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Seeds for Disaster Mitigation and Recovery in the Greater Horn of Africa

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Seeds for Disaster Mitigation and Recovery in the Greater Horn of Africa

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List of Acronyms

AAIN	Action Africa in Need (Nairobi)
ADRA	Adventist Development and Relief Association
AID	Agency for International Development (Washington, D.C.)
ARC	Agricultural Research Corporation (Khartoum, Sudan)
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
CEFA	European Center for Agricultural Training (Nairobi)
CIAT	Centro Internacional de Agricultura Tropical (Cali, Colombia)
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (Mexico)
CIP	Centro Internacional de la Papa (Lima, Peru)
CRS	Catholic Relief Services (Baltimore)
DFA	Development Fund for Africa (AID)
DPPC	Disaster Prevention and Preparedness Commission (Ethiopia) (formerly RRC - Relief and Rehabilitation Commission)
EARNET	East Africa Root Crop and Research Network
EARSAM	Eastern Africa Regional Sorghum and Millet Network (est. 1986)
EASC	East Africa Seed Company, Ltd.
ERRA	Eritrean Relief and Rehabilitation Agency (Asmara)
ESE	Ethiopian Seed Enterprise
EU	European Union (Brussels)
EUE	UN Emergency Unit Ethiopia, a UNDP project (est. 1985)
FAO	Food and Agriculture Organization of the United Nations (Rome)
FEWS	Famine Early Warning System (Rosslyn, VA)
FSAU	Food Security Assessment Unit (funded jointly by U.S. and EC and implemented by WFP and FEWS; this unit operates with respect to Somalia)
FSVs	Farmer-selected varieties (generic term)
GHA	Greater Horn of Africa (a region comprising the 10 countries of Eritrea, Ethiopia, Djibouti, Kenya, Sudan, Uganda, Rwanda, Burundi, Somalia, Tanzania)
GHAI	Greater Horn of Africa Initiative (a U.S. presidential initiative managed by AID)
GRIN	Germplasm Resources Information Network (USDA)
IAR	Institute of Agricultural Research (Addis Ababa, Ethiopia)
IARC	International agricultural research center (generic term)
ICIPE	International Centre of Insect Physiology and Ecology (Nairobi)
ICRAF	International Centre for Research in Agroforestry (Nairobi)
ICRC	International Committee of the Red Cross (Geneva)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (Patancheru, India)
IITA	International Institute of Tropical Agriculture (Ibadan, Nigeria)
ILRI	International Livestock Research Institute (Addis Ababa)
IPGRI	International Plant Genetic Resources Institute (Rome)
IRC	International Rescue Committee

List of Acronyms - Continued

ISABU	Institut des Sciences Agronomiques du Burundi (Bujumbura)
ISAR	Institut des Sciences Agronomiques du Rwanda (Kigali)
KARI	Kenya Agricultural Research Institute (Katumani, Kenya)
KSC	Kenya Seed Company (Kitale, Kenya)
NARC	National agricultural research center (generic term, sometimes NARI)
NARI	National agricultural research institute (generic term, sometimes NARC)
NARO	National Agricultural Research Organization (Uganda)
NARP	National Agricultural Research Project (Kenya)
NGO	Non-governmental organization (generic term)
NSCC	New Sudan Council of Churches
NSQCS	National Seed Quality Control Service (Kenya)
OFDA	Office of Foreign Disaster Assistance, AID
OLS	Operation Lifeline Sudan (Nairobi)
PNAP	Programme National d'Amélioration de la Pomme de Terre (Rwanda) [National Potato Improvement Program]
PRAPACE	Programme Régional d'Amélioration de la Culture de la Pomme de Terre et de la Patate Douce en Afrique Centrale et de l'Est (est. 1982) [Regional Program for Improvement of Potatoes and Sweetpotatoes in Central and Eastern Africa]
REDSO/ESA	Regional Economic Development Support Office/East and Southern Africa (Nairobi)
RESAPAC	Réseau pour l'Amélioration du Haricot (Phaseolae) dans la Région de l'Afrique Centrale (Butare, Rwanda) [Network for Bean Improvement in Central Africa]
REST	Relief Society of Tigray (Mekele, Ethiopia) (Est. 1978)
SACB	Somalia Aid Coordinating Body (Nairobi)
SADCC	Southern Africa Development Coordination Conference
SDMR	Seeds for Disaster Mitigation and Recovery
SRRA	Sudan Relief and Rehabilitation Association (Nairobi)
UN	United Nations
UNDOS	United Nations Development Office for Somalia (part of UNDP)
UNHCR	United Nations High Commission for Refugees (Geneva)
USDA	U.S. Department of Agriculture
WFP	World Food Programme (Rome)
WVI	World Vision International

Section I
Conclusions and Recommendations

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1. Conclusions

The following conclusions are drawn from investigation of the use of seeds for disaster mitigation and recovery (SDMR) in the Greater Horn of Africa (GHA). The team expects that many of these generalizations could be applied in other regions of Africa and other parts of the world where SDMR is done, but the investigation was limited to the ten GHA countries.

1.1 Disaster preparedness

- **Supplying seeds vs. improving seed supplies:** Donors readily provide funds to purchase and distribute seeds, but they appear less willing to support projects that help farmers reestablish or improve local seed supply systems or that would help develop conditions necessary for improvement of national and international seed supply systems.

- **Organizing agricultural research data:** Historically, agricultural scientists have done (and donors have tolerated) a poor job of documenting the adaptability of varieties developed, assessed, and released. Thus they have contributed much less to SDMR than they could. It is widely believed that adaptability data exist for improved varieties in research notes and in scientists' minds, but such data are not organized adequately to be of use to relief organizations. SDMR often needs to use traditional rather than improved varieties. But data to match traditional varieties to growing conditions hardly exist for major SDMR crops other than beans. National agricultural research programs should name, assess, and describe widely used traditional varieties; IARCs should help them to do so.

- **Fostering seed trade:** Regions with robust intra-national and international seed trade during normal times suffer less and recover more quickly from catastrophic loss of seed stocks during local or even national disasters. Except for disasters that are small in scope, relief agencies depend on companies to assure that seed is of appropriate

varieties and adequate technical quality. Where the seed trade is strong in normal times, seed companies maintain higher reserve stocks; seed traders know locations and varieties of stocks in other countries; they have substantial knowledge of what varieties are adapted to what conditions; and they have the knowhow and facilities to move and store seed without damaging it. Where seed companies are inactive, are not accustomed to trading internationally or are concentrating heavily on a single market (such as hybrid maize), the need for SDMR operations is likely to be higher, and the seed provided for SDMR is likely to be of poor quality, wrong varieties, and too late.

- **Finding time for procurement:** The speed with which relief organizations respond to the need for SDMR is commendable. However, in the rush to respond, NGOs require seed companies and procurement agents to deliver within 2 to 6 weeks. The result is too often procurement of whatever grain can be found that will germinate, so that the varieties delivered are not adapted to local conditions and seed quality is low. Such hasty procurement occurs not only immediately after the disaster starts; it continues for years.

- **Contracting seed multiplication:** The effectiveness of SDMR in the GHA can be greatly enhanced if relief agencies will make it standard practice to contract with growers to produce the best adapted varieties. Where disaster recovery is not yet advanced enough for local farmers to be the contractors, the relief agencies can contract with professional growers in neighboring regions. Growers in several GHA countries are equipped to control varieties and to dry, package, store, and transport seed well. As soon as possible, the first local farmers to recover productivity can become the contract growers. Contract growing will usually not be feasible for the first growing season after a disaster, but it is certainly feasible in many places where SDMR is continuing for several growing seasons. However, contract growing cannot happen until donors and relief agencies change their planning and budgeting time horizons.

- **Subsidizing non-commercial stocks:** In most countries of the GHA, an urgent need exists to develop and maintain non-commercial seed stocks for the crop varieties most likely to be needed for SDMR. To be feasible in cost, such government or donor subsidized stocks could be limited to the hundreds of kilogram quantities necessary to support a rapid multiplication (i.e. in one or two growing seasons after SDMR need is manifest) to get supplies up to the tens of tons needed for distribution to farmers. The Seeds of Hope II project is assessing methods and costs to develop such stocks for the GHA region. At present in the GHA, the seed sector is adequately developed to carry out the rapid multiplication but not adequately developed to maintain the modest reserves of seed (including traditional varieties) necessary as a basis for multiplication.

- **Sorghum vs maize**: The bias in favor of maize cultivation and against sorghum throughout the GHA countries holds implications for SDMR. Agronomically, maize is a heavy feeder and is unforgiving of poor management and inadequate inputs. The spread of cultivation of maize into semi-arid, agronomically unsuitable areas makes farming in these areas more risky, and raises the probability that disaster relief will be needed.

- **Fodder vs cereals**: A similar trend exists with respect to the spread of crop cultivation into areas that were formerly reserved for livestock grazing, particularly in Ethiopia. This poses the question of whether seed distributions that facilitate crop farming in high risk areas are appropriate relief, or whether they are contributing to the likelihood of further need for relief.

1.2 Disaster mitigation and recovery

- **Using food grain for seed:** Most of the seed used for SDMR in the GHA has been produced as food grain and later packaged as seed. It is sometimes enhanced for use as seed by extra cleaning, sorting, testing, and packaging.

- **Donors' opportunity to influence SDMR effectiveness:** Overall levels of funding for SDMR appear to be adequate or even excessive in the GHA, but the SDMR operations are too often inadequately planned and inefficiently executed. Donors could influence project quality by assessing relief agencies' funding proposals against a number of factors that influence SDMR effectiveness. A scheme for such assessment is described in the shaded box at the end of this section. Since relief agencies are quite competitive, they may respond favorably if donors would indicate that funding decisions will be based not just on the size and experience of agencies but, more importantly, on the quality of SDMR projects.

- **Identifying suitable varieties:** Seed varieties for SDMR in the GHA are being identified by 1) local farmers; 2) Ministry of Agriculture personnel; 3) staff agronomists with NGOs, UN agencies, and bilateral donors such as USAID; 4) research scientists in IARCS and NARIs; and most often, 5) private and parastatal seed companies and procurement companies. Some experts in the best position to recommend varieties, especially traditional varieties, are doing so on a bootleg basis as their cooperation with relief agencies is not authorized. Where inappropriate varieties are selected, the resulting crops grow poorly, condemning farmers to another year of poor harvest and sometimes leading to a need for another year of food aid.

- **Recognizing farmers' skepticism:** Farmers receiving SDMR assistance are skeptical of the seeds they are given and for good reason. The hastily procured seed that is distributed for the first planting season after a disaster is likely to be of varieties that are inferior to what farmers had before the disaster. SDMR often continues into the second planting season (and longer), and by then the NGOS may be able to provide the traditional varieties or improved varieties well matched to site conditions. Farmers are likely to assume, however, that seed distributed in the second and subsequent seasons is as inferior as what was distributed in the first season, and so may eat most of it. For this reason, some farmers in Rwanda ate all and planted none of the seed distributed in the second season after the war.

- **Coordinating SDMR:** Many donors and relief agencies are quick to support SDMR in the Greater Horn area. (The first planting season after the war in Rwanda had 67 foreign NGOs distributing seeds and tools.) Coordination becomes a necessity. A U.N. agency or sometimes an NGO takes the lead to coordinate logistics, sort out which agency will work in which place, liaise with national government agencies, organize

frequent meetings to share information and experience, etc. The effectiveness of overall SDMR is influenced greatly by that lead agency's technical and diplomatic decisions. When the coordinating agency facilitates only one problem, such as international transport, the consequent confusion among NGOs leads to ineffective SDMR.

- **Overcoming logistical constraints:** Transportation of seeds and tools to get them into farmers hands in good condition at the right time is a major constraint on SDMR. NGOs can either take delivery of seed at a central location, such as a national capital, and then use their own trucks or hired trucks for onward shipping, or they can maintain secure seed storage facilities as far into the disaster site as seed suppliers' trucks can go. The second option is likely to be much better for timely delivery to the farmers.

- **Fostering self reliance:** SDMR can increase poor farmers' vulnerability to the next disaster by relying on a few imported crop varieties and by supplanting traditional seed distribution arrangements to reduce the diversity of crops and varieties. SDMR can also reduce vulnerability by including seed multiplication for local varieties, supporting reestablishment or marginal improvements in traditional seed storage and distribution arrangements. The latter approach does necessitate an intervention of longer duration and articulation of an exit strategy that explicitly includes reduction of vulnerability and restoration of crop and variety diversity. A large majority of the NGOs implementing SDMR do not stay long enough to reduce farmers' vulnerability.

- **Requiring seed certification:** In most SDMR seed procurement for GHA countries, neither OFDA's requirement for certification of seed variety and quality nor the industry-standard ISTA certification is useful for overcoming the quality control problem. Most national seed certification systems in the GHA are understaffed, underfunded, and undertrained. Sometimes the department that carries out certification is part of a larger organization that is responsible for seed production, presenting a conflict of interest. Since certified seed is four to five times more expensive than food grain, a strong motivation exists for corrupt practices. However, project implementors can substantially improve SDMR by verifying the purity and germination with simple tests, and making seed suppliers aware that poor quality seed will be detected and rejected.

- **Fostering cooperation — Seeds of Hope:** The Seeds of Hope project in Rwanda demonstrated that IARCs and NARIs are prepared for a commitment to work with relief organizations, and able to significantly enhance the effectiveness of the use of seeds in disaster recovery. The Seeds of Hope II project promises to follow up this important start by promoting research organizations' involvement in disaster preparation.

- **Avoiding dependency:** Some NGOs are withdrawing the practice of seed giveaways and instead using innovative programs such as seed loans, seed banking, and food-for-seed swaps in attempts to reduce farmers' dependency on NGOs and to avoid harming coping mechanisms essential in times of disaster. Such programs are new and are still encountering difficulties, so seed giveaways will probably remain the more common NGO practice for years to come.

2. Recommendations

2.1 For donor agencies

- Relief agencies should not be funded to carry out SDMR until a needs assessment has thoroughly documented the dimensions of the need.

- Once an emergency need has been identified, the purpose of SDMR projects should be to return the seed supply of the affected population to the status quo ante as rapidly as possible. Introducing new varieties should be strictly a secondary concern. Any introduction of new varieties should be done gradually, following field screening and then trials in farmers' fields under realistic management practices, which are often low-input.

- SDMR projects should be approved for funding on the basis of a factorial weighting scheme evaluating each project in terms of its sustainability, cost-effectiveness, presence of an exit strategy, etc. (A sample factorial weighting scheme is presented in the box at the end of this section.)

- Donor agencies such as USAID should provide one or more seed experts in the GHA to help NGOs implementing SDMR to understand seed technical issues and incorporate best practices, as implied in the box at the end of this section.

- SDMR project funding mechanisms need to be streamlined, and funds need to be available in long enough time frames (more than one year) to allow contract multiplication of seeds.

- Donors agencies, to assure their funds are used effectively, need to require that SDMR implementing agencies invest in and use adequate seed technology. For example, seed quality is easily damaged if adequate storage facilities are not constructed before the seed arrives at each stop along the path from the seed producer to the farmer recovering from disaster.

- To foster robust seed trade that can reduce the need for SDMR and to increase the timeliness and quality of SDMR, donors should encourage national governments to harmonize regulations so as to facilitate movement of seed across international borders within the GHA.

- Donors should support monitoring, evaluation, formulation of lessons learned, and consequent reporting by the SDMR implementing agencies. The Greater Horn of Africa Initiative consultations revealed that officials responsible for the day-to-day management of crises tend to focus on the latest crisis, such as Somalia and Rwanda, and call for "deeper analysis" of these crises, instead of reflecting on, digesting and absorbing the lessons put forward by careful and thoughtful analyses of similar crises in the more distant past.

2.2 For NGOs and others implementing SDMR

- An SDMR intervention should not begin until the need is demonstrated by a needs assessment. Farmers often have successfully saved seeds in spite of having incurred a disaster. Returned refugees may have carried seed, or may be able to recover cached seeds. Free seed distribution by relief agencies, even if technically well done, can disrupt local informal and formal markets, and can cause people to abandon traditional coping mechanisms, leaving them more vulnerable to the next disaster. Monitoring on a local level should occur several times during each growing season, and relief agencies' seed distributions should end as soon as the farmers can cope without them.

- Local seed sources should be investigated and used if the seeds are of adequate quality. They may not be of adequate quantity, but can be used first while seeds from other sources are carefully selected, procured, and transported. Sources of seeds that can be used for SDMR usually exist within the disaster area or within walking or driving distance. This is true even for remote sites. Seeds from such local sources have several advantages over imported seeds: (i) they are likely to be of varieties which are suitable to cultural preferences, level of inputs, and ecological conditions where the assistance is being given; (ii) procurement is likely to be more rapid and less expensive than with imported seeds; (iii) assistance funds spent in or near the disaster site may have a multiplier effect that benefits the target population, at least indirectly.

- Farmers should be mobilized to carry out seed procurement in local markets whenever possible.

- Any seeds procured for SDMR, and especially seeds multiplied for specific SDMR needs, should be packaged and delivered with documentation that includes: crop and variety name, names or maps giving target agroclimate zone, target administrative areas (by commune or subprefecture). The package labeling (e.g. tags on grain seed bags or stickers on vegetable seed packets) should include information in the local language about the name of the crop and variety, its purity, and the conditions for which it is adapted. Seed should be dyed to help farmers identify it after the packaging is gone.

- In the months after a disaster and before planting time, imported food grains should be swapped with farmers for their small supplies of locally produced — and locally adapted — grain. This can then be stored to be redistributed as seed at planting time, thus conserving the ecologically and culturally desirable properties of local varieties.

- Seed packages and associated tools are best provided to refugee populations not all at one time, but rather in steps as the refugees demonstrate they are using the tools and planting the seeds. If they are eating or selling the seed and selling or not using the tools, then a renewed needs assessment is called for.

- Relief agencies should invest substantial staff time in thorough record keeping on seed transactions and in overall project documentation. These are often neglected in the rush to respond to crisis situations, and that neglect is a significant contributing cause of poor results from SDMR projects.

CHEMONICS INTERNATIONAL INC.

