, and bushes used to be protected for economic or religious reasons. Therefore what experts need today is a careful look at the social and ecological dimension of land use as well as a more sensitive appreciation of the tree/crop interface within the traditional agricultural production systems. Practical lessons can be learned from local people who are becoming aware of the serious implications of the continuing environmental degradation and are constantly developing intelligent land use practices as they attempt to overcome emerging constraints. There are also lessons to be drawn from successful and sustained developments achieved through pilot projects by governmental agencies as well as non-governmental organizations. A review undertaken jointly by the International Council of Research in Agroforestry (ICRAF) has underlined the development opportunities of agroforestry and the scope for IFAD assistance. With an appropriate institutional framework, a willingness to involve the communities concerned, and modest financial and technical inputs, environmental rehabilitation can be initiated.

However, institutionally, there are very few countries which have units that apply an integrated approach to the improvement of the traditional production system. Even where there is sound technological development, ready for dissemination to the rural population, there are often no appropriate extension services. To remedy this shortcoming, the present structure of extension services should be given an appropriate orientation by the inclusion of agroforestry themes in extension messages. A communication support system should also constitute an integral part of this endeavour.

An important element of the Special Programme for Africa would be soil improvement through tree planting. However, considerable attention would also be given to the fuel supply problems which are becoming very serious in many regions. Trees and shrubs planted mainly for environmental rehabilitation

through soil erosion control and the production of fodder and mulch will unquestionably help to cover the energy deficit. Nevertheless, there may be cases where it is also desirable to establish conventional woodlots on land of low agricultural value, around houses, etc., for the combined production of poles and fuel.

Another emphasis of the Programme's approach would be the strengthening of research activities and the establishment of appropriate pilot projects whose design, to a considerable extent, would be based on the analysis of existing agroforestry pratices, both traditional and modern, with appropriate adaptation to different environmental and socio-economic situations. It would also attempt to create an institutional mechanism for managing agroforestry programs following a broad multi-disciplinary approach. Furthermore, action would be taken to strengthen existing centres or create new means for the monitoring and evaluation of environmental changes, in particular desertification. As the Programme evolves, consideration would also be given to the creation or strengthening of regional institutions to meet needs which transcend national boundaries.

The main activities envisaged by the Programme at the sub-regional and national levels could be classified into the following broad areas of investments:

- activities which could be undertaken immediately because they require simple design and formulation efforts, e.g., rehabilitation of earlier attempts, completion of viable but inadequately supported activities and provision of support for expansion of successful operations; and

- programs and projects which would need longer periods for formulation/ appraisal and implementation because of the scale and complexity of issues.

The Programme would initially cover a few countries in sub-Saharan Africa where the introduction of some proven technologies would seem feasible. Examples of promising technological innovations to be used are the following:

- intercropping of fast-growing, short-rotation legume trees with herbaceous crops;

- promotion of the economic utilization of fruits of special variety trees for feeding dairy cattle or other livestock;

- establishment of shelterbelts in regions exposed to wind erosion based partly on the experience of some successful projects in Niger;

- creation of anti-erosion bufferstrips across slopes using a technique developed in Rwanda which could be of great value if adapted to other highland conditions; and

- protection of tree plantations by live hedges of goat resistent plants, a technology which shows great promise in Senegal.

IFAD's efforts would thus aim at making incremental improvements in existing land-use systems. Technical packages must, therefore, be compatible with the local culture and have a low technical complexity. Farmers' organizations should be used as a format within which problems can be specified, and the farmers themselves can rank their priorities, set goals, identify options, allocate responsibilities, and provide the required feedback.

In order to mitigate the negative impact on farm output due to extreme fluctuation in climatic conditions, the Special Programme puts a special emphasis on the Small-Scale Water Control Scheme (SSWCS).

Small-scale irrigation has been practiced for centuries in many forms throughout Africa with some success. The dynamic growth of such schemes in many parts of the region and the significant contribution they have made to food security, in particular at community level, is now widely encouraged. An encouraging example to contrast with the large-scale irrigation dominated by the public sector is the significant increase in informal irrigation in Nigeria for the past 25 years from 120,000 to more than 800,000 ha. Similar developments have been reported in other countries, i.e., Ivory Coast, Liberia, Mauritania, and Senegal. IFAD's experience in a number of countries indicates that promising potential exists in this area.

Small-scale irrigation should, however, be considered in its wider context, i.e., water management. It is concerned just as much with run-off farming and the control of excess water in swamp lands as it is with the more traditional process of taking water from canals and boreholes and spreading it onto the land. Such schemes which might be better called "Small-Scale Water Control Schemes (SSWCS)" include the exploitation of shallow ground water from hand-dug boreholes and wells; diversion of small streams and channels for furrow irrigation, small swamp-drainage and flood protection works, construction of simple earth bund structures to give some measure of water control, and other locally initiated developments. The most important characteristic of SSWCS is that they are developed at the initiative of the beneficiaries who retain the responsibility for operation, maintenance, and overall management.

Among the numerous advantages of SSWCS, the most important are: significantly low cost, involvement of local population in their implementation, reduced need for supporting infrastructure and external financing, and avoidance of the need to resettle the population as most beneficiaries will remain on or near their existing farms. Associated technological changes can be more easily adapted to the absorption capacity of the beneficiaries.

Despite the significant contribution that SSWCS are giving to community-level food security and their comparative advantage in the effective utilization of such scarce resources as foreign exchange and technical and managerial skills, national governments, as well as multilateral and bilateral donors, have yet to pay them adequate attention. Historically, institutions playing key roles in supporting and implementing irrigated agriculture have neither accorded adequate priority to such options nor have they included the farmers in the planning and decision-making process. Consequently, there is a dearth of knowledge and experience with regard to the ways and means of mobilizing local human resources.

Research, extension, input delivery systems, and incentive frameworks of many countries are also inadequate to contribute effectively to the development of SSCWS. Defining an appropriate role for government services merits careful examination, however. The public sector role should be focused on formulating and promoting a consistent policy and approach for the development of the sector and facilitating the establishment of forward and backward linkages with the rest of the economy for construction, input delivery, maintenance, and the marketing of products. The informal sector (e.g., masons, artisans, mechanics) along with NGOs can provide the needed dynamism and flexibility which is often lacking in government agencies.

To be sure, SSWCS are neither simple nor completely free of the technical and managerial problems that beset large-scale schemes. Due to their small size, scattered nature, and the specificity to diverse climatic, topographical, and hydrogeological local conditions, SSWCS are not amenable to a standardized design nor to a centralized supervision and follow-up. However, there are numerous instances of successful and sustained development of SSWCS achieved in particular through the assistance given by non-governmental organizations (NGOs). In most rural areas of Africa, the traditional and informal groups that exist could form the basis for such participatory development schemes if suitably strengthened and supported.

Two studies, undertaken jointly with IFAD, have underlined the development opportunities of SSWCS in sub-Saharan Africa and the scope for IFAD assistance(3). While the appropriate institutional framework for such assistance will, necessarily, vary from country to country, it should provide a flexible response to farmers' demands and ensure, through sufficient but modest financial and technical inputs, that the objectives of SSWCS are realizable and sustainable with minimum recurrent budgetary requirements on the part of national governments.

The scope of IFAD's Special Programme for SSWCS development in sub-Saharan Africa would cover those countries in the arid and semi-arid Sahel zone that already have experience in such SSWCS and where there evidently exists a good potential for further development. In addition, other countries that have more favourable climatic conditions but where increasing population pressure has already stimulated interest in SSWCS works would also be included.

Preliminary assessment of the possible total investment potential of such a Programme has also been made, based on brief reviews of country experience, resource potential, and possible paricipating organizations. These estimates should, of course, be stengthened by visits to the countries concerned and in-depth reviews of government and NGO capacities, together with an eventual evaluation of likely farmers' demands for SSWCS.

Cost of typical SSWCS varies widely depending principally on location and technology; for the purpose of preliminary estimates, recent design costs for similar works in Africa have been used as a basis. These range from US$2,500/ha for small, individual pump schemes to over US $5,000/ha for small gravity diversion irrigation schemes.

Since the types of SSWCS to be undertaken will generally be small in size, will vary widely in technical characteristics, and will be widely dispersed, it is probable that the principal constraint to implementation will concern institutional problems and the ability of the different organizations concerned to initially stimulate and, subsequently, satisfy farmers' demands. It is expected that project development would be modest during the initial two years. The implementation of the Programme will be closely associated with efforts from those NGOs that are particularly well placed to assist in both identifying potentially interested farmer groups and in developing SSWCS, due to their experience and commitment in supporting such grassroots initiatives.

In the light of these considerations, a possible IFAD program to support SSWCS developments could consist of infrastructure developments covering, in total, between 2,000 and 3,000 ha for each country. Institutional support and training would be included. Preparation of an inventory of existing and planned schemes, to facilitate the task of coordination, should precede the formulation of any development program.