DATE: June 28, 1996

TO: Raymond E. Meyer, BHR/OFDA/PMPP

FROM: Bruce A. Ross-Sheriff. DESFIL Project

RE: Report on Seeds for Disaster Mitigation and Recovery in the Greater Horn of Africa

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The report, *Seeds for Disaster Mitigation and Recovery in the GHA*, is enclosed with this letter. The report was prepared at the request, and with the sponsorship, of the Division of Prevention, Preparedness, Mitigation, and Planning of the Office of Foreign Disaster Assistance of the Agency for International Development's Bureau for Humanitarian Response (BHR/OFDA/PMPP). The report was prepared by a joint effort of (1) the Development Strategies for Fragile Lands (DESFIL) project of the Agency for International Development (G/ENV/ENR) and (2) the Famine Mitigation Activity (FMA) of the United States Department of Agriculture (FAS/ICD). The study was conducted and the report was authored by:

- Thomas Osborn, DESFIL seed specialist,
- Arthur Dommen, FMA economist,
- Bruce Ross-Sheriff, DESFIL geographer
- Karen Kaplan, DESFIL social scientist.

The report was initiated because OFDA/PMPP recognized that (1) millions of dollars are granted by USAID to nongovernment humanitarian relief and development organizations for procurement and distribution of seeds to farmers who, because of complex disasters, have lost their usual harvests and desperately need seeds to recover self sufficiency, and (2) the seeds provided are not always the optimum crop varieties for the farmers' needs, or the best quality, or provided at the best time with regard to the farming seasons. OFDA/PMPP realized that improvements in the efficiency and effectiveness of seeds for disaster mitigation and recovery could result in faster recovery and subsequent reduced necessity for continued food aid. The study bore out OFDA/PMPP's expectation. Significant scope does exist for improvement in the use of seeds, with subsequent benefits for disaster victims as well as reductions in total disaster assistance costs.

Chemonics International would like to thank OFDA for the opportunity to develop this study. To the extent that the report's recommendations can be implemented by donor agencies, NGOs, host government units, and international agricultural research organizations, we believe it will make a significant contribution to achievement of USAID's humanitarian and development objectives.

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- To carry out SDMR operations, relief agencies need to have staff who are familiar with local land tenure arrangements, farming practices, and government policies. They also need to assure that the staff can influence the SDMR at both strategic and tactical levels. Relief agency personnel who do not have such specialized knowledge should defer to people who do for strategic and tactical decisions.

- Implementers of SDMR projects need to be made responsible for verifying that seed distributed is actually planted by the recipients. This is particularly important in cases where the seed is distributed to displaced persons living in camps who have been guaranteed use of land for cropping.

- NGOs can improve SDMR results by improving information collection and record keeping. Timely and accurate seed germination tests should be carried out and documented by SDMR project implementers. Harvest verification should be carried out by SDMR project implementers. In the field some harvesting should be witnessed and the actual yields recorded. This will give solid early warning information and will provide more definitive information about the suitability of varieties to various sites. It is important to gather harvest information directly and from as many different areas as possible, since slight variations in micro-climates can be critical for variety selection.

2.3 For agricultural research organizations

- The senior management of both international and national research organizations should decide whether to encourage proactive participation in SDMR. To promote cooperation, inhibitions on researchers working directly with NGOs should be removed and effective cooperation should be rewarded.

- Agricultural research organizations in countries affected by disasters and in neighboring countries should actively seek to advise and assist relief agencies carrying out SDMR. Where the research organizations are reactive and passive, they are unlikely to be of much use as relief agencies inevitably are trying to make decisions rapidly in crisis situations.

- To enhance SDMR, research organizations should develop information relative traditional low input agriculture, since it is traditional farmers with no access to inputs who are usually the target of SDMR operations. Research that develops varieties or technologies for nontraditional farming systems is less likely to be useful for SDMR. With a few exceptions, early maturing varieties are better for SDMR. Even if the early maturing variety is less productive in a good year, it is more likely to give a crop in a poor year.

- Agricultural research organizations' personnel should work with NGOs during non-disaster times to become familiar with the NGOs' perspectives on agricultural assistance and thus be better able to work effectively with relief agencies for disaster mitigation and recovery.

- Research organizations' ability to work effectively with relief agencies is greatly increased if both parties invest adequate time, either before or during SDMR, to

establish linkages for two-way communication. Research organizations need to have time and patience to learn what relief agencies know about SDMR needs and constraints, and relief agencies need to take to develop and feed information to research organizations, including feedback on what works and what fails.

- Both relief agencies and research organizations should carefully consider how they can benefit as organizations from cooperation in SDMR. This will motivate more sustained, less ad hoc relationships, so that experiences are built upon.

- Small teams of experts from IARCs and NARIs, representing each crop for SDMR, should participate in the early NGO coordination efforts as disaster relief and recovery is beginning. The Seeds of Hope project in Rwanda demonstrated that this approach greatly enhances the cost-effectiveness of SDMR. The very early assistance from experts helps NGOs avoid potentially disastrous choices of varieties and may help NGOs identify sources or geographic areas in which they should seek suitable varieties. As the SDMR operations proceed, the IARC and NARI experts can help locate seed for multiplication.

- National research programs should make widely available their information about improved varieties released officially or unofficially and descriptions of traditional varieties. Annual reports and network newsletters, and other media, need to provide more detail about the varieties.

- For SDMR the following information is needed: the breeding line, the geographic origins, the names by which the variety is known, growing conditions for which the variety is targeted (in terms of maximum, minimum, and optimum measures -- not just averages), the varieties' advantages (disease tolerance, drought tolerance, resistance to bird predation, agroecological plasticity, etc.), and distinctive characteristics of the varieties' produce (susceptibility to pests, cooking characteristics, etc).

- Research organizations sometimes have information on names given to varieties they have described and released officially or unofficially, and where the varieties are grown. NGOs seeking seeds for SDMR would find this information useful if it were compiled as periodic updates to lists of varieties with which research organizations have worked.

3. Deciding which SDMR projects to fund

To specify criteria for donor support of a SDMR intervention, donor agencies can submit each SDMR proposal to explicit point scoring on factors listed in the box below. A score is given for each factor and the scores are summed. The minimum total score is 0, the maximum is 150. The sum is used to indicate the category of the proposed intervention, as follows:

Category 1	10 - 50 points
Category 2	50 - 100 points
Category 3	100 - 150 points

It is important to realize not every situation calls for a Category 3 intervention. Complex emergencies usually entail swift action regardless of the inadequacy of the information base. They also typically entail high transportation costs and reliance on imported seeds; thus, they will score as a low, Category 1 intervention. The overall conclusion is donor agencies should strive to fund Category 3 interventions whenever the other categories can be avoided. Because of their relatively high cost and low cost-effectiveness, Category 1 SDMR interventions need to be strictly limited in time and replaced with Category 2 or 3 interventions as rapidly as possible

Examples of Category 1, 2, and 3 Interventions are:

Category 1	CRS Rwanda
Category 2	UNICEF Southern Sudan
Category 3	WVI Mozambique

The recommend scheme is sumarized in the following table.

Categories of SDMR Interventions
(Factorial rating on a scale of 1 to 10 to be done prior to approval of SDMR proposal)

Factor	Score	Criteria
1. Needs assessment	0 =	Little or no effort made to determine seed needs of target population
	10 =	Thorough survey made of target population and seed needs assessed
2. Selection of crops and varieties	0 =	Crops and varieties for SDMR determined on basis of subjective information.
	10 =	Accurate, objective information collected on appropriate crops and varieties for SDMR (e.g. from staff agronomists, local farmer surveys, local government representatives, NARIs, IARCs, etc.)
3. Procurement source	0 =	Procurement from whatever source happens to be available
	10 =	Well thought-out procurement plan with detailed specifications of seed to be procured
4. Procurement quality control	0 =	Little or no quality control
	10 =	High degree of quality control
5. Localization	0 =	Seeds imported from outside area
	10 =	High potential for local seed multiplication and distribution

Categories of SDMR Interventions
(Factorial rating on a scale of 1 to 10 to be done prior to approval of SDMR proposal)

Factor	Score	Criteria
6. Management	0 =	Management in hands of NGO or other expatriates indefinitely
	10 =	Management can be turned over to indigenous institutions within a defined time frame
7. Farmer acceptance	0 =	Activity is likely to have low farmer acceptance
	10 =	Activity builds trust and confidence between farmers and NGO
8. Technology	0 =	Little or no technology useful to farmers
	10 =	Much technology useful to farmers
9. Relations between NGOs and NARIs	0 =	NGOs and NARIs work separately with little interaction
	10 =	NGOs and NARIs both see the common objective and work closely together
10. Exit strategy	0 =	Proposal has no exit strategy
	10 =	Proposal has a detailed exit strategy
11. Genetic erosion	0 =	Little or no account taken of likelihood of genetic erosion from the seed activity
	10 =	Full account taken of likelihood of genetic erosion
12. Food security	0 =	Minimal likely impact on food security of target population
	10 =	Substantial impact on food security of target population
13. Income generation	0 =	Little or no contribution to income generation in target population
	10 =	Positive effect on income generation and strengthening local markets
14. Appropriateness of SDMR	0 =	High likelihood seed will be eaten by farmers or sold on market
	10 =	Low likelihood seed will be eaten or sold
15. Cost effectiveness	0 =	Reliance on costly transportation results in low cost effectiveness
	10 =	High cost effectiveness achieved by minimizing transportation costs

Section II
Introduction

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1. Significance of and trends in use of Seeds for Disaster Mitigation and Recovery (SDMR) in the Greater Horn of Africa

There is general agreement among national governments and foreign aid donors that the food security situation in the GHA countries is worsening.[1] Almost half the population of the region is considered to be food insecure.[2] This is eloquent testimony that past actions undertaken by national governments and foreign aid donors have been insufficient or inappropriate for stemming the trend toward greater food insecurity. There seems to be an inability in the region to mobilize the resources needed to correct the problem. Whether this results from a lack of political will, or bureaucratic inertia, or the political instability that itself is a product of the trend, is a question that clearly is beyond the scope of this report. All we can do in this report is to highlight some of the forces at work.

The continuation of widely divergent national approaches to food security and the failure of the governments of the GHA countries, until very recently at least, to cooperate regionally to meet the problem strikes the outside observer as incomprehensible. There seems to be a feeling of powerlessness before the very magnitude of the problem. Coordination of efforts among a multiplicity of ministries of foreign affairs, planning, agriculture, and others has become a significant problem in itself.[3] Past SDMR actions have been subject to these complications. The planning of future SDMR actions will have to take them into account.

SDMR actions are one aspect, and an important one, of food security policies and measures. Because seeds are an input into agricultural production, the use of seeds for disaster mitigation and recovery (SDMR) cannot be independent of other agricultural and food policies and measures. The lack of coherence of such policies in the region is shown by the case of Ethiopia. In the opinion of one observer whose professionalism and length of experience in the field are not to be doubted, input delivery systems to farmers are in a state of total chaos. The government levies a 35-percent tariff on commercial grain imports. The government's food security policy appears to be to obtain as high an allocation of food aid as possible from foreign donors; this has been running at between half a million and one million tons per year in recent years.

Kenya's food security policy is to encourage farmers to plant maize and to fill the gap in the years when the maize crop fails with maize imports or, failing that, food aid.

Typology of Emergencies in the Greater Horn

The GHA countries have experienced many different types of emergencies in recent years, some caused by natural factors like drought and others by man-made factors such as civil strife. It will be helpful to group the emergencies in the GHA countries into types enabling us to isolate the conditions that are likely to affect the planning and implementation of SDMR measures.

In the this typology, the terms simple and complex refer to causation of the emergency, as distinct from the measures required to cope with it. Thus, failed crops and perished livestock due to drought where people remain in their villages would be categorized as a simple emergency, whereas a crop failure due to civil strife in which people not only lose their crops and livestock but also are deprived of the assets needed to recoup would be categorized as a complex emergency. Sometimes the task of providing food aid is logistically simpler in cases of complex emergencies because people are grouped together in refugee camps, but the task of mitigating the disaster by helping them to become productive once more is more difficult by several orders of magnitude.

The following types of emergencies requiring SDMR actions can be distinguished in the GHA countries:

(a) **Simple single-time emergencies**
- Crop failure in one year due to drought (e.g. Eritrea in 1993)
- Resettlement of returning wartime refugees where there is an expectation they will become self-sufficient (e.g. Eritreans returning home from refugee camps in Sudan under current programs)

(b) **Simple recurrent emergencies**
- Crop failures over several years sequentially (e.g. Ethiopia 1984-85)

(c) **Complex single-time emergencies with lingering aftereffects**
- Outbreak of civil strife (e.g. Somalia 1993; Rwanda 1994)
- May be accompanied by population movements across borders, but return of refugees to their homeland is sought by recipient country (e.g. Somali refugees in Kenya; Rwandan refugees in Zaire and Tanzania)

(d) **Complex continuing emergencies**
- Continuing or intermittent state of insecurity not accompanied by population movements (e.g. Southern Sudan 1994-95)
- Population movements due to insecurity where recipient government chooses not to evict refugees (e.g. Sudanese refugees in Northern Uganda 1995)

2. Purpose of this study

The purpose of this study is to provide information that will be useful to agencies planning and implementing SDMR programs for farmers who have suffered from natural or complex disasters in the Greater Horn of Africa. To that end, a team comprising a seed systems expert, a geographer, and an agricultural economist investigated published and unpublished documents at USAID/Washington, at the headquarters of several U.S.-based NGOs that implement SDMR activities, and in the offices of numerous agencies in Kenya, Rwanda, Tanzania, Uganda, and Ethiopia. The team interviewed experienced USAID officers, NGO personnel, personnel of private companies that produce and trade in seeds used for SDMR, scientists in agricultural research organizations, and experts in the United States, and farmers who are currently receiving disaster recovery assistance.

3. Organization of this report

The study benefited from participating in the March 1996 planning meeting in Entebbe of the Seeds of Hope II project, and from the advice received from seed and disaster recovery experts in that meeting. Personnel of numerous NGOs and agriculture research organizations provided extensive information, responding to numerous questions and follow-up questions.

This report has seven parts. Section I summarizes the study team's conclusions and recommendations for agencies implementing SDMR it the Greater Horn region, to USAID and other donors providing funds for SDMR, and to agricultural research organizations that can assist SDMR. Section II is this introduction. Section III describes the social and economic dynamics of seed distribution in the GHA, which is the context for SDMR. Section IV describes the recent experience with SDMR in the GHA to draw lessons for future activities. Section V provides guidelines for planning SDMR interventions. Section VI describes seed sources and issues of seed quality relevant to SDMR in the region. Section VII discusses the opportunities and constraints for matching crop varieties to agroecological conditions and provides maps of agroecological zones, and agro climate conditions, and also provides lists of bean, maize, and sorghum varieties that have been screened against growing conditions in the region. Appendices provide information on seed technical issues and sources of seeds.

Endnotes

1. See, e.g., Action Memorandum for the Acting Director, REDSO/ESA, July 28, 1995.
2. HASP Project Paper, July 28, 1995, p. 3.
3. HASP Project Paper, July 28, 1995, p. 38.

Section III
Social and Economic Dynamics of Seed Distribution

1. Use of seeds during non-disaster periods
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1. Use of seeds during non-disaster periods

1.1 Seed use vis-a-vis farming systems

Knowledge of the social and economic dynamics of seed distribution networks in the Greater Horn of Africa is essential for planning cost-effective SDMR interventions. Transport costs generally are so high in Africa that excessive reliance on long-distance transport, even for seed materials, is likely to make aid more costly than it need be. In addition, the high incidence of emergencies of the complex and continuing type in the GHA countries in recent years makes reliance on long-distance transport risky at best. Thus, there is a compelling reason to acquire the best possible knowledge before the onset of fresh emergencies of how seed distribution networks operate and how they involve men and women farmers, traders and other middlemen, and other actors before the onset of fresh emergencies.

The end-users of seed distribution networks are farmers. Farmers use the seed and other inputs in production of food and cash crops, and therefore farmers are the client of agricultural rehabilitation projects and programs following disaster. As small farmers are more vulnerable than commercial farmers to suffering loss of their assets in such disasters and find it harder to recoup, the following discussion concerns itself mainly with small farmers. The discussion asks a basic question: What are small farmers' seed requirements in normal times? Later, in Section 2.2, the corollary question is asked: How well are existing institutions meeting small farmers' seed requirements?

The first requirement of small farmers to be observed is that, paradoxically, they need seed for a large number of different crops and for different cultivars of each crop. This requirement is due to three dimensions of the farming system of which the small farmer in the GHA countries is the manager:

- **The varied physical environments in which farmers plant each crop.** In contrast to European and American agriculture which is characterized by large areas of uniform environment amenable to mechanical cultivation, African agriculture is characterized

by great diversity among different topographies (hillsides and valley bottoms); different soil types (due in many instances to the scattering of cultivable plots); different seasons suitable for growing crops (in many regions there is more than a single growing season, each of which restricts cultivation practices); and the different spatial and temporal patterns in which crops are grown (intercropping is frequent). An example of a farming system based on a spatial layout described in the following box.

Dinka farm layout, Southern Sudan

Gardens surrounding the compound, tended by women, sown to high-value crops such as sesame, Bambara nut, okra, white sorghum, some cassava, some sweet potato.

Small fields near compound, tended by both women and men, sown to groundnut, sorghum, millet, maize, okra, pumpkin.

Distant fields, tended by men, sown to late-maturing sorghum.

Source: WVI report on Southern Sudan project

- **The relative unimportance of inputs other than seed in production.** Farmers are led to stock seed of different cultivars as protection against the risks associated with the uncertainties of the growing season. In the face of uncertainties, they need to have on hand seed resources in the form of early-maturing, late-maturing, drought tolerant, flood tolerant, pest-resistant, disease-resistant cultivars, if possible. There is no irrigation water to make up for failure of rains at critical times in the growing season, no pesticides to ward off locust attacks, and so forth. These so-called external inputs are usually beyond the means of farmers in the GHA countries, and therefore they are not stocked in village shops or provided by irrigation dam and canal administrations.

- **The multiple end uses to which each crop is put.** Not only is the grain of cereal crops used for human consumption, but sometimes leaves and roots are also consumed. The large variety of food preparations makes the availability of some suitable for eating raw or whole while others are suitable for cooking or beer-making or some such highly desirable from the farmer's point of view. For non-edible portions, crops are prized for their straw and stovers used for animal fodder, roofing, fencing, and so forth. Finally, storability of the crop is also a desirable feature, given the seasonality of African agriculture.

In sum, the evidence collected in the field by researchers, NGO staff, and relief agency personnel all attests to the importance of each of these reasons that farmers need a large number of crops and cultivars in order to function normally. This conclusion is nothing new; it was first observed by the colonial administrators who described the complex farming systems of East Africa.

The second requirement of farmers in the GHA countries is having seeds readily accessible. Often, seeds must be stored on-farm, because input supply networks in rural areas (except for

commercial farmers) are poorly developed. Accessibility is particularly important in the case of crops with bulky seeds like beans. The results of farm surveys conducted by the Seeds of Hope project in Rwanda and by ICRISAT in Zimbabwe following the 1992 drought revealed the importance of on-farm storage as a seed supply source. This means farmers need seed that is not susceptible to sudden deterioration of its genetic potential. They need seed of cultivars which breed true to type, so far as this is allowed by the breeding system of the crop. Thus, for example, composite varieties of maize are more useful than are F1 hybrids.

These and other requirements, and others, impose rather strict conditions on projects to supply seed to farmers in normal times without upsetting their farming systems, and causing irretrievable damage to their livelihood. They are summed up by the technical term *adaptability*. Adaptability includes yield performance, acceptability in terms of earliness or lateness, resistance to diseases, susceptibility to damage by pests and birds, storage quality, ease of preparation, and palatability.

Exogenous cultivars always run the risk of not being adaptable to the farming system to which they are introduced. Sometimes the effects are surprising. Examples are given, for example, of outside seed suppliers that have overlooked the fact that women often play a key role in seed management. The first hybrid maize varieties distributed in Malawi, for example, were distributed to men only. As a result, men profited from their cultivation of a profitable cash crop while women, who grew the traditional varieties for household food consumption, were disadvantaged. The women had the advantage, however, when it was discovered that the hybrids, which had been bred from soft-kerneled material, were susceptible to pest damage in storage. The experience left a sour taste. Eventually, the error was corrected.

1.2 Crops of the GHA

The Greater Horn of Africa is a region of cultural and agro-ecological diversity. Crops vary within the countries of the region but more importantly the varieties (cultivars and landraces) display great diversity to match differences in altitude, rainfall, soil type, endemic pests, diseases, farmer preferences for the plant type, and culinary characteristics.

Important staple crops include the following:

- **Maize (*Zea mays*):** Maize is the most widely grown crop in the region as a food crop and cash crop. It is grown at elevations of less than 500 meters to over 2,000 meters. There is wide diversity in the varieties/cultivars that are grown including traditional and improved open pollinated varieties as well as hybrids from national and private seed companies. Maize requires moderate rainfall and good soil fertility to produce to its potential. It is a "heavy feeder" of soil nutrients. CIMMYT is working with the NARIs on maize in most countries of the GHA. Katumani, an open pollinated variety from Kenya that performs well under low rainfall conditions and less than optimum soil fertility conditions, has been a particularly successful improved variety.

- **Sorghum (*Sorghum bicolor*):** Sorghum is widely grown in the GHA as a food crop. Regions within Ethiopia are centers of diversity for this crop. Sorghum has wide adaptability through farmer selection, and is found ranging from coastal areas along the Red Sea and Indian Ocean all the way up to 2,400 meters elevation in southern

Uganda. It requires less rainfall than maize. Historically, sorghum was the major cereal in the region until maize became the more important crop in the last 20 years. Traditional landraces and varieties are still widely grown because of their adaptation to poor soils and drought conditions, as well as specific preferences for plant type and culinary characteristics. ICRISAT is working with the most of the NARIs in the GHA on sorghum varieties.

- **Beans (*Phaseolus vulgaris*):** A wide range of bean varieties are grown in the GHA in diverse agro-ecological zones as a food and cash crop. Beans are particularly significant in Rwanda and Burundi, where they are the number one crop. In these two countries, mixtures of 5-20 varieties are grown as a risk aversion strategy against pests and diseases. In the bimodal rainfall zones beans are often grown during both seasons. This increases the supply for consumption and sale, since beans are difficult to store due to pest problems. CIAT is working with most of the NARIs in the GHA on improved beans varieties, small-scale seed production, seed marketing, soil fertility and related technologies.

- **Cassava (*Manihot esculenta*):** In many regions cassava is the food reserve crop that can be harvested and consumed at any time in the year. Multiplication of cassava planting materials is rather slow, however, and cassava cuttings are bulky to transport and distribute. Compared to seed, it is much more difficult for vegetatively propagated materials to officially cross international boundaries. The disease problem posed by the cassava mosaic virus is being countered by efforts of IITA with the NARIs. New rapid multiplication techniques are helping to speed the spread of new materials.

- **Sweet potatoes (*Ipomea batatas*):** Sweet potatoes are an important staple in the densely populated mid-elevation (1,200-2,000 meters) areas north and west of Lake Victoria. In other regions, sweet potatoes are a secondary food crop important for food security in seasons when other crops are not available or when other crops fail. Since they are vegetatively propagated from stem cuttings, the cuttings are perishable and bulky. Like cassava, it is difficult for sweet potatoes to officially cross international boundaries. CIP is working with the NARIs on sweet potatoes to first characterize the diversity of the material that is grown in the region before developing strategies to improve this important food security crop.

- **Irish potatoes (*Solanum tuberosum*):** This crop is an important cash and food crop in the highlands above 1,800 meters. It is a significant crop, particularly in Rwanda and Burundi. Normally, the potato tubers are used as seed for planting and movement of potato seed across national boundaries is difficult. True potato seed can get around some of the problems crossing international boundaries that plague Irish potatoes, sweet potatoes, and cassava. CIP has had a strong program in the region with many NARIs in the GHA for many years that has released a number of improved varieties.

- **Vegetables:** A wide range of traditional vegetables for home consumption and nontraditional vegetables for cash are grown in the region. Vegetables are widely used for disaster mitigation because of the potential rapid improvement in food security

they can provide. Most vegetable seed is imported into the GHA, though there is some local seed production.

- **Teff (*Eragrostis tef*):** Teff is widely grown only in Ethiopia and Eritrea, where it is an important cash crop and food crop for the preparation of Ethiopian bread. Teff has a very wide range of adaptability, beginning at a little higher elevation than sorghum and extending even higher. It is low yielding but is drought tolerant and widely adapted. Mostly traditional varieties are grown but a few earlier maturing varieties have been developed by the IAR in Ethiopia.

- **Millet:** Two kinds of millet are grown in the GHA, finger millet (Eleusine coracana) and pearl millet (Pennisetum americanum). Finger millet has a longer season and needs adequate rainfall.. Pearl millet is a crop for low rainfall zones.

- **Wheat (*Triticum spp*):** Wheat is grown primarily in Ethiopia, Kenya and Sudan, but also in areas of Burundi and Rwanda. New high yielding varieties developed in collaboration with CIMMYT are replacing traditional barley varieties at high elevations.

- **Barley (*Hordium vulgare*):** Barley is grown in some of the high elevation areas of Ethiopia.

- **Other legumes:** Cowpeas (*Vigna unguiculata*), pigeon peas (*Cajanus cajan*), garden peas, lentils (*Lens esculenta*), chickpeas (*Cicer arietinum*) and horsebeans are all legumes grown in the GHA. Legumes are significant from the nutritional point of view and they are adapted to a wide range of agro-ecological zones. In addition, some of them are very early maturing and drought tolerant which makes them valuable as substitutes where other crops have failed or as a hungry season food.

1.3 Crop varieties

There are two general categories of crop varieties: traditional varieties and improved varieties. Traditional crop varieties grown by farmers and known to have had no outside intervention are called *landraces*. These are rare nowadays. More common are the traditional crop varieties for which outside intervention may have occurred, but for which the varieties are the result of generations of farmers' selecting ones that best meet their needs. These are known as farmer-selected varieties (FSVs). FSVs have various origins:

- Selections from landraces made by farmers on the basis of visible characteristics (plant height and architecture, grain size and color, etc.).

- Past releases from the formal sector's agricultural research system. These are usually obtained second-hand (from other farmers or seed merchants).

- Other exotic material that has found its way into the farming system and has been maintained, on-farm, and incorporated into the farming system. Typical examples include seed brought back by travelers and grains saved from distributions of food aid. Some of this material may date back half a century; in Malawi, the maize variety

Asikari traces back to the seed handed out to soldiers who were demobilized at the end of World War II.

Traditional varieties: This category of crop varieties includes indigenous landraces of crops and farmer selected landraces that have not been involved in formal plant breeding. There are a few crops (teff, sorghum and durum wheat) for which the GHA is significant as a center of origin or center of diversity. Many of the important crops in the GHA are not indigenous, such as maize and beans. Nevertheless, environmental selection and mutation can result in traditional varieties known for their disease or pest resistance/tolerance. Traditional varieties are generally characterized by the following:

- **Genetically heterogenous**: They have a wide and diverse genetic make-up, often more widely adapted or tolerant to drought, pests or other problems. Varieties should be thought of as populations of plants that are similar in some respects (i.e. plant height, plant type, and seed color) but very different in other respects (i.e. disease and pest resistance). Because of the way they evolve, traditional varieties may be adapted over a limited agro-ecological zone or over wide areas such at teff.

- **Well adapted to local conditions**: Traditional varieties evolve through time to provide a stable but low yield under conditions of low soil fertility and other stresses such as drought, excessive moisture, pests, diseases, and bird feeding. Their agro-ecological zone of adaptation may be broad or limited.

- **Limited response to higher fertility**: Traditional varieties respond to higher fertility by growing taller and often falling over(lodging) rather than producing more grain.

Farmer-selected varieties in Southern Sudan

Yambio Region

Cassava	
Karangba	used in porridge making
Tiara	used in porridge making
Maize	
Badari	short season
Bambayah	long season
Sorghum	
Mangbagu	used in beer, kisera making
Vunde	short season; used in beer, kisera making
Letuko	short season; used in beer, kisera making
Groundnut	
Makulu Red	Zambian-bred
Atilzol	
Awaku	short season, red
Rice	
Alwanya	high-yielding from Zaire

Tonj Region

Sorghum	
Ager	long season, white/orange
Abook	white or gray-seeded intermediate
Nuer	intermediate, closed heads of varying color
Maize	
Reep	long season, yellow flint
Gerr	white semi-flint
Makang	early maturing small-eared yellow flint
Groundnut	
Neumoh	very small-seeded early bush type
Moindite	dark-seeded bush type
Ruatte	runner type with speckled seed coat

- **Desirable plant, grain, and culinary characteristics**: This is a complex mix of characteristics that corresponds to the many uses of the crop and preferences that have evolved over time. For example, tall plants are often preferred so the stalk can be used as fodder or building material. Traditional sorghum varieties often have seed heads that droop, rather than upright ones which discourage bird feeding. Proper taste and cooking characteristics are extremely important. Traditional varieties often have a hard seed endosperm and seed coats that resist the feeding of some storage insects. Yield is often not the most important characteristic for farmers choosing new crop varieties.

Improved varieties: This category includes all crop varieties that are the result of formal plant breeding programs by the NARI or in international efforts through IARCs, CRSPs or other bilateral efforts. These varieties include open-pollinated, self-pollinated and hybrid varieties. Improved varieties may be generally characterized by the following:

- **Genetically homogenous**: Improved varieties have a more narrow genetic make up than traditional varieties as a result of plant breeding that develops varieties from the progeny of one plant or several plants. In addition, they are often bred to be adapted to a wide range of agro-ecologies rather than specific niches.

- **Higher yield**: As a result of changing the plant to be shorter, or higher tillering, more efficient, more flowers, more prolific seed producer, improved varieties usually have a higher yield under good farmer management and adequate soil fertility.

- **Respond to adequate and high soil fertility:** Improved varieties are bred to respond to higher fertility by producing more grain and not a bigger or taller plant.

- **Earlier maturing**: Sometimes improved varieties are bred to be earlier maturing than traditional varieties. This can be particularly valuable to farmers in drought conditions or where there has been a general decline in rainfall. Among all the characteristics, earlier maturing varieties are often the mostly highly valued of improved varieties.

- **Bred for specific characteristics**: Plant breeding programs often focus on a number of specific factors that include yield increase and resistance to maize streak virus or other identified diseases. For example, new irish potato varieties from CIP provide high yields because of disease resistance. However, even when the specific breeding objective is achieved that resistance may break down with time due to mutation of the disease. Also, improved variety may be susceptible to a previously insignificant disease or pest.

The findings of a postal survey of district agricultural officers in Uganda revealed that 135 landraces and cultivars of beans were in common use.[1] Some examples of crop varieties currently grown in the Yambio and Tonj areas of Southern Sudan are given in the box at the right.

2. Dynamics of seed distribution networks in the GHA

2.1 Seed sources

Farmers in the normal course of events save seed for the next planting season. The extent of seed saving varies by region, crop, and season. A survey of 300 bean farmers in three areas of Burundi showed that the extent of seed saving as a source of planting material averaged 79 percent, 66 percent, and 73 percent, by season.[2]

The seeds farmers save circulate within the farming system. As part of their seed selection process, farmers are constantly securing desirable varieties of their crops through informal exchanges and formal markets. They may do this by securing a loan in kind through family or friends.

Beans are the staple crop whose seed sources are best documented from farm surveys. These surveys show that in Rwanda, Burundi, and Uganda, which are the GHA region's most bean-reliant countries, farmers rely predominantly on locally produced seed, whether kept from a previous season or acquired from other farmers, as is the case throughout Eastern and Southern Africa.[3] The Great Lakes Region of Rwanda, Burundi and Zaire, for instance, has well-developed exchange mechanisms for bean seeds based on kin networks.[4] However, poorer farmers are especially reliant on local food markets as a source of bean seed.[5]

A survey of 235 farmers in two districts of Uganda showed that 69 percent obtained all their seed from their own stock and an additional 20 percent obtained some of their seed from own stock.[6] In a survey of bean farmers in Rwanda, Burundi and Zaire done by RESAPAC (organized by CIAT) it was found that most of the farmers interviewed (respectively 84, 87, and 73 percent) obtained their original seed at the time of household establishment from relatives, usually the man's parents. The couple often resides near these relatives, and such seed is preferred because it is said to be well adapted locally. When in need of seed over time, however, very few were able to rely on parents, and had to rely on their own stock and markets.[7]

The seed source situation for potatoes is similar to that for beans (see following table).

Sources of seed potatoes reported by farmers in 1992

(sample size):	Burundi (358)	Rwanda (325)	Zaire (100)
Source		Percents	
Own farm	41	36	51
Project/extension	33	32	7
Local market	7	9	2
Family/ neighbor	4	4	13
Cooperative	0	7	16
Regional market	5	4	0
Private supplier	3	4	8
Research program	3	3	3

Totals do not add to 100 because of multiple sources.
Source: CIP.

In the design of many development projects in the past there was a tendency to look to governments to provide farmers with seed. This has not always been an easy solution to the problem of sourcing seed, as is evident from the following observation in Somalia dating from 1984, a year of relative normality: "The conclusion is that the previous attempts to organize seed multiplication and distribution have completely failed and that a new set-up has to be introduced."[8]

Seed stocks : Farmers select their seed at crop harvest time, and store it separately from the harvest to be eaten. In the case of maize they bundle it separately from the husked grain stored to be eaten. In Somalia, where much on-farm grain storage is in underground pits, seeds are never stored underground for fear of spoilage. In parts of Ethiopia, farmers store seeds in clay pots and rock-hewn mortars which are sealed and buried or stored in other safe places. Length of storage may be up to five years for seed stock, and may include a famine period when temporary out-migration of the farm household becomes necessary, only to return to recover the seed.[9]

2.2 Ability of research establishment to meet farmers' needs

It is apparent from the discussion above that small farmers' needs for seeds with particular characteristics may not be met by the formal sector plant breeding establishment in the GHA countries which produces improved (or modern) varieties. This is not to say that improved varieties cannot be successfully integrated into traditional farming systems in the GHA countries. The result of each attempted transition from traditional to improved crops is highly location-specific.

For example, Serena and Seredo, improved varieties of sorghum, are being successfully distributed by NGOs and grown by farmers in the 7 degrees North latitude zone of Southern Sudan. Because of

higher humidity in the "green belt" of Southern Sudan at 5 degrees North latitude, however, these varieties have proven to be susceptible to insect damage in storage.

Elsewhere in the region, the diffusion of disease-resistant, high-yielding varieties of potatoes in Rwanda by the PNAP (with help from CIP) since 1979 is one of the success stories of the adoption of new agricultural technology in Africa. The improved varieties have almost entirely replaced the traditional varieties in Rwanda and to a somewhat lesser extent in Burundi.

Generally speaking, however, formal sector plant breeding establishments are geared toward generating and releasing a limited number of varieties, each of which is distinct, uniform and stable, displays wide environmental adaptability, and has potential in terms of high grain yield if grown with application of external inputs. Variation (made necessary by gradual loss of robustness of the improved varieties, their susceptibility to attack by insects and diseases (which are also continuously adapting to the new predator-prey relationships) and other causes) is dealt with by releasing a stream of new varieties over time, each to replace the previous, rather than by generating a wide range of varieties at any particular time, among which farmers can choose.

Improved varieties with a wide range of adaptability have been successfully adopted by small farmers in different regions of the GHA, as shown in the examples above. The range of environments in which these crops are grown is considerably wider than the range to which the plant genetic material of the improved varieties is adapted. Thus, it leads to a constant search for wider adaptability of plant genetic material.

Almost all improved varieties need some alteration of the growing environment. Their extra percentage of yield must come from crop management. The seed thus becomes part of a package which may also contain fertilizer or chemicals. This raises two major problems with achieving the potential high yield of improved varieties in small farmers' fields. First, the inputs for farm production of improved varieties must arrive on time, and this is seldom the case in reality. Secondly, small farmers often cannot afford the cost of purchased inputs to achieve the full yield potential of improved varieties. As a result, traditional low-input varieties sometimes yield more than improved varieties in the field. In addition, at times improved varieties fall prey to insects or diseases when they are planted off-season due to untimely input supplies.

Furthermore, misguided efforts to force or induce small farmers in the GHA countries to use improved varieties, either through extension programs or in the context of SDMR activities, regardless of whether such varieties are adapted to their farming systems, further threaten already severely degraded resource bases. This is particularly the case in highland areas, where population densities are relatively high and land use is intensive.[10] Appropriate new biological and mechanical technologies or alternative employment opportunities are absent elsewhere in the economies of the GHA countries. Therefore, farmers are compelled to extend agricultural production into areas that formerly supported only grazing on thin soils and steep slopes. Farmers are also replacing traditional cropping systems that conserved soil resources with crops less suited to such areas. While these crops erode soil at a higher rate than traditional crops, they offer greater short-term gains in years when they do not fail. ICRAF has taken the lead in launching the African Highlands Initiative to identify means to enhance sustainable land productivity in intensive land-use systems.[11]

The related question of the impacts on plant genetic resources of SDMR interventions will be discussed in Section IV.