With respect to the overall institutional and policy constraints, IFAD recognizes that the effective implementation of the various elements of the Special Programme would be contingent upon strong institutional and policy support. The emphasis would be on making use of the existing institutions to the maximum extent possible by making them more cost-effective through training the key staff and streamlining operating procedures. It is recognized that this is not an easy task and no tailor-made solutions are available. However, in designing the projects and programs to be supported under the proposed Special Programme, the implementation capabilities of the institutions to be entrusted with their execution would be carefully investigated.

At the policy level, the primary concern would be with the "downstream policy arena," i.e., acquiring a clearer understanding of the implications of macro-economic policy reforms for the target group and sensitizing the governments' decision-making organs about the policy changes which are necessary to ensure that the smallholders are motivated to fully participate in, and benefit from, the Special Programme activities.

To ensure the effective participation of all elements of the economy and to stimulate a quick and adequate response to the Programme, with minimum burden on the public sector, a comprehensive plan of action should be pursued:

* Target Group Organizations, formal and informal, in their ideal form provide an attractive strategy of participation. However, they function best where there is direct farmers' representation at each level of the structure, freedom for farmers to participate, and minimum state control. The Programme would therefore try to promote a policy environment which would be conducive to the establishment, growth, and effective functioning of farmers' organizations. In this regard, it would particularly promote the principle of voluntary membership in cooperatives. It would also encourage the review of government legislation and regulations for adoption of flexible eligibility criteria which would provide informal groups with access to the

services and resources available to the formal groups and cooperatives. The Programme would also support women's groups which have developed spontaneously in Africa to fill the existing gaps in rural institutions.

* Most cooperatives and other types of formal and informal associations tend, however, to lack the necessary managerial skill. Quite often, simple programs of training in critical areas play a very useful role. The Programme would therefore provide technical assistance and training for groups to increase their skill and improve their management capacity.

* Institutionally, the Programme would try to bring about the involvement of NGOs whenever desirable and acceptable to the concerned governments so that it could draw upon their dynamism and close interaction with communities. To do so, it would be necessary to identify the comparative advantages of each NGO for a particular type of project or task. Very often NGOs require a familiarization with financial and managerial realities. To achieve this objective, the Programme could adopt certain measures such as encouraging participation of NGOs in training programs and workshops and also their participation different stages of the project cycle.

* Support to the small-scale private sector and promotion of individual initiatives should also form an integral part of the Programme's institution-building efforts. The sector possesses such capability and flexibility as are needed for removing the critical bottlenecks of delivery systems. During project and program designs the need for making optimum use of local artisans and the establishment of small facilities such as repair shops or market places should therefore be reviewed and considered.

* Assisting governments in their efforts to decentralize public services should also form a part of the institutional approach toward implementation of the Programme. The process of decentralization needs to be as complete and as comprehensive as possible. Responsibilities should be decentralized along with delegation of authority and allocation of resources. Efforts in this area could be supported by other agencies with larger institutional capacity. IFAD would supplement these efforts in areas relevant to the Programme and its target group. An example of an area for potential IFAD intervention would be training and re-orientation of relevant Government staff to ensure a better interaction between them and the local communities.

* Finally, IFAD can increase its project-related training and development of manpower at the national and regional levels. Training of staff involved in research and extension would receive particular emphasis at the regional level. IFAD has already initiated such activities with the Agricultural Management Training Program for Africa (AMTA). The program which is financed mainly by the Fund was launched through a collaborative arrangement with the African Development Bank and EDI of the World Bank. Its design is unique in that it takes a comprehensive approach toward assisting African countries to develop their manpower capacity for managing development projects more effectively. It also contains provision for improvement of the policy and organizational environment within which individuals function. This program

could be extended to more countries and would include the project portfolio of the Special Programme.

* There is a need in the African countries for strong skills in policy analysis and the assessment of alternative options. Donors should therefore assist in increasing this capacity within the countries concerned. Moreover, the attitude of the donors should be one that promotes objective policy analysis and diagnosis by the countries themselves. Of particular significance are the government's fiscal policies dealing with the agricultural sector, including pricing, subsidy, and the overall issues related to the terms of trade within agriculture and other sectors. Through SPA, and on a selective basis, IFAD would provide the countries concerned with technical assistance in this area.

I have so far tried to illustrate the manner in which IFAD, through the Special Programme, is concretely attempting to alleviate some of the key constraints facing agriculture and rural development in drought-affected sub-Saharan Africa. However, my presentation would be incomplete if I did not mention one area of major and immediate concern to sub-Saharan countries, i.e. the early and effective rehabilitation of their productive capacity. IFAD's Special Programme does include agricultural rehabilitation as an important component.

A program of recovery and rehabilitation is needed to respond to the shocks to the rural area and to prevent further deterioration. The rationale of the Programme lies therefore in its ability to increase the resilience of the sector and to enhance its absorption capacity for longer-term measures aimed at pushing the "trend line" of production upward. In doing so a number of adjustments in the policy and institutional environment will be required. Recovery should not be viewed merely as a financial operation but also as a vehicle to improve institutions and policies perceived to have caused or contributed to the present problems. Within these general parameters, however, individual country rehabilitation programs must be developed, taking into account the specific environmental, geographic, agricultural, and related concerns and the specific impact of degradation caused by drought or desertification in that country. This greater specificity must also be the tool for organizing particular policy and institutional reforms. A target-group- focused and sector-specific recovery program is therefore both feasible and essential and should form the foundation of the Special Progamme for sub-Saharan Africa.

Recovery should be seen, however, as a sequential process. Just as administrative, social, and economic collapse have fed upon each other, similarly each step toward recovery will facilitate further improvements provided the timing is right and the order of sequence is appropriate. In this context, restoring the production ability of the smallholders and facilitating the optimum utilization of idle capacities of institutions dealing with input delivery and the development and transfer of technology to the smallholder should constitute the main focus of the Special Programme.

With the above-mentioned requirements in view, the recovery program aims at arresting the deteriorating secular trend in smallholder producion and increasing the capacity utilization of the currently functioning institutions,

existing infrastructure, and public utilities serving rural areas. In doing so, the Programme would help to consolidate existing investment portfolios relevant to the target group and food sector, thus removing bottlenecks that are inferfacing with the effective implementation of promising projects.

The Programme would also assist in providing a sharper focus for policy direction and institution-building efforts already started or being contemplated by member governments in addressing the problems of food production and alleviation of rural poverty. The effects of government macro-economic policies on the smallholder food producers would be reviewed in the context of sectoral policy issues. To achieve this objective effectively, collaboration and coordination with other multilateral and regional financial institutions would be essential.

Efforts will also be made to coordinate the work of this operation with the work of bilateral and multilateral agencies in such a manner as to augment the effectiveness of IFAD assistance by directing more attention and channeling greater resources to the smallholder sector. In particular, a recovery program with built-in flexibility and inherently quick delivery mechanisms would have a promising potential to augment the impact of the Food For Work programs of the WFP through provision of critically needed materials and equipment for the completion of such operations. Similar mutually reinforcing measures could also be achieved by synchronizing the inputs of the IFAD-intitiated recovery program with those of other institutions such as UNICEF and WHO.

The magnitude and complexity of problems call for a multi-front approach in the following broad areas of operation:

- restoring productive capacity of smallholder farmers, pastoralists, and fishermen through provision of basic tools and production inputs, vaccines, drugs and veterinary equipment, and equipment for coastal and inland artisanal fisheries;

- improvement of on-farm storage;

- reviving capacity of the village-level informal sector - cooperative, farmers' associations, village workshops, and processing facilities;

- restoring physical and social infrastructure at village level through repair of drinking water supply points, roads, storage, and rural health facilities;

- improving capacity utilization of infrastructures and institutions dealing with the smallholder sector through provision of required inputs, materials, equipment and spare parts, means of mobility, and technical assistance.

To assure that rehabilitation programs involving the provision of specific financial inputs and the appropriate allocation of government's budgetary and other resources are in fact directed clearly to the needs of smallholders and the rural poor, the following basic pre-conditions must be met:

- there must be clear positive lists of items to be financed that meet the priority production needs of smallholders;

- programs and resource flows must be targeted at intended beneficiaries by sectoral and, if necessary, geographical delineation;

- grassroots institutions of the economy, i.e. cooperatives, farmers' associations, and the private rural sector, must be involved in the distribution of items financed and the implementation of program components; and

- programs undertaken must induce adoption of a realistic pricing system, supported by a simple but effective monitoring mechanism to prevent leakages.

Consideration of the above principles makes IFAD's approach to the recovery purpose-specific and target group-focused. This is an important area where the work of IFAD would supplement the work of other financial institutions.

The Special Programme for drought-affected countries in sub-Saharan Africa focuses on staple food crops which have been traditionally grown and consumed widely in the countries concerned (e.g., millet, sorghum, maize, cassava, yams, pulses, plantains).

Traditional crops remain the staples of the African diet and in rainfed farming they form the backbone of the sub-Saharan food supply system. Traditional crops account for 70 percent or more of the energy value of the average diet and constitute the main source of protein. Traditional crops are grown and consumed by all poor smallholders who rely on them as their main source of livelihood. In many of the countries of sub-Saharan Africa, 50 percent or more of the total arable land area is occupied by this category of crops, which represent a major source of employment for the rural labour force.

Some traditional crops such as cassava, millet, and sorghum are drought-resistent or have a high degree of tolerance in times of insufficient moisture. Recent agro-meteorological studies in Tanzania, for example, have revealed that a 20 percent shortfall in rainfall during the growing season could reduce maize yield by as much as 50 percent, while for sorghum and millet, the reduction could be as low as 10 percent. These crops are better suited for cultivation under marginal conditions on lands with low fertility where the so-called preferred cereals do not flourish.

The Special Programme for sub-Saharan African countries affected by drought and desertification is intended to benefit primarily 20 to 25 countries located in the Sahelian zone of Western and Central Africa as well as in Eastern and Southern Africa. Its implementation would require US$300 million over a period of four years, representing a special effort in addition to IFAD's regular grant and lending operations in sub-Saharan Africa ($577 million for the last seven years).

In recognition of the relevance of the Programme to Africa's development as reflected in the Lagos Plan of Action, the Twenty-first Assembly of Heads of State and Government of the Organization of African Unity (OAU) adopted a recommendation urging the international community to secure "an increase in the financial resources of IFAD commensurate with the agricultural development needs of developing countries and a subsequent increase in the resources allocated to Africa" and "to provide substantial assistance to IFAD to enable it to achieve the target of $300 million for its Special Programme for sub-Saharan Africa."

IFAD has been receiving encouraging signals from donors and we hope that firm commitments will follow soon. We do believe that the Special Programme, during its detailed formulation and its implementation at country level, will offer a valuable opportunity for collaboration with other donor agencies - both bilateral and multilateral - as well as non-governmental organizations operating in the countries concerned.

In sharing IFAD's views on the agriculture and rural development problems facing drought-affected countries in Sub-Saharan Africa, and describing its Special Programme for aiding those countries in resolving some of the major constraints confronting the rural sector, it is my sincere hope that we can draw lessons which could help African Governments as well as the donor community to address more effectively the many and complex problems which must be resolved to bring Africa's agriculture back onto the track of sustained development.

ACKNOWLEGEMENTS

On behalf of Mr. Idriss Jazairy, President of the International Fund for Agricultural Development, I wish to thank IDRC, ICSU, and CIDA for inviting our organization to attend this important Symposium on Drought in Africa.

NOTES

(1) Estimates are based on data provided in the World Bank's Toward Sustained Development A Joint Programme of Action: Statistical Annex, Vol. II of II, Aug. 1984 and World Development Report 1984, Chapter 5.

(2) Undernourishment is defined as the situation where per capita daily calorie intake is below the requirements. Severe undernourishment is the situation where this intake is below 90% of requirements.
(Source of data as in note 1)

(3) FAO, Investment Center, Small Water Control Schemes in Sub-Saharan Africa, Rome, February 1985; Silsoe College, Small-scale Irrigation Scheme in Sub-Saharan Africa, Options Paper for IFAD, February 1985.

SUMMARY OF DISCUSSIONS

Each afternoon of the symposium was devoted to discussion of the morning's presentations. In the report which follows, the views expressed have been summarized under seven subject headings for the convenience of the reader:

Government and Donor Policies
Drought Prediction
Institutional Support
Extension Services
Soil Fertility
Water Resource Management
Storage Facilities

There are, however, four commentaries which deserve special reference. These are the critical opening remarks by distinguished Africans which preceded each afternoon's session.

COMMENTARY BY DR. M.F. TRAORÉ

Dr. Traoré noted that drought has been endemic in the Sahel for the last ten years and that people there no longer believe in its cyclical character but rather that it is a phenomenon which must be taken into account whenever food and development strategies are planned. In his view, rural production, especially the production of food, should be emphasized more. It is up to the extension team in the field, while encouraging agricultural development, to make sure that consideration is given to economic factors, ecological stability, and, above all, the people involved. In stressing the need to examine the problem in terms of the individual farmer who is actually the main agent in Africa's development, Dr. Traoré set the focus for the discussion which followed. He noted, in conclusion, that the movement toward self-sufficiency will require the solution of a great deal more than just technical problems on the part of African governments.

COMMENTARY BY DR. I. EL-BAGOURI

Dr. El-Bagouri provided two distinct commentaries. The first concerned the situation in the Nile Valley; the second described some of the primary components of a program to combat the effects of drought.

Egypt depends on the Nile River to satisfy its water requirements for agriculture, industry, power, and municipal use - about 55 billion cubic metres per year. The fertile Nile Valley supports two or three crops a year and is home to 99 percent of Egypt's population - drought seems unimaginable in such a lush environment. And yet water levels recorded at Aswan during the last 7,000 years show very wide variability in the Nile discharge. Prior to the

construction of the Aswan High Dam in the early 1970s, the Nile summer floods were uncontrolled; some years there would be serious problems with flooding and, other years, cultivation of certain crops would have to be curtailed because of water shortages.

During the drought years 1978 through 1984, Egypt had a yearly water deficit of between 5.5 and 23.5 billion cubic metres that was only compensated for by withdrawing water from the reserves of Lake Nasser, behind the Aswan High Dam. Without that reserve, the country would have been forced to cut water usage, probably at the expense of the agricultural sector since industrial usage cannot as easily be varied. Curtailing summer crops such as cotton, rice, and other exporting commodities would have resulted in increased food imports and a foreign exchange deficit. This year, just as the lake is reaching an almost critically low level, an above-average flood is expected from the Ethiopian highlands which will surpass water requirements and replenish the lake. This is an example of one capital-intensive project which has proven highly successful and should continue to provide benefits for another 500 years.

Dr. El-Bagouri explained that, just as the stress-effect of drought in Sudan is moving southward into important agricultural areas, the stress is moving in the opposite direction in the North African countries. Marginal areas are losing natural vegetative cover, upon which livestock depend, as rainfed cultivation expands into these regions. Livestock are pushed southward into marginal rangeland areas where they overgraze and denude the soil and they then move northward and invade cereal growing areas in the agricultural zone. Both rangeland and rainfed areas are therefore suffering, and the problem is becoming more pervasive.

Integrated and well coordinated efforts of a multidisciplinary nature are needed in dealing with the complex problems of the drought-stricken areas in Africa. The countries concerned should first choose priorities from among the possible immediate and long-term strategies - it is they who are the most capable of assigning these priorities since they are familiar with the constraints and the most pressing needs.

The fundamental challenge to be faced is that of restoring productivity to vast rainfed areas that have lost their natural plant cover. There are many approaches that can be taken: rain-harvesting techniques, water storage, use of appropriate drought-resistant plant species, pest control measures, animal fodder reserves alongside water points (to be used under stress conditions when the natural rangeland has been overgrazed), and improvement of local breeds through selection and breeding programs. For example, the Awasi sheep in Syria and Iraq and the Barki sheep in North Africa have been greatly improved in terms of meat and milk production and yet they have retained their drought and disease resistance.

Dr. El-Bagouri stressed that the identification of appropriate farming systems and management practices, which can cope with the large variability in water resources and thereby optimize their utilization, is another key requirement. These practices could then be introduced through pilot projects where excellent

opportunities exist for data gathering, expert-farmer dialogue, evaluation of socio-economic impacts, on-site training programs, and generation of acceptance of new techniques at the grass roots level.

COMMENTARY BY DR. ZEWDIE WOLDE GEBRIEL

Dr. Zewdie identified the lack of comprehensive food and nutrition policies in most African countries as one of the exacerbating factors in the present drought situation. It is quite common for the governments of these countries to have no well-defined policies on food pricing, production quotas, food-crop/cash-crop land allocation, distribution from areas of surplus to areas of need, and import/export of food grains. For example, the large farms often continue to produce mainly cash crops, even though food shortages remain critical. With regard to food aid, Ethiopia has been receiving shipments for the last ten years but their effectiveness has been hampered by inadequate delivery mechanisms causing uneven distribution among regions.

To counter these problems, Dr. Zewdie urged international agencies to act as catalysts to stimulate governmental initiatives on policy formulation and to work cooperatively with governments in formulating and implementing the necessary food and nutrition strategies.

Another chronic difficulty has been the lack of program coordination among donor agencies in Ethiopia. An office has recently been established by the United Nations to minimize duplication of relief projects and inconsistencies in their administration. The government has also formulated guidelines for feeding and shelter programs, sanitation, immunization, and communicable disease control - even so, problems still exist.

Dr. Zewdie mentioned several programs of proven success in combating the effects of drought. One is the food-for-work program, inititated during the 1972-74 famine and still on-going. It has allowed some important development activities to be completed: road construction, afforestation, terracing, construction of small dams, and soil/water conservation programs. Another, more controversial, long-term measure has been the gradual resettlement of over half a million people in more fertile, less populated areas in southern and western parts of the country, with another million slated to be eventually relocated. Dr. Zewdie supported this government initiative as a necessary adjunct to other policy measures and he was able to vouch for the overall success of the program.