Endnotes

1. W. Grisley and T. Sengooba, "Bean Cultivars Sown by Farmers in Uganda during 1989-90: Results of a Survey of District Agricultural Officers," in W. Grisley (ed.), A Collection of Papers on the Economics of Beans in Uganda and Eastern and Southern Africa (CIAT-Uganda).

2. Stephen B. Walls, "Informal Bean Seed Channels in Three Regions of Burundi," unpublished paper, table 3.

3. Soniia David, "Seed First: Developing Farmer Seed Enterprises in Uganda for the Production and Distribution of Bean Varieties," paper presented at the Rockefeller Foundation Social Science Fellows' Workshop, ILCA, Addis Ababa, Ethiopia, November 14-18, 1994, p. 1.

4. ICRC Nairobi Delegate Jurg Eglin, interviewed by Karen, Nairobi.

5. Sperling et al., op. cit.

6. David, op. cit., table 4, p. 5.

7. Louise Sperling, U. Scheidegger, B. Ntambovura, T. Musungayi, J. Murhandikire, S. Walls, B. Smith, and L. Niyobampampa, "Analysis of Bean Seed Channels in the Great Lakes Region: South Kivu (Zaire), Southern Rwanda and Select Bean-Growing Zones of Burundi" (RESAPAC Occasional Publications Series, No. 13, May 1994), pp. 2-3.

8. Ministry of Agriculture, Somali Democratic Republic, "Agricultural Inputs and Services Study, Final Report, Vol. 1, Main Report" (COWIconsult in association with Hostrup-Schultz and Sørensen, April 1984), p. 62.

9. Melaku Worede, "Ethiopian In Situ Conservation," unpublished paper, p. 3.

10. To see that land use intensity is highest in highland areas in one GHA country one has only to compare the two maps "Landuse and Land Cover" and "Topography" in the National Atlas of Ethiopia (Addis Ababa: Ethiopian Mapping Authority, 1988), pp. 4 and 11. The area described as "Intensively Cultivated Land" coincides almost exactly with the areas of the country situated at 2,000 meters elevation and above.

11. F. Wang'ati, "The African Highlands Initiative: A Conceptual Framework" (Nairobi: ICRAF, 1994).

Section IV
Experience of SDMR interventions in the GHA

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1. Trends in SDMR

The most prevalent activities relating to food security in the GHA countries are: agriculture, early warning systems, emergency relief, enterprise development, extension and training, fisheries, food distribution, food for work, general food aid, institutional development, integrated rural development, monetization, nutritional monitoring, pastoral and rangeland development, refugee assistance, rural rehabilitation, seeds and tools distribution, veterinary, and water activities. These activities can be found in several countries in the region, and most are being implemented by more than one organization.[1]

FAO estimates that upwards of $10 million per year are being spent in the GHA countries on procurement of seeds for projects.

The potential magnitude of the task of seed distribution to farmers is illustrated by the case of potatoes in Rwanda. Approximately 40,000 ha have been planted in recent years in that country. Since about 2 tons of seed tubers are needed to plant a hectare, the total tonnage needed for distribution would theoretically amount to a maximum of 80,000 tons. If the seed tubers had to be transported at the standard air shipment rate of $1,000 per ton used by NGOs in the region, transport costs would total approximately cost $80 million.[2]

2. Organizations involved in SDMR

The number of organizations working in the GHA countries is large. There are at least 597 different organizations working on food security issues in the region. These include 10 national governments, over 21 bilateral aid donors, 17 multilateral aid donors, 204 indigenous NGOs, 297 international NGOs, 39 national institutions, 4 regional institutions, and 15 UN agencies.[3] Of these, more than 160 are operating in more than one country and thus can be considered regional.[4]

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In the discussion that follows, the activities of these organizations in SDMR are treated according to the operative components of such activities, namely seed needs assessment, funding, vulnerability assessment, project design, seed procurement, on-station varietal trials, seed multiplication, seed distribution, on-farm seed testing, and project monitoring and evaluation.

National governments: National governments in the GHA countries assume primary responsibility for the food security of their people, even in countries like Ethiopia where efforts to decentralize government are under way. Many of the national governments have engaged parastatals in seed multiplication and distribution. In many instances these parastatals are being privatized or have been privatized, either as part of relief efforts or development programs. The Transitional Government of Ethiopia put forward one of the most ambitious plans for ensuring seed supplies to small farmers. This plan aims to establish a national emergency seed reserve amounting to 20 percent of the annual seed requirement of the target areas (in terms of vulnerability to disaster) of the country. The seed reserve will be organized at the wereda (district) level and will be expanded to cover all drought-prone agro-climatic zones.[5]

As part of or in addition to direct responsibility for seed supplies, national governments, in the form of their various relief and rehabilitation commissions or associations, continue to play a vital role in coordinating the activities of the indigenous and international NGOs, which often form partnerships, within their borders.

Finally, not to be neglected, is the support furnished by national governments to national agricultural research institutions.

Donors: Donors are the principal funders of SDMR projects. Because they deal on a day-to-day basis with national governments, however, they are subject to certain limitations. AID cannot use DFA funds in Sudan because of that government's loan arrearages (Brooke Amendment), the lack of a democratically elected government, and because it is on the list of governments that support terrorism.

Three research networks funded in the past by AID have proven particularly valuable as sources of information to those engaged in responding to disasters in the GHA countries. These are EARSAM, RESAPAC and PRAPACE.

A frequent problem with seed projects is the timeliness of receipt of donor funding. Sometimes this can compound problems encountered. In the case of a project to purchase locally and distribute 600 metric tons of seed implemented by the Eritrean Catholic Secretariat through an OFDA grant to CRS, delay in receipt of funds meant that the purchases had to be deferred to the following year. Since a poor harvest year intervened, purchasing had to be done at a larger number of sites, increasing staffing costs.[6]

Office of Foreign Disaster Assistance (OFDA) Requirements

Two issues involving seed specification requirements of OFDA came to the attention of the team and are of particular concern.

- Under the *Special Provisions* of OFDA's operating procedures, NGOs operating with funding from OFDA are required to furnish a seed grower's certificate (q.v.). In cases where there is no operating seed certification service, as in Southern Sudan, OFDA relaxes this requirement when the NGOs can make some tests such as germination percentage on their own and the local varieties seem appropriate to the need.

- Grant proposals submitted by NGOs to OFDA for funding specify the tonnage (or number of cuttings in the case of tuber crops) of seeds to be procured and distributed, but do not specify the variety. There is an obvious tradeoff here of NGO needs. On the one hand, NGOs need to be as specific as possible with regard to the seed material to be procured and distributed to farmers in order to ensure project effectiveness. They also need to be flexible in responding to emergency situations that change rapidly and therefore hold the potential for changing target populations, with corresponding changes in crop adaptability requirements.

NGOs: Non-governmental organizations (NGOs) are the implementers of many SDMR projects in the GHA countries. They have demonstrated their capacity to play a legitimate role as brokers. Because of their activities in food aid delivery and disaster mitigation activities, the NGOs have become major factors in markets in the GHA countries. In Ethiopia, for example, the NGOs are the major grain traders. Most of the selling business of the Ethiopian Seed Enterprise is with the NGOs.

A significant change since the 1970's and 1980's is that NGOs are better attuned and equipped to monitor indicators of famine in the region and commonly exchange information with one another, often through informal coordination meetings chaired by governmental or parastatal liaison bodies or by NGO umbrella organizations or by UN agencies. In Ethiopia, such meetings are held monthly by an association comprising some 90 member organizations. The meetings review, among other things, the "famine situation," because, while there is no widespread famine in Ethiopia, there nevertheless exist pockets of vulnerable people who are at risk of famine.

Where disasters are identified, NGOs submit proposals to OFDA and other donors for funding. Considerable variation characterizes the NGOs' SDMR projects and their implementation. NGO personnel in the field working on these projects have the satisfaction of working directly with farmers to solve real-life problems, in contrast to dealing in "process." These constitute a minority because the majority of NGO personnel are employed in support functions in the capital city, or even in a different country in the cases of Southern Sudan and

Somalia. They work under difficult conditions, and are in no way responsible for project failings higher up in their chain of command. They deserve medals in many cases.

The most successful example of an NGO-implemented SDMR project the team found was not in the GHA countries but in Mozambique. World Vision has collaborated with Mozambique's national agronomic research institute and seed supply company and a number of IARCs to provide seeds to over one million returnees and farmers in "liberated areas" after a destructive civil war. Unfortunately, this experience has not been comprehensively documented, which makes learning lessons from it more difficult. However, an important factor in success appears to have been the presence of full-time agronomists on the World Vision team who were able to work productively with their Mozambican counterparts.

In Southern Sudan, CARE, World Vision, and AAIN are working in Western Equatoria, while CRS is working in Eastern Equatoria. World Vision is working at Yambio in Southern Sudan and its program includes rehabilitating the agricultural research station where Philippe de Schlippe first described the complex sorghum-based farming systems of the Zande people in the 1950's. In these systems, several varieties of sorghum were often planted in the same field.[7] World Vision personnel now claim they are at the point where they can say "no" to any further distribution of imported seed in their project areas. CARE Southern Sudan is engaged in seed multiplication in its SDMR project at Tambura in the "Green Belt." Quality control on sorghum seed multiplication in this area is reported to be satisfactory. Sales are to UNHCR and other agencies and NGOs.

Some NGOs, including Oxfam, have grown sour to the practice of distributing seed for grain after a 1990 experience when they purchased sorghum seed in Uganda for Southern Sudan only to find it was grass. In fact, Oxfam is now concentrating its efforts on groundnuts and vegetable seeds. The latter are imported, but packaged in Kenya.

Representative costs of seed incurred by SDMR projects in Southern Sudan in 1995

Seed	Cost per ton (U.S. dollars)
Maize	$400 to $700
Sorghum	$400 to $500
Cowpea	$800
Groundnuts	$900 to $1,200

Note: Transportation costs of $1,000 per ton are to be added to these amounts.

Source: German Agro Action, Nairobi.

In Somalia, also under difficult conditions, CARE Somalia since 1992 has run a triangular monetization program which has as its objective the generation of local incomes. Funding is secured by an OFDA grant to CARE. WFP donates commodities to the project through Mombasa or Dar es Salaam, and the commodities are stored in warehouses. They are then sold commercially for cash (formerly Somali shillings, now U.S. dollars), which is placed in a safe account and used to finance rehabilitation projects in Somalia. Seeds are purchased from local surplus areas in-country. CARE also encourages the involvement of indigenous NGOs in its projects; again, the problem of accreditation of unqualified NGOs is raised and requires careful monitoring.

NGOs work most effectively with local communities, and this link represents a strength that can be built upon. Ethiopia's white paper on national policy for disaster prevention and management gives the leading role in planning, programming, implementing, and evaluating all relief projects to local communities.[8]

A good example of an effective community-based SDMR intervention administered by an NGO is the seed bank project in operation since 1986-87 under the Relief Society of Tigray (REST). REST is an NGO in the northern region of Ethiopia where small mixed farms prevail in a total population of four million. A Norwegian NGO assisted in setting up the seed bank project. The seed banks are of two kinds: community seed banks and central seed banks. Five of the latter exist already with a capacity of 100 tons of seeds and an additional five are programmed for next year. They are to be located in each wereda, an administrative district containing approximately 50,000 inhabitants. The objectives of the program are food security and germplasm conservation.

At the community level, the seed banks are managed by 10-member committees made up of representatives of REST, the baito (community council), and the agricultural extension service. Half the members of committees are usually women.

Intake: At the harvest time of the particular crop for which seed needs to be conserved the committee sends its representatives to survey farmers' fields and select the required seeds. Contracts are agreed with farmers on the quantities to be procured and the terms of procurement. The committee pays farmers the going market price for the seed from REST's budget.

Outflow: Farmers in need of seed for planting submit applications for seeds to the committee. The committee screens the applications and determines distribution based on need and merit. The farmer is charged 6 to 9 percent interest.

Presently, only local varieties are stored (crops are millet, sorghum, wheat, beans, maize, teff). Future plans include introduction of improved varieties to the project. The Ethiopian Plant Genetic Resources Institute made an evaluation of the procedures for conservation of landraces. The project also trains extension agents for community-level work.

REST's seed bank project shows how local knowledge can be mobilized and used for SDMR interventions. Similarly, diocesan officials are valuable sources of knowledge about varieties and informal sector seed sources in CRS's SDMR projects. An advantage of community-based farmer seed production schemes is that their decentralized nature, although worrisome to the schemes' proponents, reduces management costs.[9]

The team found that NGOs are generally making an effort to monitor the social equity effects of their seed activities. There is a danger that such activities may be discriminatory unless carefully monitored. For instance, access to seed may be limited to certain ethnic or social groups. Another example can be found in areas where a large proportion of households are headed by women, whose asset position is usually worse than men. If large quantities of seed are required as payment for in-kind seed loans, access mechanisms may perpetuate poverty.

Women within male-headed households are usually responsible for preparing food for the household. They are, therefore, particularly concerned with the storage, processing, cooking and organoleptic qualities of the cultivars used in the household's farming system. However, these requirements are often relatively neglected by formal sector plant breeders who interface primarily with the male members of farming communities. It is important to ensure that farmer-based seed production and distribution systems do not unduly transfer attention and resources away from women.[10]

NGOs also play a major role in assessment of seed needs. Often the first warning that an emergency situation exists comes to donors from NGO staff in the field.

An Effect of USAID's Title II Programs

Title II support to NGO development activities also enables these agencies to maintain an institutional presence in the historically most famine prone areas of the country. This provides USAID, the TGE [Transitional Government of Ethiopia] and other donors a reliable early warning and response capability in these areas should a drought strike.[11]

Agricultural research institutions: National and international agricultural research institutions play a vital part in SDMR. Because their core responsibility is breeding of plant materials, they are vital sources of knowledge about food crops, cash crops, and pastures in the region. This knowledge is fundamental to success in SDMR interventions.

Most of the improved varieties of crops adopted by farmers in Africa, according to one knowledgeable source, have a history of African plant breeders working on them. Examples are the MH17 and MH18 varieties of flinty hybrid maize in Malawi and the Namwezi cowpea variety in Mozambique. Both were the result of farmer-demand-driven searches for appropriate technology. As mentioned above, the most successful SDMR experience in terms of outreach and cost effectiveness recorded by the team involved a national agricultural research institution in Mozambique. Most NARIs, however, are short of resources and are not yet self-sustaining.

International agricultural research institutions have concentrated their efforts on plant breeding, technology elaboration, germplasm collection and conservation, and policy research. While these are important areas of specialization, they had up to recently little directly to do with SDMR. Often the only contact scientists at the IARCs had with farmers was at the annual Farmers' Day, when their fenced enclosures were opened to farmers from the surrounding area

to come and observe the crop trials under way. Slowly, the IARCs began to add small socioeconomic research units to their staffs.

Lost Crops of Africa

One of the most ambitious attempts to compile scientific knowledge about farmer-selected crops in Africa in danger of being overlooked in terms of their contribution to food security is a small volume published in 1996 by the National Academy of Sciences. The volume comprises information from over 900 respondents on some 3,000 crop varieties, compiled by NAS scientists Noel Vietmeyer and Mark Dafforn..

Efforts such as this, by appealing to a wide audience of researches and administrators, help build a solid foundation for future collecting and cataloging projects. The result will greatly expand the basis for SDMR interventions that are more appropriate, timely, and cost-effective

Lost Crops of Africa. Vol. I. Grains. Washington, D.C. National Academy Press. 1996.

This situation of the IARCs in Africa changed dramatically in 1992 as a result of widespread crop failure due to drought. The ICRISAT/SADCC station in Bulawayo, Zimbabwe, received a grant of half a million dollars from USAID/Zimbabwe to multiply and distribute to farmers in Zimbabwe, Namibia, and Malawi seeds of two improved varieties of sorghum and millet. Although the degree of success varied by country, this effort was generally successful and was shown to be more cost-effective than importing seed.[12] A post-facto impact assessment was conducted, not without opposition from elements of ICRISAT management, which saw the exercise as an aberration from ICRISAT's mandate.[13]

The successful experiment by ICRISAT Bulawayo was soon followed up by a more ambitious undertaking involving several IARCs to provide seeds of a number of staple crops in Rwanda following the upheaval that began in April 1994. This joint undertaking, known as Seeds of Hope, placed the IARCs in close collaborative relationships with NGOs.

These experiences have shown that the IARCs can successfully contribute to SDMR, a role that is certainly non-traditional for them. Sometimes the role of the IARC can be as simple as rapidly producing a brief pamphlet describing suitable varieties of crops for the guidance of NGOs engaged in emergency seed distribution. ICRISAT Nairobi did so in the case of sorghum for Rwanda. Many of the IARCs have representatives stationed in Nairobi or elsewhere in the GHA countries. The ICRISAT office in Nairobi, for example, has had a research program on sorghum and millets since 1982.

Private sector: The private sector has a legitimate and vital role to play in SDMR in the GHA countries. Much of the seed used for sowing crops in GHA countries is produced by small farmers without any outside assistance. This is especially important for "minor" crops (including

forage crops) where there is no organized commercial activity. Informal seed markets function for the "major" crops, showing surprising resilience even in countries torn by conflict. A Somali businessman gained a reputation among CRS workers for the rapidity and efficiency with which he was able to supply seed, along with other inputs for a seeds distribution project in Baidoa. This is an extreme example and verges on the formal sector.

Formal markets are the origin of much of the seed procured for SDMR interventions in the GHA countries. However, these markets are nowhere near fulfilling their responsibility of providing appropriate, high-quality seed to small farmers at an affordable price even under normal conditions, according to the team's informants. The recent proliferation of SDMR activities, which up to now have been concentrated in formal market transactions, has made the situation worse. The large and growing problem of seed adulteration in donor-funded SDMR projects for which sellers in formal markets are responsible is symptomatic of this dysfunctional state of the private sector, according to several of the team's sources. This is a fairly recent phenomenon, and is due in part to the proliferation of seed distribution in emergencies and seed distribution projects which put a heavy strain on quality seed supplies, mainly in Kenya and Uganda. "When there is a disaster, everybody wants to bring in seed," one plant breeder told the team. The implication is that a seller's market is thereby created, and abuses follow.