Finally, Dr. Zewdie expressed concern at the high capital costs of large-farm inputs (fuel, tractors, fertilizer) which deplete valuable foreign exchange reserves. He echoed the sentiments of many others in calling for greater attention to be directed toward the development of small farms. He added that international agencies and governments alike are reawakening to the value of traditional farming systems.

COMMENTARY BY MR. K.Y. AMOAKO

Mr. Amoako described the World Bank's view of the drought situation in Africa and proposed a three-dimensional response by the international community, including emergency relief, medium- and long-term measures. He also applauded the work of the FAO, WFP, WMO, and other organizations in connection with drought relief and drought prediction while recognizing the many constraints under which they operate.

Two important suggestions for improved emergency relief were that speed and flexibility become priorities and that it not be limited to food aid. The world community must always prepare for the worst (for second and even third years of drought) by means of contingency plans, and must develop the capacity to mobilize relief efforts quickly and effectively in case of need. Equally necessary is the flexibility to cease operations as soon as special assistance is no longer needed. This would limit the dependence of African countries on permanent food-aid programs which generally repress local initiative to restore food supplies and frustrate the capacity for long-term recovery. Emergency relief should include the transportation of water by trucks and the distribution of medicine as well as food. In the short term, the efforts of international agencies in providing vaccines, drugs, cattle fodder, seeds, and fertilizer should be assisted by the bilateral aid organizations.

Medium-term programs aimed at rehabilitating the productive capacity of drought-stricken countries should be carefully prepared on the basis of realistic government programs. Governments should be supported in completing inventories of the effects of drought on both overall economic activity and specific sectors and in identifying remedial actions and rehabilitation programs in which external donors may participate. Attention should be paid not only to food crops but also to export crops and energy sources - they affect the balance-of-payments and the public finances of a country well beyond the end of a drought.

The essence of a long-term strategy should be the development of various types of drought-resistant farming and economic systems with emphasis on the needs of the small farmer. Mr. Amoako stressed that more research effort should be focused on increasing yields in the lower-rainfall areas under rainfed conditions. In addition, research findings should be carefully tested under pilot schemes before large-scale introduction is attempted, to take into account the complex ecological and socio-economic factors which are particular to lower-rainfall areas.

Irrigation development has been seen by most African governments and many donors as the optimum long-term solution to drought in vast arid and semi-arid areas. The Sahelian drought of 1970-73 was instrumental in mobilizing considerable amounts of external assistance for the Senegal River development program and other large-scale irrigation projects. There are, however, severe constraints on the success of these projects:

- long gestation periods and high development costs (over $10,000/ha)
- high maintenance costs (requiring capital-intensive inputs)
- lack of trained management and operating personnel
- inadequate cost-recovery mechanisms
- government pricing and marketing policies which often impose artificially low food prices on producer and consumer (particularly damaging to large-scale irrigation schemes which need to sell the bulk of their output in urban markets).

For these reasons, it is time to re-emphasize modest expansion of small-scale irrigation schemes which offer comparatively low costs, and opportunities for local input planning, construction, and maintenance. An appropriate rural water supply strategy should also include:

- systematic assessment of water supplies (donor agencies could help in the evaluation of groundwater irrigation potential as a supplement to rainfed cultivation in drought-prone areas)
- assistance to rural committees in the design and financing of initial investments and future operations
- the development of locally adapted handpumps
- possible expansion of rural water supply through the construction of boreholes (if the problems of high investment costs of as much as $10,000/borehole, maintenance, and financing of recurrent costs can be overcome).

Mr. Amoako concluded that over the last few years the consensus reached by both African governments and the international community is that lack of policy and institutional reform is the root cause of the problems facing Africa. Accordingly, the World Bank is actively supporting these countries in their efforts to bring about policy reform by offering technical assistance to increase their capacity for policy formulation. The World Bank recognizes that while the international environment remains so severe, African government efforts to implement policy changes are in jeopardy unless their limited resources can be sufficiently fortified by external sources.

One particular aspect of policy reform was highlighted by Mr. Amoako. He suggested that one of the most effective lines of defence against localized drought is the expansion of cereal trade among African countries through improved national marketing policies.

African climates are so diverse that even during the most severe droughts there are still areas where rainfall and food production conditions are quite favourable. But grain trade in Africa is a difficult enterprise which requires the capacity to handle both small and widely-scattered purchases in isolated rural areas as well as large-scale operations in major cities. Private trade offers the flexibility necessary to serve all the markets competitively, at commercial margins that are only a fraction of the operating costs of grain marketing boards in the public sector. Unfortunately, many governments began implementing large-scale grain storage and marketing programs after the 1972 drought with the dual objectives of storing food for bad years and regulating

food producer and consumer prices; but through high costs, rapid degradation of stocks and inefficient management, they have in fact become instruments of rigid grain pricing and marketing policies that have daunted private trade and discouraged farmers from producing grain surpluses for the market. Mr. Amoako urged active policy re-evaluation of this issue by governments and donors.

The following are comments, observations and responses which arose during the discussion sessions. They have been categorized under the subject headings listed above (p. 155).

GOVERNMENT AND DONOR POLICIES

"The question of government policies is one of the most important subject areas we have to address." Three differing views were presented regarding the importance and effectiveness of agricultural policy planning in Africa today. The majority opinion was that the lack of well-integrated policies is a very serious problem, one which has significantly contributed to the current stagnation in agricultural growth.

Various explanations followed: it is difficult to formulate national policies when there is a shortage of critical manpower at the top levels of government with capacity to handle sectoral problems and horizontal interactions with other Ministries; governmental systems which operate through several separate Ministries all too often result in uncoordinated parallel programs which overlap with each other and clash in focus and aim; development plans are often based on inaccurate figures because African governments don't have the resources to gather the information from the field that they need.

In addressing the need for better policy planning, it was agreed that governments must first exert political will in this direction and then commit themselves to developing the necessary capability. Integrated strategies, based on a multi-disciplinary approach are required. It must be realized that the resulting blueprints are by no means static; planning is a long-term undertaking which requires regular review and redefinition of goals as uncontrollable input variables change. Kenya has had some success in creating multi-disciplinary teams to discuss development projects, made up of representatives of each of the Ministries, and Zimbabwe now effectively coordinates programs through the Ministry of Financial and Economic Planning.

A second perspective suggested that the problem is not so much a lack of policies but, rather, severe limitations on the financial resources necessary for implementation of these policies. This is exacerbated by competition from other sectors of the economy for these scarce resources, often to the detriment of agricultural programs. This viewpoint underscored the importance of recognizing that it is upon agriculture that the majority of Africans depend and priorities must be assigned accordingly in development planning.

A third opinion was that, compared with other nations, the African governments are not doing such a bad job in setting agricultural policy, particularly in view of the severe constraints under which they must operate - erratic food

production from year-to-year, the necessity of keeping food prices at a reasonable level for low-income consumers, and all the difficulties inherent in changing agricultural policies based on cash crops which generate needed foreign exchange to purchase imports and service debts. It was pointed out that we often forget that African governments have virtually no room to manoeuvre and that so called "sensible policies" are much easier to concoct than to implement in such an environment.

Illustrations of this difficulty are the prevalent two-tier currency systems and the slow development of value-added industries in many African countries. Official exchange rates are often out of line with true market values, prompting the co-existence of black-market rates. But the causes of over- or under-valuation are usually beyond governmental control. Realignment is constrained by a scarcity of foreign exchange. It was pointed out that just opening the markets and allowing these currencies to float would leave economically weak countries in a highly vulnerable position.

Another problem has been the limited growth of value-added industries. Botswana has been very slow to develop a leather-based industry. This is because setting up facilities for the tanning of hides beyond the wet-blue stage and the manufacture of leather-goods would not be cost-effective at the present time. It would require a large domestic market (Botswana has only one million inhabitants) and access to international markets plus sufficient economies-of-scale to allow a competitive edge over other imports into both markets. None of these conditions can currently be met.

It was suggested that some of the confusion among donors is being exacerbated by a lack of clear directives from the national governments themselves. It appears that while development agencies are seeking policy guidelines, African governments are looking toward the donor community for assistance in setting those guidelines - in maintaining up-to-date statistics, developing policy planning skills, and providing long-term commitments to allow implementation of certain programs. The symbiotic nature of government relationships with donors becomes apparent, as does the need for better communication and coordination at every level; donor organizations should not limit themselves to top-echelon interaction in planning their own programs but should also maintain contacts right through to the grass roots level. Coordination of donor programs through a centralized office (usually a particular Ministry) was highly endorsed as one way of avoiding duplication.

With regard to bilateral vs. multilateral aid, the participants were unanimous in confirming the continuing usefulness of both. Bilateral aid, sometimes fostered by political interests, is preferrable for smaller, more urgent projects because the negotiations are usually more staightforward and facilitate rapid execution. The rapid policy shifts that may accompany this form of aid can make bilateral arrangements difficult to cope with however. Multilateral negotiations take longer because everyone involved must reach agreement so implementation is slower but they do allow more room for maneuvering in that no one political view usually dominates. For bigger projects with longer time-spans that one country alone cannot finance, a multilateral arrangement is generally more desirable.

DROUGHT PREDICTION

There was considerable discussion of recent progress in the field of drought - prediction and climate modelling. Studies carried out so far do not point to the immediate possibility of prediction of drought - there are just too many cycles super-imposed upon one another. But the situation is not hopeless. By plotting a time-series of rainfall over reasonably large areas (eg. N. Kenya) for long periods of time, we find that the fluctuations of annual rainfall are not wholly random. Cyclical patterns are almost impossible to discern but there might be some underlying logic to them that we could conceivably use for prediction purposes.

Major attention has recently been focused on the nature of the enormous disturbances of the tropical climate (El Niño events, fluctuations in the monsoon) to which the droughts in Africa belong. It is becoming apparent that these are really planetary events and that we might learn enough about them one day to attempt predicition. By understanding the mechanics of these disturbances we could also gain some predictive ability.

So there are distinct possibilities of looking at global weather systems and drawing inferences about past weather patterns and expectations for the short-term future (up to a few weeks). Some participants felt that the real challenge now is to make better use of the information available to us. This presupposes a need for much better data collection, analysis and dissemination. It was noted that information-gathering systems in Africa have decayed over the past twenty years and that we must begin now to address this problem if we hope to ever understand the climate of Africa.

There was some question as to the viability of sustained investment in the atmospheric sciences at the level necessary to provide useful information and even whether these resources could be better spent elsewhere. "Is a seven-day weather prediction of use in the southern hemisphere on a continuing basis?" one participant asked, given that farmers more or less know intuitively when it is the best time to plant their crops.

It was acknowledged that multi-million dollar experimental programs represent a sudden intense effort to reach some new threshold in understanding and have to be dismantled at their conclusion because of cost considerations. But since no one has really explored the question of the effective scale on which people could make economic use of weather forecasts, it was argued that it is premature to judge the worth of predictability.

Mention was also made of joint WMO-FAO efforts to develop agro-ecological models for crop monitoring and yield forecasting. It was pointed out that the uses of climatological data have not been fully recognized anywhere in the world, either in monitoring the current situation and assessing how it will affect the next yield, or in analyzing the variability in rainfall over the long-term and its effect on the production of various crops. It is now possible, using simple climatological data, to assess soil moisture conditions and to then relate this information to crop development, yields and total

production levels. This is achieved through the application of "black box" models which can be used anywhere in the world, if accurate data and the necessary tools of agricultural data analysis are available: a computer, and trained personnel. A lot of time can be saved by using these models to answer questions such as: How much soil moisture do we need for optimum use of fertilizer? What is the potential for a new crop variety to provide an economic return in certain unfamiliar climatic conditions?

INSTITUTIONAL SUPPORT

"What we mean by institutional development is not just a question of putting up a laboratory...it is the development of the people within a country who can carry on the very long-term aspects of research and development." Unless there is significant development of local personnel during the start-up phase of a project, it will collapse once the team of expatriate researchers has to leave.

This concern was central to the discussion which followed, much of which focussed on national and international research centres. The important role of donor agencies in stimulating research capability in countries of Africa was acknowledged but there were doubts as to whether the international agricultural research centres, which were created essentially to strengthen national capabilities and systems, are in fact fulfilling that mandate.

It was felt that interaction between international and national institutions has been unsatisfactory. It is up to the national research institutes to initiate research programs; it is then germane for the international bodies to support these programs and ensure that research capability will extend beyond the period of donor intervention.

The example of the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) was used to describe the operations of an international agricultural institute. ICRISAT has worked in the semi-arid tropics for the past twelve years with separate programs in East Africa, Southern Africa, the Sahel and India in recognition of the vast diversity in program needs across regions. Most decisions are still made at headquarters in India, and program administration needs to be more decentralized to facilitate location-specific work. ICRISAT needs to work closely with national and other international centres and be particularly concerned with building national research capabilities to enable them to adapt results from international sources for national and regional benefit.

Training is a high priority; it was viewed as the most important aspect of an international centre's work. What is needed is training which encourages scientists in national research systems to work closely with and for the benefit of smallholder farmers. Communication with national programs has not been as close as it should have been in the past; better cooperation between international and national programs is an urgent necessity.

Several other concerns were voiced:

* donor agencies seem to be neglecting institutional support; quite a number of African universities seem to be in a much worse condition now than when their countries became independent;

* donor agencies are not giving enough support to the smaller, provincial universities which are closer to the farmers;

* it is very hard to get universities, even agricultural faculties, into rural areas because rural-based research is expensive and can fail much more easily - it needs more financial backing;

* research institutions are not concerned enough about funding practical, relevant research that considers actual on-farm situations; integrated research on crop-animal interaction has been stymied in the past by narrowly defined mandates which are, fortunately, now becoming more flexible.

Examples of successful programs offered some reassurance that progress is being made. In Egypt, most faculties of agriculture have moved into rural areas to foster interaction with farmers. Pilot development programs there are using an integrated approach to bring research and application together. Research results are compiled, evaluated and then introduced through on-site training programs. Tanzania has had a policy for many years whereby university students must spend six weeks a year at a Ujamaa village working with the farmers during the cropping season and also must do two years of national service, working largely in a rural setting. Bangladesh has had some success in encouraging civil servants to accept rural postings by offering double pensions and no loss of seniority for every year spent outside the capital city.

EXTENSION SERVICES

The participants discussed the difficulty of getting the smallholder directly involved in the agricultural development process. It has been shown repeatedly that while new, effective technologies are available to produce high-yield crops and use water resources more efficiently, the information has not been adequately communicated or accepted at the rural level. Four contributing factors, along with remedial suggestions, were identified:

* "We are seeking to improve the farmers' performance in many cases without understanding what the farmers' problems are." Agricultural improvement has to be a top-down and bottom-up process - we need to generate local involvement in it so we can understand what bothers and what motivates the farmer.

* "We hire experts who have been trained elsewhere to come in briefly and teach the farmers what to do." Though more difficult to organize, it would be far better to train selected farmers to do the teaching. They would provide continuity and would be able to relate more easily to their fellow farmers, having a bond of mutual trust and respect amongst themselves.

* Farmers are primarily interested in averting risk within their farming system. They will not entertain new technological packages unless they can be proven to be superior to what they had before. In the past, not enough

effort has been made to really allay their skepticism. Small-scale pilot projects on which farmers can participate in the testing of new practices and witness tangible results were stressed as an integral link in moving new technology out into the rural areas.

* Effective communciation of new and useful information presupposes a user-intelligible form and a viable means of distribution, both of which have been traditionally lacking in the extension services. Improvement could be achieved through the use of more basic easy-to-follow instructional material prepared for a particular target audience and by more imaginative use of the mass media channels which are widespread across Africa.

The realization behind these insights is that individuals, particularly smallholders, must have control over the changes that fundamentally affect their lives or they are bound to reject those changes, even though they may offer potential rewards. Extension services emerging from the application of the suggestions made would be based on a marketing approach, one in which the end-user (the farmer) and his needs are pivotal, and the question of how to "sell" a new technology at the rural level becomes a major consideration. As with all efficient marketing programs, the customer's attitudes, needs and constraints need to be fully understood. In this context the smallholder farmer is the customer. Technological improvement will be accepted only if the farmer is a full partner in the planning and implementation of research and development.

SOIL FERTILITY

Various ways to improve the fertility of the soil and thereby increase crop and livestock production were suggested. These included mulching, appropriate use of organic materials, development of fertilizers, fodder crop expansion, better understading of traditional cropping systems, and improved tillage methods.

The benefits of mulching - leaving trash cover on the surface - were acknowledged. Compost and manure are often wasted or misused. It was suggested that, in the long run, we have to find ways of continued improvement of utilization of organic matter within the soil in order to facilitate the effectiveness of inorganic fertilizers which, though essential, are too expensive for most smallholders.

Crushed rock as a mulch and as a fertilizer has been effectively used. There is work underway now on the conversion of rock phosphates into phosphate fertilizers. Area experiments have been quite successful, especially in pastures with soils of high acidity (pH of less than 5). Under these conditions, rock phosphates are converted in the soil and plants are able to use this phosphate directly. Use of local phosphate should increase in the future.

Fodder is an important aspect of the fight against drought. In rainfed agriculture, eradication of the vegetative cover leads to soil erosion, lower water infiltration, increased run-off, and nutrient and humus loss in the

topsoil. Reversal of the cycle requires range regeneration through the introduction of a mix of legumes and grasses suitable for fodder production. This is important both for animal welfare and for improvement of the organic content and fertility of the soil. One project in Egypt has proven the effectiveness of fodder crops in increasing organic content under irrigated conditions: desert sand of only .004 percent organic matter has increased after only a few years to .12 percent - still very low but nevertheless a 30-fold improvement.