In 1992, the relief agencies were able to procure and distribute good quality seeds in Somalia when that crisis broke. Some of this seed was sold by Magrick Seed Co. in Uganda, which enjoyed a good reputation at the time. The increase in quantities transacted, however, has overtaken quality control measures. It is reported that seed is now commonly sold with fraudulent certificates, which can easily be purchased, and seed lots are frequently adulterated. Germination rates of seed recently sent by UNICEF to Southern Sudan averaged 20 percent. This fraud is having a negative impact on the recipient population. Even in Kenya, with relatively well-developed private seed companies, farmers have complained recently that they are buying falsely certified maize seed at exorbitant prices. Sellers of adulterated seed are known locally as "seed cowboys."

The seed companies know there are no sanctions against this kind of adulteration in SDMR operations. First, efforts at quality control at Lokichokio where seed is loaded for air transport into Southern Sudan appear to be ineffective. Second, there is usually no follow-up after the seed is distributed to ascertain results in the field because the NGOs are too thin on the ground and have too rapid a turnover in their regional offices. In these conditions, the seed companies have little to fear from evidence of adulteration being produced in court. The corruption surrounding the seed supply business extends to the NGOs and even the UN agencies involved in seed purchasing, according to our informants, both Sudanese and expatriate. The NGOs are under pressure from their funding sources to move seed out to allegedly starving people.

As one knowledgeable informant summed up: "Until producer grain prices improve, no existing formal markets exist to provide the type of seeds farmers want at a price they can afford." This situation is bound to change over time. The farmer was the biggest competitor of the seed companies in the United States for a long time. The characteristics of a viable seed industry in the GHA countries were described as follows to the team: (1) robust (i.e. going for long-term profits and capable of absorbing short-term losses); (2) incremental yield increases, not sudden yield increases; and (3) situated very close to farming communities. Integrating seed systems to serve small farmers' needs when disaster strikes remains a major challenge for

researchers, governments, and other institutions, and will undoubtedly involve liberalization of breeding strategies and varietal release regulations, as well as laws and regulations governing seed certification, as Soniia David has pointed out.[14]

United Nations agencies: Major UN agencies represented in the GHA countries, because they generally have more resources at their disposal, play an important role in SDMR activities. Their lead in seed needs assessments is obvious. In Southern Sudan and Somalia the UN agencies are heavily involved in project implementation because they control practically the only transportation available. The UN agencies generally do a poorer job of project evaluation than NGOs, however.

3. Links among the organizations

Not surprisingly, the activities of any one group of organizations listed above impinge on those of the other groups. This causes certain problems, particularly having to do with incentives and disincentives to farmers.

Where national governments, donors, and NGOs are all involved in the same activity, such as distributing food aid, the risk of creating disincentives that sometimes undermine SDMR and other rehabilitation projects is very real. The team found, for example that the designers and implementers of a SDMR project in Somalia were very concerned about the problem of relief food aid destroying incentives to farmers. They said that one of the tasks of the FSAU is to prevent this from happening through constant updates of information on stocks and markets. The success of the FSAU's action in this respect, however, was not completely assured.

4. Results of past SDMR interventions

Much has been learned in the recovery from previous disasters in the GHA countries. The chaotic responses of governments and other organizations to the 1973-74 famine in Ethiopia, when information during the initial critical period was scarce and sometimes deliberately kept secret, and to the 1984-85 famine in the same country, when a highly centralized and xenophobic regime created difficulties for the implementation of a coordinated response, are hopefully things of the past. Today governments in the region are better prepared to cope with an emergency and mitigate its effects on their population. This is due in no small measure to the establishment of functioning early warning systems.

SDMR interventions have produced mixed results. The experience provides a number of important lessons for national governments, aid donors, NGOs, and agricultural research institutions operating in the region. Some of these have been touched on above in the discussion of the activities of different organizations in the region. Others are raised here.

There is an obvious need to formulate the lessons learned on the basis of past experience. The Greater Horn of Africa Initiative consultations revealed that officials responsible for day-to-day management of crises tend to focus on the latest crisis, such as Somalia and Rwanda, and call for "deeper analysis" of these crises[15] instead of reflecting on, digesting and absorbing the lessons put forward by careful and thoughtful analyses of similar crises in the more distant past.[16]

4.1 Southern Sudan: A documented example of key elements of SDMR

The portfolio review undertaken by the BHR team in southern Sudan on February 12-March 1, 1996, illustrates many of the problems, successes, failures, needs, and lessons encountered by SDMR activities in the GHA countries. The team's report and the cabled summary of findings contain many useful, practical lessons.[17] In drawing upon these documents, we are aware that we may not be telling AID anything new, but we take this opportunity to focus attention on lessons for SDMR in terms of needs estimation, coping mechanisms, project design, project implementation, capacity building, sustainability, project monitoring and evaluation, exit strategy, and many other functional aspects. We therefore discuss this experience at some length here, not because southern Sudan and its 4.25 million war-affected people are of more importance than the other GHA countries, but because the example has recently been documented extremely thoroughly.

Southern Sudan is, by GHA standards, not an extreme case. While OFDA-funded SDMR activities in the region operate without direct reference to the central government of Sudan, their linkages with local authorities and with indigenous NGOs are well established. The international donor community is extremely active. The political environment is not one of chaos, but rather one of a long standing civil war with no prospect of ending until underlying factors change. The war, as well as natural disasters, has been responsible for large-scale loss of life and livelihood. The war is now accepted as part of the environment. Finally, southern Sudan offers a tremendous diversity of cropping, herding, and fishing systems that make it a true laboratory of survival under disaster conditions and a test case of international humanitarian aid achieving its objectives.

Institutional setting: SDMR activities in southern Sudan operate through local organizations on the ground whose expatriate partners are based outside Sudan and cooperate, for the most part, in an undertaking called Operation Lifeline Sudan (OLS). OLS is a consortium of some 40 NGOs which was inaugurated in April 1989 as a means of getting badly needed humanitarian aid to the population of southern Sudan, failing facilitation of this task by the central government in Khartoum. OLS is coordinated from Nairobi by UNICEF and operates an airlift into southern Sudan out of a logistical base at Lokichokio in northern Kenya. In addition, many international NGOs are able to maintain key personnel such as public health specialists and agronomists inside southern Sudan to implement their projects.

Within southern Sudan, partner NGOs operate in collaboration with regional authorities such as the Sudan Relief and Rehabilitation Association (SRRA) and the Relief Association of Southern Sudan (RASS), which are in fact civil arms of the various armed factions that have been fighting the central government for the past two decades and more. These authorities have a long way to go toward fulfilling a purely humanitarian mandate and coordinating relief activities at the field level. One problem is weak institutional structures in the field, but another equally serious problem is the functional dependence of these civil authorities on military groups vying for control of territory and people, and whose word, in the final analysis, represents the rule of law in the region.

Besides the regional authorities, the partner NGOs have been operating in close association and collaboration with local organizations representing communities and benefactor groups. Some of the most successful projects reviewed by the BHR team were found to have benefited from such associations. Conversely, the groups were strengthened by their association with the outside

project funders. Arguments are powerful and convincing in favor of forming Sudanese partners of this sort who understand the ground rules of humanitarian assistance and are prepared to aid the beneficiaries to defend the help received against abuses by marauding armed bands to promote better accountability for relief efforts.[18]

SDMR accomplishments: Seeds and tool distribution projects in the region have been remarkably successful under the prevailing conditions of absence of functioning government and continuing warfare. According to UNICEF statistics, OLS has distributed 2,000 MT of seeds and over 1 million tools to southern Sudanese farmers in the last two years.[19] By and large most populations, except those in camps, and those living in areas of Bahr el Ghazal and Jonglei which are affected at the moment by military operations, have achieved a measure of food security stemming from these distributions and good weather. This has allowed an increased focus on testing and dissemination of better performing seed varieties and improved farming techniques in the areas of more marginal natural resources.[20]

Farmers in Western Equatoria, traditionally a surplus-producing area, produced a dramatic surplus in 1995, using the new seeds and tools and stimulated by the availability of consumer goods (i.e. soap, salt, jerry cans, bicycles, spare parts) in barter shops supported by OFDA. By some estimates, this surplus reached 20,000 MT. Through the OFDA-funded World Vision and CARE barter shop programs in Yambio and Tambura, part of this surplus could be purchased and redistributed in other needy areas. By so doing, the high costs of airlifting food aid from Lokichokio were reduced, and a simpler procedure than obtaining clearance from Khartoum for each flight contracted to OLS was used. The added income from sale of grain surpluses could be reinvested by farmers, for example, in facilities such as oil presses, that transform basic agricultural commodities into higher-valued products.[21]

Areas of Bahr el Ghazal also recorded increases in food production due to a variety of interventions, including distribution of seeds and tools, extension work, and good rains. Overall food security for the resident population has consequently improved. According to farmers in Akot, the introduction of the ox plow in their area by the Association of Napata Volunteers (ANV) permitted them to increase areas under production as much as four-fold in one year. Farmers reported they had grown enough food to carry them through the hunger gap and to hire labor to help with the extra weeding that was now required. Another NGO working in the Akot area, Norwegian People's Aid (NPA),[22] has now turned its attention to refining farming techniques by improving tool designs, testing local seed varieties under different farming conditions to determine best efficiency, and training progressive farmers to disseminate new technologies.[23]

Similar work was being done by World Vision in Tonj County, in Lakes. Their program, which began as a relief program in 1993, has shifted almost entirely to a rehabilitation program involving the multiplication of maize and sorghum varieties and the dissemination of fruit trees and horticultural crops. Focus on root crops as a hunger season crop was investigated and tried. Nearby, SUPRAID began a program to train community development workers and progressive farmers as well as establishing seed banks for horticultural crops.[24]

Needs assessment: The importance of needs assessment in effective SDMR interventions has been stressed elsewhere in this report. NGOs engaged in disaster mitigation in southern Sudan have been experimenting with a new tool for needs assessment, the Household Food

Economy Model introduced to the World Food Programme (WFP) by Save the Children/United Kingdom (SCF/UK) consultants. The model takes into account the various traditional sources of food, including exchanges and gathering besides home production, to determine household food needs. Data are collected from a number of sources and key informants, and other sampling are used to gather information on populations.

The BHR team concluded that the need to rely on translators in using the model and the frequent difficulty of finding sufficient informants merited caution in overly relying on the model in the field. However, the model's introduction has had the positive effect of spreading a better understanding of traditional coping mechanisms, with the consequence that these mechanisms may be preserved instead of destroyed by SDMR interventions.[25]

Disincentives dampening effectiveness of SDMR interventions: Working through WFP, Catholic Relief Services (CRS), and NPA, BHR/FFP provided over 42,000 MT of Title II emergency food commodities (cereals, pulses and vegetable oil), valued at $23.7 million, to vulnerable groups in war-affected rural communities and displaced person camps in southern Sudan in 1995. With the improvement of food security in the region, overall requirements for emergency food aid are on the decrease and should drop further if rains are adequate and no large-scale displacements of population occur due to the war, in the judgment of the BHR team.[26]

As in many such complex disasters in which populations are on the move over wide areas and sometimes across international borders, the estimation of numbers of needy persons remains an issue, in this case seven years after the start of the relief and rehabilitation effort under OLS. The BHR team found a need to improve the accuracy of estimates of needy population numbers.[27]

Moreover, the team perceived an over dependence on food aid in many parts of Eastern and some parts of Western Equatoria, and this was having a negative effect on efforts to produce more food. The problem was found to be particularly acute among displaced persons. The team recommended that distribution of food aid in displaced person camps be withheld pending the preparation of land for planting by camp inmates. Many displaced persons were being provided with access to land along with seeds and tools, but showed little effort to actively cultivate.[28] NGOs in some areas visited by the BHR team where food aid and SDMR interventions are being distributed simultaneously welcomed the team's efforts to pressure the SRRA into motivating the people to produce for themselves.[29] The team also recommended that targeting of populations receiving food aid be further refined.[30]

Coordination of SDMR activities: To ensure the highest cost effectiveness of SDMR interventions, coordination among implementing agencies is necessary. In southern Sudan, because many of the NGO programs are managed from outside the region due to prevailing insecurity and resulting impermanence of staff locations, this coordination is especially difficult to achieve. The BHR team expressed its dissatisfaction with the existing state of affairs, which often resulted in duplication of efforts, differences in approach by different NGOs, and a real risk that inappropriate seeds would be introduced to farmers in some areas.[31] OLS is only now beginning to improve its consultations and workshops with NGOs working in agriculture.

Capacity building: SDMR activities afford a valuable opportunity for local capacity building. Yet the BHR team found that in southern Sudan the first year of experience in partnering between Sudanese NGOs and international NGOs was mixed, but on the whole

positive. The intent of supporting Sudanese NGOs was not only to build their capacity, but also to identify groups that could deliver such assistance more effectively over the long term. In the team's view, international NGOs needed to spend more time building the capacity of their Sudanese partners, while the Sudanese NGOs themselves needed more discipline and focus in their activities.[32]

Exit strategy: It is notable that whereas addressing the question of an exit strategy is a prerequisite for NGO's obtaining a grant from OFDA, nowhere in the BHR team's report is the issue of an exit strategy specifically addressed. Instead, the team foresaw an expansion of the OLS airlift operations through Lokichokio, an increase in the number of NGO program staff, and a planned upgrading in OLS leadership at Lokichokio from logistics coordinator to senior field program coordinator.[33]

An apparent contradiction exists between these indicators of activity and generally improving food security and health situation of the population in southern Sudan noted by the team elsewhere in its report. The supposition is that, with no end to the civil war in sight, the present trends of increased security are merely temporarily, and can be expected to be reversed rather suddenly at any moment (as indeed they can be, if the present war goes on). Therefore, it is better to be prepared for the worst.

This air of expected disaster is sustained by the ease with which NGOs find always new population sub-groups somewhere in southern Sudan that are in need of humanitarian assistance, either because their lands have been flooded or dried out or because their villages have been razed by any of the many marauding armed bands in the region whose actions are unpredictable. Thus, awarding of grants can always be justified.

The presumption of humanitarian motives: Underlying the humanitarian assistance situation in southern Sudan is the presumption of humanitarian motives on the part of the civil authorities in the region, such as they are. The BHR team found these authorities leaving a lot to be desired in terms of effectiveness, particularly in shielding the population from those armed with weapons. But their good will was always presumed.

The situation is made worse by the fact that the SRRA, a civilian organization, cannot ensure the security of the people and their possessions. Only those with some direct control over the armed bands can achieve this. The SPLM[34] governor of Bahr el Ghazal, for example, pledged to the BHR team that the security of food stored at designated locations would be assured.[35] Yet the NGOs who implement SDMR projects do not deal with the governor and his subordinate commanders. They deal with the SRRA. Thus, the security of storage depots is completely outside the purview of the NGOs, both international and indigenous. The same applies, of course, to transport of agricultural commodities and other things of value, which are particularly susceptible to expropriation under the guise of road tolls. This represents a major obstacle to the success of SDMR interventions. The question is whether SDMR can be effective in the absence of rule of law, and southern Sudan proves it.

4.2 Other lessons learned

OFDA's present requirement that seeds procured and distributed in SDMR interventions be accompanied by official documents certifying the seed variety has the negative effect of creating

monopolies. The requirement thus creates an environment in which fraud and corruption proliferate. Apparently the seed certification requirements are not having much positive effect on seed quality. Seed of the most suitable varieties often is not produced with official inspections during planning, growing, and processing necessary for strict adherence to certification procedures. Thus seed that is certified is likely to be either a less well adapted variety or the result of a corrupted certification process, or both. There is an obvious tradeoff between the need for ensuring seed quality and the need to give the NGOs flexibility and rapidity of response to emergency situations. Now that many of the larger NGOs have their own staff agronomists on projects, there would seem to be the possibility of relaxing the rather stiff requirements for seed certification.

A few simple steps could go a long way toward ensuring honesty on the part of seed suppliers in dealing with purchasers in formal markets, however. The biggest incentive seed suppliers have to supply high quality seeds is the expectation of renewed business with donors, NGOs and other buyers. The best way for the purchaser to determine whether renewed business is warranted is farmer feedback. Therefore, donors and NGOs should pay attention to obtaining farmer feedback from their seed distribution activities.

While the decision whether to import or to purchase locally is usually up to the donor funding the project and the NGO implementing it, sometimes the impetus comes from local administration or the target population itself. Thus, for instance, the experience of CRS is that the dioceses with which CRS works as counterparts request local purchases of seed.

NGOs working in crisis situations, such as Southern Sudan, Somalia and Rwanda, feel that the international community is attempting to substitute humanitarian action for policy, a practice that complicates the situation on the ground and, in some cases, compromises the NGOs.[36]

The proliferation of NGOs and their activities in the region is itself contributing to the worsening of the food security well-being of the region's population, in effect negating some of the benefits brought by the NGOs. Most obviously, this proliferation makes coordination more difficult and creates a competition for resources that has unhealthy effects. The emergency relief aid effort, closely associated with NGOs, is threatening to swamp the development aid effort. This is causing the eclipse of ministries of agriculture, where development aid efforts have traditionally been centered, by relief and rehabilitation agencies of all sorts. This causes demoralization in the ministries. Moreover, the appearance of the better-paying NGOs, supported by a variety of public and private donors, is drawing skilled professionals away from the line ministries.

In Southern Sudan, the NGOs are actually hiring the agricultural extension agents in areas no longer under the control of the central government. Governments in countries like Eritrea and Ethiopia have become suspicious of the NGOs and the implicit power they wield. Yet the GHAI is predicated on the ability of the national governments of the region to take the lead in suggesting ways of meeting the needs of restoring food security, another of the many interesting contradictions inherent in the present situation. The NGOs, to their credit, have been frank in raising the question of the line between government responsibilities and NGO interventions, for instance in the consultations on the GHAI.[37]

Both NGO representatives and USAID officials complained to the team that AID's distinction between funding for emergency relief aid and funding for development is artificial and creates problems. NGOs, especially, find that the need to shift from one type of funding to the other causes delays in project implementation. USAID missions, on the other hand, find they have to justify approval of emergency aid funding over and over again in order to keep up a flow of funding without which any hope of rehabilitation of the target population is likely to be lost.

It is felt that local communities and their institutions need to be included in considerations of aid delivery, in contrast with the present situation where "capacity building" is often construed by donors to mean training of organizations to meet donor requirements and to replicate donor styles and methods.[38] As has been pointed out, local communities and their institutions are important to success of SDMR activities, which often depend on mobilizing local resources. Their comparative advantage should be made use of.

Research organizations and networks operating in the region asked during the GHAI consultations why information and other resources that are readily available and are appropriate for the region are not being utilized.[39]

NGOs complain about the shortness of the funding horizon for their projects, especially seed multiplication and distribution projects.

Impacts on farmers' behaviors: The impact of SDMR interventions on farmers' behavior is likely to be more positive when seeds are procured locally. First, locally available seeds stand a better chance of being adapted to the target area than imported seeds. Second, purchasing locally available seeds puts income into the target area and has a positive effect on the economy that importing seed materials does not. However, it may not always be possible or desirable to purchase seed locally. If the area is insecure, transport, even over relatively short distances, poses a problem.

While farmers can generally be counted on to tell the truth, they have an interest, with the present proliferation of NGOs, in understating their seed stocks, knowing they will be replenished with new seed, which they can sell or barter. This has the effect of vitiating seed needs assessments.

Impacts on crop productivity: Sometimes gains in crop productivity can be achieved through well thought-out seed distribution projects. There is not, however, an automatic correlation between SDMR interventions and crop productivity gains. On the other hand, the SDMR sometimes means the farmer has a crop to plant instead of not having one, which is a productivity gain of a particular kind. [Need to expand this thought]

Impacts on genetic resources: The germplasm resource base of the GHA countries consists of the germplasm of all the crops grown in the region. It is generally acknowledged that the introduction of crop varieties from outside the region implies a displacement of local crop varieties. If the local crop varieties are grown only in a small area because they fit an ecological niche, then the consequence of the introduction may not be merely displacement, but loss of the local varieties altogether. This is an ongoing process the extent of which is unknown and is called genetic erosion. A proposal to conserve and utilize the germplasm resource of one crop in the region, sorghum, is given in Appendix 2.

Impacts on donor expenditures: The theoretical cost-effectiveness justification for SDMR projects (as distinct from humanitarian justification) is that rural people adversely affected by disaster will be enabled to resume production activities if inputs that are missing as a consequence of the disaster are provided to them. If seeds are missing, the cost of providing them with seed will normally be less than the cost of providing food aid to their households for an additional year or more while they obtain sufficient seed through their usual channels to resume production. The costs of transporting food aid are far larger than the costs of transporting seeds. Thus, a great gain in cost savings will have been achieved from the donors' viewpoint.

Endnotes

1. *Project Paper (PP) for the Horn of Africa Support Project*: "The HASP," Project Number 623-0006, REDSO/ESA, July 28, 1995, p. 24. Hereafter referred to as HASP Project Paper.

2. IP, "Potato and Sweetpotato Research Networking in Africa."

3. *HASP Project Paper*, July 28, 1995, p. 6. The listing omits the 10 national governments.

4. *HASP Project Paper*, July 28, 1995, p. 42.

5. Transitional Government of Ethiopia, "Directives for Disaster Prevention and Management," White Paper, October 1993, p. 20. For the location of drought-prone zones, see *National Atlas of Ethiopia, map "Drought and Food Shortage," p. 21.*

6. CRS, *Project Progress Report No. 1*, March 17, 1994, p. 7.

7. Philippe de Schlippe, *Shifting Cultivation in Africa (London: 1956).*

8. Transitional Government of Ethiopia, "National Policy on Disaster Prevention and Management," White Paper, October 1993, p. 5.

9. E. Cromwell and R. Tripp, "Proximity Is a Plus: The Economics of Farmer Seed Production and Distribution in Developing Countries," in J. Hanson (ed.), *Seed Production by Smallholder Farmers, proceedings of the ILCA/ICARDA Research Planning Workshop* held at ILCA, Addis Ababa, June 13-15, 1994 (Addis Ababa, 1994), p. 16.

10. Cromwell and Tripp, *op. cit., p. 20.*

11. USAID/Ethiopia, "Food Security and Economic Growth in Ethiopia: An Action Plan for Sustainable Development," December 8, 1994, pp. 12-13.

12. A description is in Esbern Friis-Hansen and David D. Rohrbach, "SADC/ICRISAT 1992 Drought Relief Emergency Production of Sorghum and Pearl Millet Seed: Impact Assessment" (ICRISAT Southern and Eastern Africa Region Working Paper 93/01, October 1993). This report, however, understates costs by failing to report seed distribution costs.

13. Lee House, personal communication to Tom Osborn.

14. David, *op. cit., p. 16.*

15. HASP Project Paper, July 28, 1995, p. 36.

16. E.g., Fassil Gebre Kiros, "An Assessment of the Economic Consequences of Drought, Crop Failure and Famine in Ethiopia - 1973/74 - 85/86," *Ethiopian Journal of Development Research, Monograph Series No. 1* (Addis Ababa: Institute of Development Research, Addis

Ababa University, October 1990); and idem., *The Subsistence Crisis in Africa: The Case of Ethiopia* (Nairobi: Organization for Social Science Research in Eastern Africa, 1993). For analysis of disaster mitigation in the GHA published outside the region, periodicals such as *Disasters* and *The Journal of Development Studies*.

17. BHR *Portfolio Review Southern Sudan, February 12-March 1, 1996. "Sudan - USAID/BHR Portfolio Review Mission," Nairobi cable 003217, March 6, 1996.*

18. BHR Portfolio Review, p. 12.

19. *BHR* Portfolio Review, p. 19.

20. Cable, p. 5.

21. BHR Portfolio Review, p. 19.

22. NPA is the only OFDA grantee that is not a member of the OLS consortium. NPA's untied funding sources permit it to respond to emergency situations with high flexibility and creativity.

23. BHR Portfolio Review, p. 20.

24. BHR Portfolio Review, p. 20.

25. Cable, p. 6.

26. BHR Portfolio Review, p. 17.

27. BHR Portfolio Review, Pages III-11 to III-12.

28. BHR Portfolio Review, p. III-3.

29. BHR Portfolio Review, p. III-5.

30. BHR Portfolio Review, Page 18.

31. *BHR Portfolio Review, p. 4.*

32. Cable, p. 3.

33. Cable, p. 7.

34. The acronym for one of the warring factions in the region.

35. Cable, p. 3.

36. HASP Project Paper, July 28, 1995, p. 36.

37. HASP Project Paper, July 28, 1995, p. 36.

38. HASP Project Paper, July 28, 1995, p. 36.

39. HASP Project Paper, July 28, 1995, p. 36.

Section V
Planning SDMR

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1. Needs assessment

Relief agencies often initiate SDMR activities without a thorough assessment of farmers' needs, although they should not do so, since unneeded seed distribution can cause more damage than it mitigates. A useful guide to needs assessment is presented in the box below.

A Practitioner's Guide to Assessing the Need for Seed

A. Is there a current seed shortage?
   1. If so, why?
      a) No harvest? What is the evidence for this?
         - What specific causes?
         - Do you observe grain for sale in local markets?
         - Do you observe new home grain storage structures?
         - Do you observe after-harvest stubble in the fields?
         - If stubble is present, does diameter of stalks indicate crop was dwarfed by drought or of normal size?
      b) No interest in saving seed? If no interest, then what response would be appropriate?
         - If it is not the custom to save seed, how has it been acquired in the past?
         - Would providing seed reinforce feelings that seed-saving is necessary, or act as a disincentive?
         - Can a seed-saving development activity be considered instead of supplying seed, in order to enhance sustainability of seed supply?
         - Farmers fleeing their homes and leaving all their belongings behind?
   2. Was there a harvest last year?
      a) If so, why is there a seed shortage now?
      b) Has there been an effort to encourage seed-saving?

B. Seed supplied the previous season.
   1. In areas where NGO/donor seed was supplied, how much local seed was planted?
   2. Is there any evidence that farmers ate the donated seed and planted their own seed? This can be visually verified at harvest time by comparing harvested grain or beans with that which was distributed as seed.
   3. Is there evidence that farmers in areas receiving NGO/donor seed late in the season went ahead and planted without the donated seed? This would be evidence of over-estimation of need for seeds and of not having taken into consideration local seed resources.

C Are local seed sources being utilized?

Source: Memo written by Darryl Jordan, CRS

2. Selecting crops and varieties for SDMR

The Great Lakes Region of Rwanda, Burundi and Zaire, for instance, has well-developed exchange mechanisms for bean seeds based on kin networks.[1] In surveys in this region, it was found that poorer farmers are especially reliant on markets as a source of bean seed.[2] The Great Lakes Region of Rwanda, Burundi and Zaire, for instance, has well-developed exchange mechanisms for bean seeds based on kin networks.[3] In surveys in this region, it was found that poorer farmers are especially reliant on markets as a source of bean seed.[4]

It is difficult to generalize about the characteristics of improved varieties and traditional varieties/landraces across the staple crops and agro-ecologies of the GHA. Nevertheless, the advantages and disadvantages of each should be explored on a crop and site specific basis in making decisions about crop varieties to use for SDMR. SDMR activities most often take place under low input conditions that may not allow the improved varieties to perform to their potential.

Factors inherent in the situation on the ground affecting the selection of crop varieties for SDMR include farmer preferences, agro-ecological zones, and availability of seed.

- **Farmer preferences**: What are the crop varieties that the farmers are now growing? Where did the varieties come from? How long have they been growing them? Improved varieties in the farmer's eyes become traditional varieties with local names after a period of time. There are a number of improved varieties that have been released for over 20 years that many farmers now consider to be traditional varieties. Understanding what farmers are now growing and selecting something similar in planning an SDMR intervention is essential. Comments from relief organizations in Ethiopia illustrate that farmers will often not plant crop seed they do not recognize. If given unfamiliar seed, farmers will eat the seed or sell the seed and buy seed they know.

- **Agro-ecological zones**: Agro-ecology refers to rainfall, temperature, latitude, elevation, soil type, pests and diseases. The GHA is a region of diverse agro-ecologies. Plant populations vary in their sensitivity to the environment in which they are grown and when a uniform population is grown in a different environment, it can become much less uniform. It is difficult to predict how a plant population will perform in a different environment until it is actually grown in that environment. Ensuring that varieties are adapted to local conditions is essential. There are certain endemic diseases in the GHA that present problems for improved varieties such as rust of wheat in Ethiopia. The problem with some diseases is that buildup takes several years, but once the disease has reached a certain threshold it can severely affect the crop across wide areas. In addition, disease resistance can break down or the disease can mutate. Breeding for pest and disease resistance is what keeps plant breeders on their toes. Attention to pest and disease problems is important. Moreover, avoidance of genetic erosion is also an important consideration (see Box 1).

- **Availability:** After satisfying the previous two considerations, the final selection can be determined by what is available and therein can lie a problem. There are differences in availability between traditional and improved varieties.

- **Traditional varieties:** These varieties/land races can often be purchased in local markets in regions, that have similar agro-ecological zones surrounding the areas to receive SDMR. In food deficit regions foodgrain in the market probably comes from food surplus regions of different agro-ecological zones that may not be adapted to the region of SDMR. If purchase in local markets is not possible, similar agro-ecological zones in other countries can be a source of seed. Normally, the seed source is the merchants that are purchasing foodgrain from farmers. In this case, seed quality becomes difficult to control unless the merchant pays particular attention to intermixing of other varieties, small immature seed, inert matter, or weed seed, which results in low seed quality. Some programs trade food for seed with farmers in order to get local varieties for SDMR. Another strategy that has been used is to inspect local farmers' fields before harvest and arrange to purchase the harvest as a source of seed for SDMR.

- **Improved varieties:** If the improved varieties are widely used there should be a source through seed producers or the local markets. If the improved variety is new or not widely grown then there may not be an adequate supply. Additionally, if these sources are not functioning due to the severity of the disaster situation then finding an adequate supply of the seed outside the country may be a problem.

- **Traditional and Improved varieties:** Some relief organizations provide traditional varieties for SDMR and small quantities of improved varieties for farmers to try. This approach to crop varieties for SDMR combines the reliability and acceptance of traditional varieties with potential benefits from improved varieties in a strategy that is low risk for the farmer.

Among the factors to consider, seed availability often determines what a relief organization actually procures. For SDMR to function properly, advance planning is necessary to insure that sufficient supplies of traditional and improved varieties are available when the need arises. In particular, farmer input should be key to the decision making process.

Genetic Diversity and Crop Varieties for SDMR

Consideration of the potential for erosion of the genetic diversity of farmers' landraces and wild relatives should also be a concern in the selection of varieties for SDMR[5]. Genetic diversity is important as a storehouse of genetic resources that can be used in crop improvement programs worldwide as sources of resistance to pests, drought and disease, earliness, and nutritional quality. The GHA is an important area of genetic diversity, but the significance of the diversity varies greatly between crops, countries and regions within those countries. Ethiopia is a center of origin for coffee, teff, sorghum, sesame, and minor millets. Ethiopia is a center of diversity and domestication for durum wheat and barley. Though beans (*Phaseolus vulgaris*) are an introduced crop in Africa through natural selection and mutation Rwanda and Burundi and parts of Tanzania are significant centers of diversity.

The three primary factors involved in genetic erosion are:

Replacement of indigenous landraces by new genetically uniform crop varieties: Well adapted, improved crop varieties are replacing traditional varieties in some areas. In addition, farmers are shifting crops based on higher yielding new varieties, market conditions and other factors. Examples include wheat replacing barley in Ethiopia, maize replacing sorghum in Kenya.

Destruction of habitat: Expansion of areas under cultivation and destruction of forests and range land adversely affect wild relatives of crops that can be sources of significant genetic diversity.

Drought: Genetic erosion can result from selective elimination of particular genotypes in a crop or from total crop failure. The result can be a genetic wipe-out when no seeds of a particular genotype are produced. The indirect effects of drought can be devastating when farmers are forced to eat or sell their own seed supply in order to survive.

The challenge is to provide farmers with appropriate crop varieties in SDMR while at the same time not threatening significant areas of genetic diversity. A number of organizations are involved in various aspects of the genetic diversity issue in the GHA.

National agricultural research institutes (NARIs): These institutions are involved in breeding improved varieties. Collections of local varieties are often used in plant breeding programs. Sometimes they cross local landraces with introduced varieties in order to develop a new variety that will have the right combination of characteristics.

Plant Genetic Resource Center (PGRC): Ethiopia has the most significant genetic resources in the GHA. The PGRC has undertaken extensive collecting of local landraces and wild relatives in order to preserve them for use at a later point in time. In addition, Seeds for Survival, an NGO, is spearheading efforts in *in situ* conservation in selected communities with specific crop varieties in Ethiopia in collaboration with the PGRC. This project is aimed at maintenance and improvement of local landraces.

Genetic Diversity (Continued)

International agricultural research centers (IARCs): Various IARCs have conducted collecting missions for local landraces and wild relatives of crops in the GHA. These include CIAT, ICARDA, ICRISAT, and CIMMYT. These collections become part of the gene banks of the centers that are used in plant breeding programs. Recently the gene banks of several IARCs have played a new role in SDMR. In the Seeds of Hope project led by CIAT, landraces of beans collected by CIAT have been multiplied and returned to Rwanda for distribution. This action is highly significant from an institutional point of view and counters the genetic erosion that can occur in disaster situations.

IPGRI: The International Plant Genetic Resources Institute of the CGIAR has a mission to encourage, support, and engage in activities to strengthen the conservation and use of plant genetic resources worldwide, with special emphasis on the needs of developing countries. Through their regional office in Nairobi, Kenya they provide training and work with the NARIs of African countries to develop their own ex situ gene banks of local material and to develop in situ genetic conservation programs of local landraces with local farmers. IPGRI can provide information to developing countries on how to access the genebanks of the other IARCs when the need arises. In the GHA IPGRI compiled an inventory of Rwandan genetic resources that are held in collections around the world so that they may be multiplied and distributed to farmers to prevent loss of material due to the recent conflict. Similarly IPGRI has assisted in identifying Somalian genetic materials for multiplication and return to Somalia.

USDA: The USDA National Germplasm Resources Laboratory has one of the largest gene banks in the world which includes many crop of significance in the GHA. There are crop germplasm committees for major crops. The committees include representatives from seed companies, universities and USDA staff who have a wealth of knowledge about specific crops and know many of the other researchers with the CRSPs or IARCs that are active in the field(see appendix of the crop germplasm committees). As the National Plant Germplasm collection expanded to include hundred of thousands of accessions, it became necessary to develop a national information system to meet the need for easily retrievable information. As a result, a project was undertaken in 1983 to create a central repository for information about germplasm in the NPG collection. The Germplasm Resources Information Network (GRIN) database has been functioning since 1988. The GRIN is accessible worldwide via the INTERNET.

Conclusion: The significance of the genetic diversity issue for crop variety selection for SDMR depends on the specific region of the GHA under consideration. The work of the PGRC in collecting significant local material in Ethiopia is an example of an approach to genetic diversity for other countries in the region to consider. Seeds for Survival is developing strategies for working directly with farmers for preservation and improvement of local materials. This effort should provide important lessons learned that could be applied in other countries. Nevertheless, an awareness of this issue is important for all organizations involved with seed for relief and/or development. Whether an improved variety or a traditional variety/landrace is appropriate will depend on the specific area.