Better use of forage crops is also necessary to maximize the nutritional value of livestock in the most cost-effective way. Zimbabwe has been working on the development of more palatable grasses by introducing indigenous and imported legumes into grazing areas. This effort, along with better management of grazing (avoidance of depletion of grasses by overpopulation) should alleviate dependence on grain sources for the production of beef and help Zimbabwe's beef industry remain competitive.

High priority was given to finding suitable crop mixes that balance the best of traditional crops, which are more hardy, and hybrids, which offer larger yields. Cassava, an important staple crop for over 200 million people, was discussed in particular. Quite a lot of work has been carried out by IITA on the development of improved mosaic-resistant cassavas. It was cautioned however that, having developed very high-yielding varieties and encouraged farmers to increase production, the question of food technology projects for cassava processing must also be addressed since the fresh markets simply cannot cope with the huge quantities involved.

With regard to the introduction of exotic species, we cannot generalize by stating that, in every case, improvement of indigenous species is preferable. The prickly pear has been successfully introduced into Australia and such trees as Eucalyptus and Casuarina have adapted well on the African continent.

As with traditional crops, traditional methods of cultivation have become established because they are demonstrably the best for the prevailing conditions. The transfer of technologies across climatic zones carries many risks that need to be fully assessed from the smallholder's point of view.

Tillage of rich vertisols has traditionally been thought to be possible only with mechanized farming. But recent field experiments have shown that smallholder utilization of vertisols may be feasible. They require a lot of draught power (at least two oxen) and weeding can be a problem but by fallowing during the wet season and then dry-planting, at least one crop per year can be grown. ICRISAT has studied the use of vertisols in India and has found that, with the additional moisture provided by a watershed two crops per year are possible. Cooperation between adjacent villages in establishing the watershed and in sharing oxen to contour the land into beds (with furrows on each side to conserve the water from the wet season) has resulted in improved yields.

WATER RESOURCE MANAGEMENT

"In order to support sustained agricultural production and minimize the negative impact of recurrent droughts, irrigation is necessary - look at the success India and Asia have had with irrigation schemes. People say the record of such projects in Africa has been unsuccessful, but this is because we haven't done enough to improve their efficiency, to properly manage the schemes and offer suitable support services to the farmers. The cost-benefit analysis may be poor but we have no alternative."

Irrigation, rainfall catchment and groundwater development were each discussed as possible means of minimizing the impact of highly variable rainfall. While gradual introduction of small-scale irrigation schemes received the strongest support, a role for large-scale basin developments such as Lake Nasser was also foreseen. They are able to cushion the spatial and temporal fluctuations in rainfall for extensive surrounding areas.

Groundwater resources are extensive in Africa. There is over sixty times more water from groundwater sources available than all other sources of fresh water put together in the world and in Africa that balance is proportionately larger because a lot of the above-ground fresh water is concentrated in the high latitudes of temperate countries. Techniques have been developed in recent years to survey these groundwater sources much more effectively using remote sensing geophysical techniques and fairly economical aerial electromagnetic methods. The particular type of problems related to groundwater extraction in Africa are due to the inaccessibility of aquifers there. Africa is the oldest of the continents and has been exposed to erosion for a very long time, in geological terms, so the aquifers are in weathered and deeply-fractured rock and would require special techniques for investigation and utilization.

Water catchment during good rains, for both drinking purposes and supplemental agriculture, was recognized as a useful adjunct to irrigation. Research is currently underway to discover what ancient civilizations already knew. There are almost no operational rainfall catchment systems in north Africa (except perhaps the hafirs in western Sudan). Research is focusing on computer models to determine optimum tank size, rationing schemes to compensate for changing water demands as supply increases, substitution of plastic liners in areas where cement, sand and gravel are unavailable, and development of quality-control measures. There is great danger of contamination from bacterial pathogens as a result of thatching material being used for tank roofing and there is also worry about the long-term effects of de-ionized or distilled water consumption by a malnourished population. The problem of leaching out of certain minerals from the system is under study.

STORAGE FACILITIES

"The questions of post-harvest food losses and food storage seem to come to us only when we are hungry. We forget, in times of plenty, that we must have well-organized food harvesting activities planned before the need for grain

occurs. We talk extensively about what we can do to ensure food security and then we don't implement the necessary policies."

This sentiment was echoed by others. There was general agreement on the need for sustained commitment to increasing and improving traditional storage facilities. Participants also concurred that concentration should be placed on location-specific structures built mainly for resource-poor farmers to store subsistence requirements.

It was explained that giant silos have been favoured in the past for the stock-piling of huge national reserves in central locations, for strategic purposes, and because they are very eye-catching and symbolically indicative of progress. But small farmers, who produce the bulk of food crops, are often not offered high enough prices to provide the incentive to sell to the public corporations which are set up to buy and store the produce. In these cases, it becomes necessary to foster a return to smaller, traditional types of storage facilities and this is what many African governments are now trying to do. Of course, if governments do offer a sufficiently high price for a certain agricultural product, then the farmer has no incentive to store it for himself and storage becomes the government's problem. So the situation is a complex one and some balance between on-farm and regional storage facilities must be found, depending upon national constraints.

In this context, it was further noted that the problem is not simply a matter of finding appropriate storage methods, it is also one of generating the appropriate infrastructure - the delivery mechanisms for economically moving variable crop yields from the farmer to the low-income consumer, and between years and areas of plenty and those of need.

Several other concerns mentioned briefly were the damage caused by boring insects and other grain predators which deserves more attention, serious management problems (eg. failing to organize adequate packing facilities at a tomato-processing plant), and missed value-added opportunities in the food industry which could greatly expand the use of agricultual commodities and help to smooth out surpluses and short-falls. It should be added that important progress is being made by the International Institute for Tropical Agriculture (IITA) in the field of biological control of insect pests. Predators of the green spider mite and the mealy bug, which attack cassava, have been found in Brazil, mass-reared and released. Early indications are that the program is working.

Although most participants would support international centres in directing more of their resources towards work on post-harvest losses, there was some disagreement on the question of research priorities in this area. One view was that more study of traditional storage methods is needed because Africans still do not have the type of facilities they need in place. An inventory of traditional storage methods from which to draw and develop adaptions would be very useful.

The other view was that, collectively, the people of Africa already have enough knowledge, they just need help in applying it and in convincing governments and farmers to listen. "There are a lot of local structures in Africa that just need some professional fine-tuning to become really ideal." Research now should be undertaken to determine why people do not accept the technologies which are available.

During the discussions, the importance of participation by farmers and other rural people was repeatedly emphasized in a variety of contexts. Integrated extension services based on the needs and aspirations of rural agricultural communities must be implemented to allow useful research to evolve into improved farming practices, whether in the fields of water resource management, improved soil fertility or storage facilities. That governments and donor agencies are beginning to recognize and support each other's efforts in this direction was perhaps the most heartening news to come out of the symposium.

APPENDIX 1 - List of Participants

SPEAKERS AND COMMENTATORS

K.Y. Amoako	Division Chief East Africa Programs Department The International Bank for Reconstruction and Development Washington, D.C.
E.S. Ayensu	Chairman African Biosciences Network Washington, D.C.
M. Blackie	Dean, Faculty of Agriculture University of Zimbabwe
H. Doggett	Cambridge, U.K.
I. El-Bagouri	Desert Institute Cairo, Egypt
M.D. El-Khalifa	Director, Institute of Environmental Studies University of Khartoum, Sudan
P. Haines	Vice-President Professional Services Branch Canadian International Development Agency
F.K. Hare	Provost, Trinity College University of Toronto Toronto
I.L. Head	President International Development Research Centre
J.H. Hulse	Vice-President, Research Programs International Development Research Centre Chairman of the Symposium
L.H. Karstad	Animal Pathology Division Food Production and Inspection Branch Agriculture Canada, Ottawa

D.F. Kraft	Professor Agricultural Economics and Farm Management University of Manitoba
The Hon. David MacDonald	Canadian Emergency Coordinator/ African Famine
R.C. McGinnis	Dean, Faculty of Agriculture Univerisity of Manitoba
M.C. Mensah	Assistant President Project Management International Fund for Agriculture and Development Rome
M. Mokone	Deputy Permanent Secretary Ministry of Agriculture Botswana
J.H. Monyo	Chief, Research Development Centre Food and Agriculture Organization Rome
R.M. Mupawose	Permanent Secretary Ministry of Agriculture, Zimbabwe
A. Ngongi	Chief, East and Southern Africa World Food Programme Rome
D. Sharp	Associate Director, Health Sciences International Development Research Centre
F. Traoré	Director, Rural Economic Institute Bamako, Mali
F.J. Wang'ati	Secretary National Council for Science and Technology Nairobi, Kenya
Zewdie Wolde Gebriel	Director, Ethiopian Nutrition Institute Addis Ababa