3. Deciding among types of SDMR interventions

3.1 Identifying pre-existing seed networks

The GHA countries have numerous seed distribution networks. Accordingly, before undertaking a seed distribution, one of the most important factors that must be taken into consideration for evaluating the necessity of an intervention is the possible existence of seed networks. Rwanda is an example of too much seed being rushed into the country for emergency relief, without adequate assessment of existing seed networks, several of which still remained. (Ngoga, FAO, Kigali) Rwandan farmers managed to save more seed than expected, often getting seed from kinship ties in other communities, or bartering for seed with others who were not in deficit areas. (Eglin, ICRC) Borrowing seed along kinship lines is not uncommon, and some farmers may even exchange seed for small livestock and vice versa. (Bernard and Patrick, World Vision, Sudan) One instance, however, where farmer to farmer seed diffusion may have broken down is when farmers began purchasing more expensive improved varieties which they are not as willing to give away to others. (David, CIAT, Uganda)

3.2 Selection of beneficiaries

Organizations that have decided to undertake a seed distribution will often work through local communities in order to determine beneficiaries, and even to undertake the actual distribution. It is not unusual for an NGO to approach village leaders and ask them to determine the neediest people in their communities. Occasionally, organizations may also enlist the help of the Ministry of Agriculture and other local counterpart NGOs. (Skivild and Alemu, LWR, Ethiopia) (CRS, Eritrea) In some cases, the leaders will be tasked with identifying only the neediest members of the community to receive distributions, in one instance, only 25-30 percent of the community were slated to receive seed (Skivild and Alemu, LWR, Ethiopia). In other cases, the village leaders will be asked to do a census of the village in order to determine what is needed for each family, and how much. Other organizations will rely on lists of beneficiaries used for food distributions, which often precede distribution of seed (Luzobe, World Vision, Uganda) and may even use the same ration cards (Nasir Emergency Seed Purchase, CRS) and distribution centers (Jordan, CRS)

When working with the community to determine beneficiaries, the NGO will request a list from the village leaders, usually detailing a head of household and number of beneficiaries, which will be spot-checked for accuracy by NGO staff, provided that the time and manpower are available. (Eglin, ICRC). Some organizations will even penalize the community in some manner if they find discrepancies between the lists given to them and the random checks done by their staff. An example is listing more dependents than actual exist, which may result in a larger distribution to a family. (Munir, SCF) In some instances, an organization may even have criteria used for ranking priorities of who will receive seed, as in the case of CRS, Burundi, where seed recipients were selected according to: land available for cultivation, whether members of the household have returned to their land and are remaining there, families whose houses have been destroyed or looted, and female heads of household. These rankings were necessitated by the limited amount of seed available for distribution at that time. (CRS, Burundi Emergency Seed Distribution Grant)

Often when enlisting the help of local community leaders village committees will be formed. The role of these committees may vary from one NGO to another. In one case where the village determined the criteria for beneficiary selection, they selected recipients based on factors which varied based on local circumstances. The most common included: number of livestock, other sources of income, and access to arable land and farming equipment. (CRS, Emergency Seed Distribution in Eritrea) Often the members of village committees are selected by the community itself. The community, rather than a few individuals would then generate the list for distribution. (Ghanim, CARE)

Village committees may play an even larger role. Once established, locally elected committees may be responsible for everything from accepting and processing farmer applications for assistance, screening beneficiaries, purchasing seed from local markets, and collecting loan repayments. This was the case with World Vision, Ethiopia. In addition, the committees were accountable for funds, and had their members trained in community capacity building programs. (Dejenu, World Vision, Ethiopia)

It is important to keep in mind, however, when dealing with Ethiopia that organizations may be assigned by the DPPC to the same region for several years. This consistency gives them the baseline data necessary to design a comprehensive program in a shorter period of time by collecting data on number of people in the area, land holdings, number of dependents, and so forth before an actual emergency arises. This may eliminate the entire census process if the baseline data is updated properly. Another instance where village committees played a large role in distribution was in Sudan on a CARE project. In this instance, the seed committee performed the actual seed distributions. These committees were formed and oriented prior to the arrival of seed, and seed loan agreements were designed and signed by the village seed committees. These committees also worked to select storage sites and operate the village seed stores.

In cases where community leadership may not be evident, as may occur in situations of civil unrest, the NGO may conduct its own census, as was done for a targeted distribution to women and recent returnees by CARE Rwanda. For the first few weeks before a distribution, a census team worked to organize lists through daily visits to communes on sector levels. Discussions would be held with base animators and those responsible for sectors to identify those in need of assistance. When the census team lists were created, local authorities were consulted about any others who needed to be added to the list, and the communes were then notified about when distributions would occur. The census team then remained to assist with the actual distribution. (Danzoll, CARE, Rwanda)

Difficulties were reported, however, by some organizations that relied on local elders or committees to determine beneficiaries of their projects. Community leaders may be inclined to take care of their own families, and the neediest may not always receive seed. (Baily, SAWSO) Some organizations had other difficulties working with village elders and community leaders who may not honor signed commitments. For example, one organization operating in Somalia expressed frustration about its relations with village leaders. Even though the NGO held signed agreements from the village leaders stating that the NGO would distribute seed directly to the farmers, the leaders insisted on doing it themselves. As a result, many farmers did not receive seed, and arrived at the NGO's office demanding to know why they had been overlooked. In another case, a village leader refused to take the seed from the NGO because he believed that the

quantity was inadequate. Several days later, the same leader came to the organization asking for the same seed. (Turk, IRC Somalia)

The quantity of seeds and tools distributed may be consistent, with each family receiving the same amount, or the quantity of seed per family may be contingent on specific elements. In some cases, only the number of dependents in each family will be taken into consideration. In others, the number of dependants who are of an age where they can assist with cultivation of the land is more important. This scenario is especially true in countries where there is a surplus of available land, and civil unrest may have blurred issues of land tenure. Therefore, available manpower becomes the deciding factor. (Lokombu, NSCC) Decisions about amount of seed to be distributed to each family may also rest with established village committees. For a project done in Sudan, CARE delivered seed to village committees for distribution. It was documented that in a majority of cases, the village committee distributed equal quantities of seed to every family. However, there were some instances where the local committees distributed seed per capita, with more seed going to larger families who required more food and could farm larger areas (CARE, Kordofan, Sudan)

3.3 Strategies for seed distribution

Once the beneficiaries have been determined, there are different strategies that can be used for seed distribution. The most common way to distribute seed is by grant. This may be done for several reasons. For example, the NGO may not think that the farmers are capable of purchasing seed, especially in an emergency situation. There may also be some concern that the farmer will not harvest enough to return any seed, and, in some cases, it may be questionable as to whether or not the harvest will be enough to feed the farmer and his/her family. (LWR, Ethiopia)[6] Organizations may also give seed as a grant simply because it is logistically easier and does not require the manpower that other methods require. (Eglin, ICRC)

However, there does seem to be a trend among NGOs to move to seed distributions on a loan basis of some kind rather than on a grant basis. Some organizations, like the CRDA,[7] distinguish between relief projects, where seed is given as a grant, and rehabilitation and development projects, where participating NGOs are required to establish some kind of credit scheme for seed distribution. What form the credit scheme takes is up to the individual NGO and the assessment it makes of the farmer's ability to repay the loan. (Biru, CRDA)

Unfortunately, there are also several problems that arise, from the point of view of the NGO, when seed is given out as a loan. Some organizations have found that repayment of seed done in kind is a problem. Farmers may return poor quality seed, if they return any seed at all.[8] (Needham and Rewald, CARE, Ethiopia). For this reason, World Vision in Ethiopia will only accept payments for seed in currency and never in kind because they have had too many difficulties in the past. Farmers have returned poor quality seed, seed of a different variety, old seed, or seed with pests in it. Another problem with seed repayments in kind is the need for a storage area to keep the seed, or a buyer to purchase it. As a result, World Vision Ethiopia requests seed payment in currency on a yearly basis, tool repayments in 2-3 years, and payment for oxen within 45 years. No interest is charged on these loans, but World Vision is working on efforts to establish the time value of money (Dejenu, World Vision, Ethiopia)

Another difficulty with distributing seed as a loan may occur when working with Muslim communities, as Islam bans interest on loans. So should an organization wish to collect more seed than originally distributed, perhaps in order to establish seed stores, it may encounter difficulties. (Ghanim, CARE) Some organizations base the level of seed repayment on harvest conditions. They may assess farmer ability to pay by taking into consideration the regularity and quantity of rainfall and the incidence of pests. (CARE, Kordofan, Sudan)

Many other organizations have had very few problems with seed loans being returned in kind. CRS reported that the principle of payback seed was widely accepted in the project areas, and in areas where rainfall was adequate, many farmers honored a commitment of repaying 150 percent of the original seed received, after harvest. (CRS, Angola Emergency Operational Plan) CARE had documented a similar experience with its Kordofan project in Sudan, where it received excellent seed repayment and some seed of a poor quality was actually rejected by the village committee in charge of storage (CARE, Kordofan, Sudan)

Another problem with repayment of seed in kind is availability of storage facilities. Aside from the fact that storage facilities are simply inadequate or don't exist, other considerations include loss to pests (Ghanim, CARE), moisture, and looting from community stores. Even more serious is the possibility that individual or community seed surpluses will attract the military in countries where civil unrest is endemic. For example, in one region of Sudan the people had to stop growing a surplus because they no longer had access to local markets, and the surplus attracted the local army who would not only steal the surplus, but also rape the women and take the sons. Families in this region were only willing to grow a surplus if the NGO agreed to remove it immediately. (Hodgdon, CARE, Southern Sudan)

3.4 Follow-up (agricultural extension)

Agricultural extension work varies by project and by organization. While some organizations believe, correctly, that extension work is one of the keys to a successful and sustainable project, other organizations do not feel that it is necessary or within their manpower resources. Extension work is also understandably hindered in situations of civil strife where staff may not have the accessibility to the farmer needed to do the work. Extension work can be especially important in situations like Sudan[9] where many traditionally agro-pastoral, or pastoral communities are turning to agriculture as a means of survival. (Lokombu, NSCC)

Some organizations do no extension work at all. The reasons for this vary from lack of manpower to the belief that it is just not necessary. At the very least, some organizations set up demonstration plots where farmers can see the results of improved varieties (Salmond, World Learning Inc., Uganda) or improved cropping practices. In countries where civil strife is an issue, even if there are government-trained or local extension workers, they are not doing extension work but are often out fighting instead. (Lokombu, NSCC) This is somewhat similar to the case of Somalia, where there are no longer any government extension agents available, so organizations are training villagers with agricultural background to act as extension workers.

Organizations draw upon different resources for extension agents. Some NGOs will use their own staff as extension agents, others will work with government extension agents. Some organizations recruit and train locals as extension agents. But most organizations use some combination of the three. Some NGOs hesitate to work only with government extension agents,

feeling that they are inadequately trained. (Muijsers, GAA, Kenya) Other organizations find the government extension workers helpful, and may even use the Ministry of Agriculture staff to train local extension workers. (Dejenu, World Vision, Ethiopia) CRS held a series of workshops in Southern Sudan, about one per week, in order to train the Sudan Relief and Rehabilitation Association (SRRA)[10] agricultural staff. This training was done to better equip the SRRA staff with the appropriate agricultural skills. (OFDA Global Seed and Tools in S. Sudan, project. document CRS)

In situations where an NGO is acting through local counterparts it may even undertake to train them, as CRS did in Angola, by contracting the services of a local agronomist who was familiar with the region. This agronomist conducted a course on basic agricultural techniques for the counterpart organization's volunteers, village traditional elders, and other pilot farmers. The course involved a practical hands-on workshop which emphasized proper planting techniques, composting, weeding, seed conservation, and other techniques found to have a measurable impact on production. According to project documents, the course was enthusiastically received and drew large crowds. An illustrated field manual was also given to each locality visited explaining and demonstrating the improved techniques in simple language. (CRS, Angola Emergency Operations Plan, 1993-94, project. doc) In addition, CRS works strongly to encourage communication between its local counterparts and government extension staff. If the counterpart does not have the necessary expertise, its staff will be introduced to government agriculturalists who will provide support as necessary. (Mburu and Muthee, CRS Kenya)

Once trained, extension workers can be used in many ways. Some NGOs have extension workers build and maintain demonstration plots in the village fields. (Turk, IRC Somalia) Extension workers may also advise about agricultural inputs for the upcoming planting season (Hodgdon, CARE, Southern Sudan) or advise farmers about improved agricultural techniques. (Needham and Rewald, CARE, Ethiopia) Targeted extension messages can be especially useful, for example, explaining to farmers the source and quality of seed in order to prevent the possibility of planting seed too densely due to uncertainty about seed germination rates. (CRS, Somalia Agricultural Rehabilitation, project. doc.) Extension workers may even be used for information dissemination before agricultural inputs are distributed, as in the case of CARE Rwanda, where beneficiaries were invited to come to the commune in order to discuss what they would receive and how to use it, instructions about the application of fertilizer for vegetable seed, and other extension messages. This extension program got about 30 percent attendance. (Danzoll, CARE, Rwanda)

Some NGOs emphasize the training of villagers and government extension agents in conjunction with their own extension workers, so that once the NGO pulls out, government and village extension workers will follow up and continue the work. (Ghanim, CARE) World Vision, Ethiopia, even makes a point of keeping the salaries of locally trained extension workers low, so that when they pull out, the community will still be able to pay their salaries. (Dejenu, World Vision, Ethiopia)

Extension work does not need to be limited to improved cropping practices and setting up demonstration plots. It will ideally continue with the community in an effort to provide some sort of project sustainability, hopefully moving toward seed/food security. For example, ADRA Ethiopia has developed a gardening security program based on four categories of crops: leaves, roots, legumes, and fruits. These four crops are rotated to preserve the fertility of the soil. For

insect control, plants that repel insects are placed among them. Keeping in mind that land plots in Ethiopia are often very small, a family of 6-7 people farming a 16m x 16m plot can feed itself for 90 percent of the year. (Richardson, ADRA, Ethiopia)

An example of a project that had an extremely strong extension component built into it, which targeted several villages in the project area for the purpose of eventually establishing seed storage and creating food security, was the CARE Kordofan Project in Sudan. As part of the program, project staff toured the area regularly during reporting periods visiting village seed committees in order to modify, monitor the performance of, and train the village seed committees on stock management, follow up on the training of the village extension agents and assure that the community was receiving their extension messages. CARE staff also worked to define in public meetings the roles of the seed committee, the village extension agents, and the community in village level seed security. These groups would work to ensure adoption of appropriate seed storage system in the village, and community participation in order to achieve a high level of seed repayment to the village seed banks.

The project also initiated a competition aimed at selection of top performing "Seed Friendly Villages" to further enhance performance of communities. Two selected villages in each rural council were selected as model villages in sustainable seed supply. Those selected were nominated to the MOA to receive special treatment in terms of incentives and closer follow-up after project phase-out. Success was monitored by the adoption of extension messages by the villages, which at one point reached 90 percent. Adoption of messages was reflected mainly by the complete awareness of the goals of the project, seed selection, use of traditional methods of store pest control and store organization. An intensive extension drive was implemented successfully in 103 village councils in 7 rural councils in the targeted province.

The final results were 22 CARE and MOA staff trained, 177 farmers acting as village extension agents, the formation of 103 village seed committees, and the convening of a seminar on seed supply sustainability in the village. In addition, extensive staff training (TOT - Training of the Trainer) took place emphasizing the following areas: 1) objectives of the Seed Project and the role of the targeted provincial seed bank; 2) role of local institutions in ensuring a sustainable village-level seed supply; 3) community motivation; 4) the participatory approach; 5) improving traditional seed selection methods; 6) rural seed stores and natural methods of storage pest control; 7) agro-monitoring and information gathering techniques; 8) extension theory and practices; 9) development of training curricula; and 10) training skills.

There were also training sessions for the Village Extension Agents (VEAs) developed by the participants of the staff training sessions. Objectives of this exercise were to : 1) define training areas, session contents and methodology for training VEAs; 2) develop necessary training curriculum; 3) determine selection criteria for participating villages and trainees; and 4) test a developed curriculum in two sample villages and revise it according to the test run.

The following training areas were identified: 1) creating an awareness among framers regarding the roles of CARE and the PSB in the present endeavor to achieve village level seed security; 2) mobilization and motivation of the village community to achieve seed security; 3) selection, harvesting, and processing of good quality seed stocks; 4) seed loan repayments; 5) improved methods of village-level storage of repaid seed; 6) sustainability of village-level seed supply; and 7) the role of the VEA.

Participants discussed training areas in depth and detailed them into lessons or curriculum to be used by the trainers. This curriculum was then pre-tested in two villages and revised. Participants then determined criteria for selecting Village Councils to be targeted and for selecting the farmers who would be trained. Totals were set at 103 VCs and 177 farmers VEA. Extension messages were developed during the project's monthly coordination meetings. Each time, the staff reported feedback from their last trip, and decided what message to carry in the following month. These messages reflected the community needs at each stage of project implementation and followed the training areas covered by staff and VEA training programs.

In addition, CARE project staff were to be trained in the following areas: 1) storage pest control and management with the intention to improve traditional storage; 2) community management and participatory rural extension methods, particularity facilitation skills, problem solving methods, use of visual aides in extension, non-literate methods of communication and recording of information; 3) stock management and inventory control (i.e. waybills, stock books, stock reporting, damage and loss verification, stacking and counting, receipt, dispatches, book balance, physical balance and reconciliation); 4) need assessment survey methods; 5) agro-monitoring (i.e. estimation of areas planted and yields, monitoring of crop performance, rainfall pattern and incidence of insects and pests).

4. Determining seed quantities needed

There are a number of strategies used to determine the quantities of seed to distribute to individual farm families. In discussions of this issue with NGOs these strategies: 1) supply all the seed the farmer needs to plant and 2) supplement the seed supply of the farm family.

Technical aspects of these strategies are summarized in the following two tables on seed distribution and seed multiplication.

The two tables show that seeding rates and yields vary greatly among the crops used in SDMR. Seeding rates and yield are provided for 0.1 ha since farm sizes in the GHA are often small and computing seed needs based on actual crop areas per farmer can be done as increments of 0.1 ha. In examining the seed needs on a farmer basis in increments of 0.1 ha.

- Relatively small quantities of seed of Group 1 (maize, sorghum, millet and teff) 1.0-2.5kgs can produce 160-300 kg yield.

- By contrast, when considering Group 2 (wheat, barley, and legumes) the amount of seed for 0.1 ha ranges from 10-12.5 kgs, 4 times the amount as Group 1 and the yields range from 100-250 kgs.

- Group 3 illustrates the difficulty of providing vegetatively propagated crop. The weight and bulk and perishability of potatoes and cassava means that using these crop for DMR requires special considerations.

When weight and bulk are important in SDMR due to transport considerations, the first group will provide more yield for less seed. Therefore a mixture based on the first and second group should be considered.

Seed Distribution

CROP	Seeding Rate KG/HA[1]	Seeding Rate KG/0.1HA	Yield KG/HA[2]	Yield KG/0.1 HA
Group 1				
Maize	25	2.5	3000	300
Sorghum	5	0.5	2500	250
Millet	5	0.5	1500	150
Teff	25	2.5	1600	160
Group 2				
Wheat	125	12.5	2500	
Barley	100	10.0	2500	
Beans	100	10.0	1200	250
Peanuts	*100	10.0	800	250
Chickpea	100	10.0	1000	120
Cowpea	40	4.0	1000	80
				100
Group 3				100
Irish	2000	200.0	6000	
potatoes	0.3			
seed				600
potatoes				
true potato				
seed				

[1]Seeding rates vary greatly with the farming system. These are conservative estimates for monocropping.