OTHER PARTICIPANTS

H. Archer	International Development Research Centre (IDRC)	Ottawa
W. Baier	Agriculture Canada	Ottawa
F.W.G. Baker	International Council of Scientific Unions (ICSU)	Paris
M. Belisle	Canadian International Development Agency (CIDA)	Hull
H. Black	UNICEF	Toronto
A.C. Brandenburg	University of Guelph	Guelph
R. Campbell	Assoc. of Universities and Colleges, International Development Office (IDO)	Ottawa
D. Chapetin	CIDA	Hull
M. Chevalier		Quebec
Yong-Ja Cho	IDRC	Ottawa
R. Dallenbach	MacDonald College	Quebec
C.L. Delgado	International Food Policy Research Institute (IFPRI)	Washington
C. de Laet	University of Regina	Regina
T. Dottridge	IDRC	Ottawa
M. Dow	Board of Science and Technology for International Development (National Research Council - BOSTID)	Washington
H.L. Friesen	World Concern	Vancouver
G. Gagnon	CIDA	Hull
A. Gingras	CIDA	Hull
P. Hazelton	CIDA	Hull
R. Huggan	IDRC	Ottawa
R. Hughes	CIDA	Hull
K. Johansen	Canadian Emergency Coordinator/ African Famine	Hull
F. Kishk	IDRC	Ottawa
J. Kramer	CIDA	Hull

D. LeClaire	Assoc. of Community Colleges in Canada (ACCC)	Toronto
C. Liebich	CIDA	Hull
P. Loan	World University Service of Canada (WUSC)	Ottawa
F. MacHardy	University of Alberta	Edmonton
N. Martin	Canadian Council for International Cooperation (CCIC)	Ottawa
J. Matt	Agriculture Canada	Ottawa
A. Morantz	External Affairs	Ottawa
S. Moreau	CIDA	Hull
Y. Morneau	CIDA	Hull
K. O'Shea	External Affairs	Ottawa
C. Reaney	ACCC	Toronto
A. Ruffo	External Affairs	Ottawa
H. Saisriso	CIDA	Hull
L. Siemens	Agriculture Institute of Canada	Winnipeg
D.W. Steedman	IDRC	Ottawa
H.A. Steppler	McGill International	Montreal
M. Stone	IDRC	Ottawa
F. Symington		Almonte
J. Tubino	CUSO	Ottawa
R. Vincencio	IDRC	Ottawa
J. Wieler	African Emergency Aid	Ottawa
R. Wilson	IDRC	Ottawa
W.J. Winegard	Chairman, Parliamentary Committee on External Affairs	Ottawa
L. Wolde-Yohannes	Carleton University	Ottawa
R. Young	North-South Institute	Ottawa
S. Young	Prime Minister's Office	Ottawa
H. Zandstra	IDRC	Ottawa

APPENDIX 2 - Agenda

CIDA IDRC ICSU

Symposium on Drought in Africa

Government Conference Centre - Ottawa, Canada

12-14 August, 1985

Monday 12 August

8:30	Registration	
9:00	Introduction	J.H. Hulse, Chairman of the Symposium
9:10	Greetings from IDRC, CIDA, and the Canadian Emergency Coordinator/African Famine	Ivan L. Head President International Development Research Centre P. Haines Vice-President Professional Services Branch Canadian International Development Agency The Hon. David MacDonald Canadian Emergency Coordinator/ African Famine
9:30	Pattern and Impact of Drought in the Sahel Countries	E.S. Ayensu Chairman African Biosciences Network Washington, D.C.
10:05	Pattern and Impact of Drought in East Africa	F.J. Wang'ati Secretary National Council for Science and Technology Nairobi, Kenya
10:40	Coffee	
11:00	Pattern and Impact of Drought in the SADCC Countries	R.M. Mupawose Permanent Secretary Ministry of Agriculture, Zimbabwe
11:35	Pattern and Impact of Drought in the Sudan	M.D. El-Khalifa Director, Institute of Environmental Studies University of Khartoum, Sudan

12:10	Pattern and Impact of Drought in Western Canada	R.C. McGinnis Dean, Faculty of Agriculture Univeristy of Manitoba D. Kraft Professor Agricultural Economics and Farm Management University of Manitoba
12:45	Lunch	
14:30 - 18:00	Discussion of the Presentations of the Morning	M.F. Traoré Director, Rural Economic Institute Bamako, Mali

Tuesday 13 August

9:00	Opening Announcements	Chairman
9:10	Drought tolerant crops: their nature and value in drought situations	H. Doggett Cambridge, U.K.
9:45	Animal production in drought-prone areas	M. Mokone Deputy Permanent Secretary Ministry of Agriculture Botswana
10:20	Coffee	
10:45	Relationships between drought, and infections, and infestations in African animals	L. Karstad Agriculture Canada, Ottawa
11:20	Land and Resource Managment in Southern Africa	M. Blackie Dean, Faculty of Agriculture University of Zimbabwe
11:55	Provision of water for drinking and sanitation in semi-arid areas	D. Sharp Associate Director, Health Sciences International Development Research Centre
12:30	Lunch	
14:15 - 18:00	Discussion of the Presentations of the Morning	I. El-Bagouri Desert Institute Cairo, Egypt

Wednesday 14 August

9:00	Opening Announcements	Chairman
9:10	Programs of Action Proposed by International Agencies	
	- World Meteorological Organization	F.K. Hare Provost, Trinity College Toronto
	- Food and Agriculture Organization of the United Nations	J.H. Monyo Chief, Research Development Centre Rome
	- World Food Programme	A. Ngongi Chief, East and Southern Africa Branch Rome
	- International Fund for Agricultural Development	M.C. Mensah Assistant President Project Management Rome
12:30	Lunch	
14:15 - 18:00	Discussion of the Presentations of the Morning and Review of Recommendations	Zewdie Wolde Gebriel Director, Ethiopian Nutrition Institute, Addis Ababa K.Y. Amoako Division Chief East Africa Programs Department The International Bank for Reconstruction and Development Washington, D.C.

APPENDIX 3 - Additional Comments

The following comments have been taken, usually verbatim, from the presented papers and the discussion transcripts, to draw attention to the wide variety of views on the problems and prescriptions associated with drought in Africa.

DEFINING THE PROBLEM

* Agriculture is by far the most important sector both for domestic consumption and generation of export income. It influences the social and economic livelihood of 70 to 90 percent of the people and yet it has consistently received insufficient recognition and support.

* We shouldn't expect African governments to resolve appropriate agricultural policies so soon after independence - this has been a lengthy and difficult process everywhere.

* To date very little concrete action has come of beautifully-stated policy pronouncements by regional organizations like the OAU and the Club du Sahel - so while regional cooperation is desirable, it is equally important for African countries to act independently.

* It is totally unconscionable for African governments to be spending US$8.2 billion annually on armaments. Another US$8 billion is spent annually on 80,000 foreign expatriate development "experts."

* Substantial amounts of food aid have, paradoxically, become a major disincentive - if not the major disincentive - to local food production. Governments of the region are now paying attention to this fact and are ensuring significantly increased prices to farmers which are announced prior to the planting season.

* Some donor countries are still dumping excess agricultural produce in the form of food aid - it harms the confidence of the people and undermines the economies of these countries.

* 5.7 million tonnes of food aid were pledged in 1984/85 to meet 90 percent of estimated food aid requirements in Africa but deliveries have been slow; only 55 percent of pledged assistance for the period July 1984 to June 1985 had been delivered by the end of May.

* Too much applied soils and agronomic research is undertaken in the better arable areas and with levels of inputs appropriate for large-scale mechanized agriculture.

* The effectiveness of investment in agricultural research in Africa has been limited by over-reliance on expensive short-term expatriates and by limited applicability to smallholder agriculture.

* Research has for too long focused on commodities and not enough on farming systems. So, extension workers haven't been able successfully to pass on high-yielding crop varieties or technological advances to small farmers because the technical messages delivered did not fit into those farmers' risk-averting production systems.

* Underlying the stagnation in agricultural production and the consequent vulnerability to drought of the region's burgeoning population, is an inadequate technological base for agriculture.

* The failure to compensate for social, cultural, economic, political, and bureaucratic constraints is probably a key factor in every unsuccessful project.

* Centralized food storage is unlikely to meet the needs of the largely rural populations during emergencies.

* Heavy crop losses both in the field and in storage (57 percent loss in maize in Kenya in 1984 due to insects and rodents) must receive more attention.

* Scientific and economic action in Africa is handicapped by a lack of reliable and accessible data about climate - in many parts of Africa, the observation of climate is less effective now than it was two decades ago.

* A large number of badly conceived, uneconomic, socially disruptive, and technically mismanaged irrigation schemes have shaken the confidence of the rural populations (irrigation has gotten a bad reputation which must be overcome because irrigation on a far wider scale is imperative).

* What we often have is not so much a failure of technology per se as a failure of the local administration to really handle an installation that was effective - it was technically satisfactory but beyond their capacity to handle.

ADDITIONAL RECOMMENDATIONS

* One thing that might come out of this meeting is in fact the magnitude of the problem we are facing and the whole question of priorities.

* We must be better prepared for the next drought; we need to set up proper arrangements to cope with acute food emergencies, early warning systems, special drought-relief emergency funds.

* We should be planning for a recurrence of drought with contingency plans for both "rain" and "no rain" scenarios.

* We are all finally learning the greatest lesson. The people themselves are paramount - the key to Africa's recovery, and the key to Africa's future. They should be the proper focus of our efforts.

* An estimated 42 percent of the Sahelian regions' 83/84 food import requirements were met by aid (85 percent in Cape Verde, 75 percent in Chad). This permanent dependence on donor countries for food to feed their people is a matter of great concern (during the same period some of these countries harvested exportable quantities of cotton fibre but couldn't feed themselves). Striving for a reasonable level of self-sufficiency in food production is absolutely essential.

* Food aid can be channelled through the food reserve system which should in turn be linked with price incentives, credit facilities and other measures as part of a longer term development program.

* Any food strategy that is likely to place any nation in a vulnerable position will be counterproductive and, in fact, the wrong policy to follow in this unpredictable state of the world economy. There is an imbalance between the production of cash crops and food crops today - the continuous production of the former, to the detriment of the latter, has earned many African countries far less foreign exchange than they had hoped (because of declining export prices and the need to import more fertilizer, pesticides, equipment, and fuel).

* The constraint that most African governments face is how to deliver food at a price that consumers can afford to pay, since most are the urban and rural poor; in countries that are relatively self-sufficient in food, the bulk of fertilizer is used on food crops - and the only way to pay for that fertilizer is with cash crops because a high proportion of it is imported. The combination of cash crops and food crops is therefore extremely important.

* Large-scale vs. small-scale farming - whereas in Asia smallholder agriculture was generally accepted, African governments tend to favour large-scale state farms as a major component of agricultural development. Yet there is little scope for economies-of-scale in farm production. Small farms have proven responsive to good support services and improved technology (eg. in Zimbabwe, marketed maize from the smallholder sector rose to over 30 percent of total deliveries in 1983/84, up from 10 percent only 3 years before; projections for 1984/85 indicate that smallholders may deliver over half the marketed crop).

* In weighing the relative merits of small and large farms, we should consider the type of farm income that is going to be attractive enough to provide the incentive to young people to stay in the rural areas.

* Farmers need more than just food; they want all the things urban folks have - but they can't buy them in the rural areas so what good is extra money to them? They need good support services and marketing outlets.

* Provision of adequate supplies of high-quality seeds is paramount but it could be very difficult to get enough for distribution if planning for seed production is delayed by even a few months.

* The two major cereals best adapted to drought conditions are pearl millet and sorghum; hybrid sorghum also deserves more attention.

* The important role of traditional food crops like sorghum and millets, sweet potato, and especially cassava, which have tended to disappear from diets, should be re-emphasized at the rural level.

* Small-scale weening food production projects would be useful in providing supplementary food for the very vulnerable children - we need small flour mills, and simple mixers for production from locally-available foodstuffs.

* An important lesson to be drawn form our experience with drought is that neither of the two economies (livestock raising and crop production) can be maintained productively without being balanced with the other.

* Fodder is an important aspect of the fight against drought - the mix of legumes and grasses suitable for fodder production also improves organic content and soil fertility (proven in Egypt, under irrigation).

* The major remedial measures are concerned with land use control which is also the most effective form of local climate control.

* Actions to reverse deforestation, and soil degradation, and increase albedo also help restore a healthy microclimate.

* Raising levels of available phosphorus in tropical soils is a major problem due to rapid fixation of phosphorus in the soils and the high cost of phosphatic fertilizers; natural rock phosphate deposits in the region need substantial capital for economic exploitation.

* Extension of irrigation schemes requires additional private investment (long-term soft loans, grants) and more basic skills and expertise in irrigation systems.

* The cost-benefit analysis of current irrigation schemes may not be good but this is because of poor management and inefficient usage - we have no alternative but to improve their efficiency.

* We shouldn't go any further with increasing cassava yields until we have addressed the need for accompanying food processing facilities - otherwise rapid deterioration in quality will soon discourage farmers from growing it.

* The problem of bird pests must be addressed; it has largely contributed to the replacement of sorghum and millets, which are better adapted to erratic rainfall, by maize which needs a long rainfall season to give a reasonable yield.

* For economic recovery in most African countries, livestock disease control is essential.

* There is need for coordinated international effort to control rinderpest in Africa.

* Research is needed, in parallel with vaccination, to determine the role that wildlife may be playing in the perpetuation of rinderpest in some countries.

* Improved feed utilization should be a major research priority for improved livestock systems.

* Small ruminants, important in food security strategies, have been neglected.

* Research on the poisoning of humans by the consumption, during drought, of certain plants is needed, as is more education to increase public awareness of this danger.

* Research on tubers and root crops should be expanded (e.g. Enset (Musca ensete), a banana-like food which is a staple in the diet of over 8 million Ethiopians and is greatly affected by drought and bacterial infections).

* We need imaginative new research on fertilizer usage which addresses the problems of extremely low moisture supply.
* A thorough inventory must be carried out of potentially suitable technologies existing in the regions concerned, as well as in other geographical areas offering similar ecological conditions.

* We have seen in places like Tanzania that the programs seem to have failed miserably simply because there was no follow-up behind the actual provision of wells and pumps; whereas in N. Ghana there has been 85 percent success with 2,500 wells, using NGOs in the villages.

* Users of new technologies must be supplied with easy-to-understand information about the benefits of change - appropriate technologies can be transferred to the village level if participants receive sufficient training, experience, and resources.

* We must pay more attention to maintenance of newly introduced equipment - if a malfunctioning pump is not repaired quickly (say within 3 days), the user population becomes frustrated and may vandalize the pump or well and lose faith in the technology.

* An increased supply of safe water must be accompanied by certain behavioural changes that affect personal hygiene and sanitation practices before enteric diseases can be significantly reduced.

* We need concrete support programs for small groups within the villages, to enable them to initiate some immediate activities.

* If we could only get the local people involved and motivated, then things would really happen; we must identify the individuals who are interested in getting a certain system to work and then provide them with the means.

* We need to develop resources at the local level to manage production and distribution and credit facilities.

* Cash requirements and the returns to cash are often key criteria in the selection of our development of innovations at the smallholder level.

* Regarding food storage, governments have to consider appropriate delivery systems, ones flexible enough to handle variability of production and still allow low enough prices. The problem isn't simply one of finding appropriate storage methods, it's also one of generating the appropriate infrastructure, the whole mechanism of getting the crops from the farmer to the low-income consumer.

* Triangular arrangements for procuring food aid from neighbouring countries with surplus production, as opposed to direct shipments from abroad, should be actively pursued.

* Regional cooperation is crucial for economic and social development in Africa (e.g. disease control in livestock production, grassland control, marketing of livestock).

* Preferential trade agreements between countries in the region would also allow the regional grouping of states for development cooperation.

* We must not lose hope; hard work can lead to the fulfillment of realistic expectations; erosion of living standards can be stopped; marginal lands can be reclaimed.

THE ROLE OF DONOR AGENCIES

* We need the kind of aid that brings opportunity for the rural farmers to be productive and not the kind of aid that kills the entrepreneurial spirit of a people.

* The greatest contribution donor countries can make to help Africa is to stop providing food aid in its current form and help establish innovative national agricultural and industrial recovery plans. If all the donor countries are able to take this bold stand in concert, it may well be considered the best foreign aid package of the century.

* We need help in the formulation of rehabilitation programs that will, in particular, affect the livelihood of the rural populations; we need an integrated framework for cooperative rural development projects.

* Donors must look beyond the emergency to better times and work to establish a solid foundation for sustainable development by determining the root causes for failure and inefficiency in the past.

* What is needed, if we can find it, is a way to build a cycle of increased self-sufficiency, capacity to cope with disasters that will come, and movement beyond to further confidence and indigenous capacity for development.

* More attention should be paid to assessing social, cultural, and economic constraints which inhibit meaningful involvement when implementing water development projects - this requires a multi-disciplinary approach by a team of professionals.

* International agencies should be pushing governments and supporting them in formulating food and nutrition policies.

* Research must be more practical - farming systems must consider the actual on-farm peasant situation including both crops and animals. For too long, international institutes have concentrated on only one or the other, not on the interactions. Probably the most important aspect of an international centre is the training program it can provide.

* What is needed is not more technology but the application of more appropriate technology. What is needed is not more research but more relevant research into the development of durable, low-cost technologies and the software needed to put them in place.

* International agencies could assist African countries in collecting the data we need to be able to draft more realistic plans - it's expensive to keep this information up to date.

* Donors can make a significant and long-lasting contribution with a long-term commitment to the support of small-scale irrigation projects.

* Representatives of several non-governmental agencies have the judgement and experience to help out immediately to improve small-scale irrigation projects at the village level; these NGO personnel may be the Sahel's most valuable asset - that is, after the people themselves.

* NGOs are increasingly assuming responsibility for water supply and sanitation in rural communities. They are less bureaucratic, close to their target audiences, and are the most familiar with social and cultural factors that inhibit the effective adoption of new technologies and are therefore most effective as agents of change. We should acknowledge and support their role.