[2]Yields vary greatly depending on the farming system and agro-ecological factors. These are conservative estimates that would be considered good for low input farmers' fields but well below the potential with inputs.

Seed Multiplication

CROP	Multiplication Factor (yield/seeding rate)	Area (Ha) planted from 1 ton of seed	Number of 0.1 ha plots from 1 ton of seed
Group 1			
Maize	120	40	400
Sorghum	500	200	2000
Millet	300	200	2000
Teff	64	40	400
Group 2			
Wheat	20	8	80
Barley	25	10	100
Beans	12	10	100
Peanuts	8	10	100
Chickpea	10	10	100
Cowpea	25	25	250

The *multiplication factor* is the amount of seed produced from a given quantity of seed. Using better management and fertilizer, the multiplication factors can be substantially increased. The cereals in Group 1 have very high multiplication factor whereas Group 2 crops have very low multiplication factors. The multiplication factor can be useful in estimating the number of generations of seed production that will be necessary to reach a certain quantity.

For seed multiplication a much larger area and larger quantity of seed must be devoted to Group 2 crops compared to Group 1. For example, compare maize and beans. To multiply in one generation enough maize seed to provide 10,000 farm families with seed to plant 0.2 ha each, a project must start with 25 tons of seed and plant it on 8.3 ha. To multiply enough bean seed in one generation for the same 10,000 families with 0.2 ha plots, the project will have to start with 100 tons of seed and grow it on 83 ha.

Thus when seed multiplication efforts for Group 2 crops must start with a small quantity of seed, it may require several growing seasons to get enough seed for distribution. Beans with a multiplication factor of 12 if starting with 100 kg will require 2 growing seasons to get 14,400 kgs of seed (12 multiplication factor x 100 kgs=1200 kgs, 12 multiplication factor x 1200 kgs = 14,400 kgs).

5. Withdrawing SDMR interventions

One of the most important aspects of withdrawing from a seed intervention is to ensure that the beneficiary population has not become dependant on NGO seed grants or loans. More and more NGOs are realizing that distribution of seed and tools as a grant may create a negative precedent. Especially in cases of civil unrest or recurring drought, or any instance where the NGO may not be able to pull out after just one year, farmers may begin to expect free seed, making the transition from relief to development more difficult. (Dejenu, WV, Ethiopia) The results of this could be devastating if the NGO pulls out after a planting season, and the farmer, once again expecting seed, has neglected to save any from the previous years harvest. Several organizations have reported protests from communities when seed distributions suddenly stop and the NGO pulls out. (Bailey, SAWSO)

As a result, some organizations are moving more towards involving communities and placing more emphasis on extension work and training in order to better equip the community for an eventual end to distributions. Isam Ghanim of CARE believes that seed programs should not last for only six months or a year, but that a community must be taken through a full cycle which includes distribution follow-up addressing issues of seed storage and development of a safety net for the community for future stress situations. (Ghanim, CARE) One option is to try and plan a smooth hand-over of the project to the local Ministry of Agriculture and local counterparts. (CARE, Kordofan project doc., Sudan)

There are several other possibilities for phase out activities. Many of these are pre-withdrawal activities aimed at establishing self-sufficiency and sustainability. World Vision, Ethiopia, is trying to establish programs working with farmer associations selling inputs to the farmers on a half cash, half credit basis. The farmer associations would then be responsible for accountability of funds, and deciding what to do with the money collected for the inputs. (Dejenu, World Vision, Ethiopia) CARE Southern Sudan is currently working on a project to buy surplus seed from farmers to sell to other NGOs. Rather than paying the farmers in currency, seed is bartered for goods that are not available on the local markets. In addition, local markets are monitored to ensure that the barter shop established by CARE is not competing with the markets and driving local merchants out of business, thereby defeating the self-sufficiency objective of the project. (Hodgdon, CARE, Southern Sudan)

Other possibilities involve seed multiplication schemes. World Vision Rwanda does both on-farm multiplication and on station multiplication, in an attempt to rehabilitate some of the abandoned research stations. It is working on multiplying several crops that were commonly used by Rwandan farmers before the conflict, including maize, wheat, beans, soya, and groundnut. It is focusing on gradually handing over multiplication activities to the Government. One of the main goals of the seed multiplication by World Vision in Rwanda is to eventually be able to restore to the farmer what he had before. (Hooper, World Vision, Rwanda)

A natural follow-up to seed multiplication, especially that done on-farm, is the establishment of seed banks. While some organizations shy away from providing seed to farmers on a loan basis, if storage is available, the repaid seed could provide the basis for a community seed bank which may be able to provide, at least in part, for future deficit situations.

Endnotes

1. ICRC Nairobi Delegate Jurg Eglin, interviewed by Karen, Nairobi.

2. Sperling et al., op. cit.

3. ICRC Nairobi Delegate Jurg Eglin, interviewed by Karen, Nairobi.

4. Sperling et al., op. cit.

5. Melaku Worede, "Ethiopia: A Genebank Working with Farmers," chapter in *Growing Diversity, Genetic Resources and Local Food Security,* Intermediate Technology Publications, 1992.

.6. In Ethiopia, even when the rains are good, there is often a food deficit, because land holdings are just too small. Traditionally, land is divided up and shared with the children, so with each generation, land holdings get smaller and smaller. Plots are often so small that people cannot produce enough on them to feed themselves and their animals. (Skivald and Alemu, LWR, Ethiopia)

7. The CRDA is an organization in Ethiopia that gives grants, mostly to smaller NGOs, on a 60:40 basis (60 percent donated by CRDA and 40 percent by the NGO) for relief and development projects.

8. In the past, the Government of Ethiopia had given seed out on a "loan" basis but never collected anything from the farmers. As a result, the farmers are not used to honoring their repayment commitments.

9. In addition to problems of civil strife and drought in Sudan, some regions are experiencing an active desertification process which continues to significantly reduce soil fertility and result in poor crop output. (CARE, Kordofan, Sudan)

10. The SRRA is the civilian branch of the Sudanese Peoples Liberation Army (SPLA). The SRRA is responsible for civil administration of SPLA-held territory.

Section VI.
Seed Sources and Seed Quality

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1. Seed sources for disaster mitigation and recovery

The nature of the "market" (supply and demand) of seed for disaster mitigation and recovery creates many difficulties for providing quality seed of the appropriate varieties at reasonable prices. This market consists of a demand side which is the relief organizations that issue large, competitive-bid, seed tenders in response to predictable and unpredictable demand for seed for disaster mitigation and recovery. On the supply side there is the commercial seed (and food grain) industry that responds to the seed tenders. Normally seed production is contracted far in advance of its delivery but this is not the case for SDMR. Further characterization of the situation includes the following factors:

- There is little or no advance notice that relief organizations will be purchasing seed since they need to have the funds from donors/contributors before seed tenders are issued. Relief organizations issue seed tenders with delivery dates of only 4-6 weeks in the future. In drought relief situations the relief organizations may know that they will need the seed but they are unable to finalize the seed tenders until they have the funds. In acute situations of civil conflict, advance notice of the need for seed depends on the dynamics of each situation.

- The demand of SDMR varies greatly from year to year making it difficult for seed suppliers to plan ahead in order to respond to the requests of relief organizations.

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- Rather than being able to contract in advance for seed of the appropriate variety to be produced, seed sources must use what they have in inventory or rush out and purchase seed from farmers and merchants to respond to the seed tenders.

- In the seed industry, decisions about production are made six months or more in advance because of planning, planting and growth of the seed crop and the harvesting, conditioning/processing and marketing/distribution that are required. In addition, seed production in the GHA is mostly carried out under rainfed conditions and projected seed production can be severely affected by adverse conditions.

- Competition for seed supplies among relief organizations in large scale disasters may result in a limited seed supply and price increases. Additionally one may having to settle of seed that is not quite the right variety or poor quality seed. This was clearly the case in of SDMR in Rwanda in 1994.

- Due to lack of preparedness for SDMR by national seed systems and the seed industry, adequate quantities of seed of appropriate varieties are usually not be available. Even when there is advance notice, starter seed is often insufficient to multiply enough in one season to produce a stock for distribution to farmers.

- Seed is perishable. It is subject to deterioration in germination and vigor during storage. The rate of deterioration depends on the crop, the moisture percentage of the seed, temperature and relative humidity of the storage environment. In many regions of the GHA the high humidity during harvesting and storage makes seed storage difficult. Consequently seed should not be stored for extended periods of time without the realization that the seed quality can be adversely affected.

- Relief agencies turn to a variety of organizations to purchase seed. Seed sources and seeds varieties vary greatly between the countries of the GHA. The source of seed for a particular situation depends on a complex range of factors that include availability, price, transportation, ease of purchase, delivery time and historical/institutional relationships. Organizations involved in the seed trade can overlap in the functions they perform since they have often evolved based on local needs. The seed sources include international procurement organizations, regional/national seed producers, regional/national seed suppliers/traders, and local seed supplies from merchants and farmers,

1.1 International Procurement Organizations (IPO)

These organizations supply a wide variety of commodities from vehicles and equipment to medical supplies, food, and seed. IPOs vary greatly in size from single office operations to world wide networks of offices and agents. Some IPOs focus only on working with NGOs whereas other service UN organizations, World Bank and bilateral projects. IPOs are experienced in responding to a wide variety of needs of international organizations on a competitive bid basis. IPOs are freight forwarders which deal with all aspects of moving goods and equipment anywhere in the world and all the legal and customs documentation required to move across international borders. They often have regional and national offices to facilitate providing services to their clients.

Seed is normally a small component of the services of IPOs. IPOs bid on seed tenders and food tenders from NGOs and other organizations. IPOs don't normally produce seed themselves. Instead IPOs request bids from reliable seed producers when they are responding to a seed tender. IPOs normally procure the seed as near as possible to where it will be delivered. The reason for this strategy is simple. They will be more likely to find the specific seed variety the tender requires and the cost of transport will be lower. Transportation often accounts for a significant portion of the overall cost of seed and food grain.

After selecting a bid, the IPOs buy the seed and arrange for transport and delivery to the purchaser with necessary documentation to move it across international borders and to meet the specifications of the buyer, that is phytosanitary certification and seed testing for moisture percentage, germination, and purity. Sometimes IPOs, through regional/national offices, become involved in purchasing seed directly from farmers or merchants. One of the unique services they are sometimes required to perform for relief organizations is to assemble packages of commodities (i.e. tools, food, blankets, small quantities of seed) for distribution to rural families.

International procurement organizations are significant suppliers of seed to relief organizations. Their reputation and future business depends on providing good service and delivering a quality product at a reasonable price. Relief organizations will sometimes reject the lowest bid in order to deal with an organization they know and trust. In summary, the reasons for using IPOs include:

- IPOs are reliable, experienced, and professional.
- Financial arrangements are often made through letters of credit with small initial deposits rather than with small suppliers who may require full payment in advance and then not be able to deliver the commodity.
- Relief organizations often have small procurement sections with limited time and personal to arrange purchasing of seed directly. IPOs take care of the procurement for them.
- Competitive bidding keeps the cost low. Also, IPOs search for the best prices with suppliers they trust. They honor bids and make deliveries on time. There is a multiplier effect of reaching many seed suppliers because relief organization normally seek at least three bids and each IPO in turn seeks three to six bids.
- IPOs will guarantee the quality of seed and will move it through international border as required.

1.2 Regional/national seed suppliers/traders

NGOs claim there is no shortage of IPOs and seed suppliers/traders to bid on seed tenders. In fact new suppliers turn up at the doors of relief organizations almost on a daily basis with claims of low prices and high quality products. These organizations are often import/export businesses in specific countries that deal in commodities like food and seed. The size, expertise, and credibility of these organizations varies greatly. There are very reliable seed suppliers, some of which are affiliated with international procurement organizations. However, there have been

incidents when seed suppliers have delivered poor quality seed, mixed seed of the wrong variety or not delivered it at all. Relief organizations have learned a difficult lesson due to problems with local suppliers, so they normally deal with suppliers they know and trust.

Seed suppliers often have facilities for cleaning, treatment, and storage of seed and other commodities. Seed suppliers sometimes subcontract with seed producers to provide certified seed for DMR depending on the specifications. Otherwise seed from these suppliers is usually food grain that is rapidly purchased from rural grain merchants when a seed tender is won. The food grain is then cleaned, bagged and shipped as specified in the seed tender. They sometimes import vegetable seed from Europe in bulk and package it locally. Similar to IPOs, they sometimes assemble packages of commodities (i.e. small quantities of seed, food tools blankets, etc.) for distribution to rural families as specified by the purchaser. Examples of seed suppliers and traders are provided in the country by country list of seed sources in an appendix to this report.

1.3 Regional/national seed producers

Seed producers mentioned here focus on producers of certified and commercial seed that could be used for DMR and not research institutes that produce breeder (pre-basic) and foundation(basic) seed. These organizations can be sub-contracted by the seed suppliers to deliver specified quantities of seed to be included in packages of commodities for relief organizations. However, seed producers are often not used as a source of seed for relief operations since they normally produce certified seed. Instead, seed suppliers arrange for the purchase of food grain rather than certified seed to be used as seed which is then cleaned, bagged, and tested. When relief organizations are given the choice of purchasing certified seed or food grain for seed they often choose the less expensive food grain for seed. Certified seed can be 2 to 8 times more expensive than food grain.

Seed producers range from small independent seed producers such as Hortitech in Kenya to parastatal or semi-autonomous government seed companies such as Kenya Seed Company or the Ethiopian Seed Enterprise to a variety of medium and large international seed producers such as Cargill, and Pioneer. Seed producers grow seed themselves or contract seed with farmers. This seed may or may not be certified seed. Parastatals are large seed producers in the GHA. The quality of seed produced by these organization is variable. Some reports were favorable and others were unfavorable, depending on the crop and the country. Parastatals have less flexibility on pricing their seed when bidding on seed tenders, so they are sometimes high-priced seed providers of last resort.

Examples of regional/national seed producers are included in the country listing of seed sources appendix of this report. Two important listings of seed producers are:

- **WANA Seed Directory**, published by the West Asia & North Africa Seed Network (WANA). Available from the International Center for Agriculture Research in the Dry Areas (ICARDA), P.O. Box 5466, Aleppo, Syria. This directory was published in 1995. (The 1995 edition notes that a more complete directory is to be published in 1996.) For each of 12 countries (including Sudan and Ethiopia from the GHA), the directory lists the seed law implementing agency, the seed certification agency, sources of breeder and foundation seed, government seed production and processing companies, private sector seed production and processing companies, seed importers

and exporters, licensed retail seed dealers and merchants, genetic resource (germ plasm) banks, plant and seed quarantine offices, agencies which control seed import and export, seed testing labs, referee testing labs, and seed health testing labs.

- **World List of Seed Sources,** published by FAO edited by E. Sgaravatti, Seed Service Plant Production and Protection Division. This catalogue of seed sources compiled in 1986 is the third edition and provides more than 7,000 addresses of seed producers in 150 countries. A new edition will be released early in 1996. It is a comprehensive listing by country with the addresses of plant breeding stations, cooperatives and commercial seed producers. The catalogue includes breeder, foundation, registered and certified seed producers and a listing of the crop seeds of each producer.

- **International Seed Directory:** World Reference for the Commercial Seed Industry, published annually by Seed Trade News, Dean Publishers, 9995 W 69th St. Suite 201, Eden Prairie, MN 55344; Tel (612) 941-5822; Fax (612) 941-1708. This directory includes seed producers in the developed and developing world with import and export information about each country as well as a range of information about each seed producer. Unfortunately, the African countries covered only include Egypt, Ivory Coast, Kenya, Malawi, Republic of South Africa, Tunisia, and Zimbabwe.

1.4 Local supply of seed directly from merchants and farmers

During large-scale drought such as in Ethiopia in 1986 or civil war in Rwanda in 1994, it is difficult to avoid bringing in seed from other regions of the country or from neighboring countries for DMR. However, in smaller scale, more localized relief efforts due to drought, the trend has been for relief organization to rely on purchasing food grain for seed from nearby markets. Some relief organizations such as CRS through the Catholic Diocese in Harerge region of Ethiopia have followed this policy, and merchants make special effort to maintain relatively pure seed so they can maintain their good customers. There are several advantages to this approach.

- The particular varieties will more likely be appropriate and familiar to farmers. In fact, farmers are sometimes involved (and should be involved) in identification of varieties they know and want to grow. This results is a higher likelihood that seed will be planted and not eaten or sold.

- Transportation costs can be greater than the cost of seed if it must be transported long distances over difficult terrain on poor roads. Local sourcing of seed can dramatically reduce transportation costs.

- It is more likely that seed will be delivered in a timely manner. Timing of seed delivery is one of the major problems of SDMR.

- Overall costs of this approach are much less with a higher likelihood of timely delivery of an appropriate variety than bringing in seed from the outside.

A number of relief organizations, particularly in Ethiopia, (in Tigray region of Ethiopia the NGO REST) have pursued the concept of local seed security through the use of community seed

banks. Farmers with the best fields are selected by the seed bank committee, so the harvests from those fields can be purchased and loaned to needy community members for the upcoming season. If there is a crop failure, seed is brought in from other seed banks. Such approaches are oriented toward local solutions to seed problems that are lower cost and more sustainable than conventional seed relief operations. A sound local management system and strong local participation is needed for this kind of approach to succeed. In case of a general crop failure local solutions can be difficult.

2. Seed quality and certification

2.1 Quality

Any activity involving seed has to make certain decisions or assumptions about seed quality. The basic question for SDMR is, whether the activity is delivering an appropriate level of quality seed to farmers to improve their food security or it is instead unknowingly contributing to food insecurity by providing poor quality seed. If farmers suspect poor quality seed, they will often sell or eat the seed, which must be viewed as a failure for SDMR objectives. One of the ways attention has been given to the seed quality issue by relief organizations is by insisting on tests of germination and purity of seed provided by seed suppliers on seed tenders. Similarly OFDA-funded activities require that certified seed be provided for SDMR as a guarantee of seed quality. These are good precautions but they fall short of verifying the quality of seed provided to farmers. Discussions with relief organizations reveal that they consider the quality of seed to be adequate in most cases. Nevertheless, problems with poor quality seed have been revealed. Relief organizations need to give greater attention to and verify the quality of seed before it is provided to farmers. The Seed Technical Notes section provides details of sampling and testing procedures.

Quality seed is critical to agricultural production. Poor seed limits potential yield and reduces farmers' productivity. Farmers need every possible advantage in crop production and starting with quality seed is important. There are two basic parameters to seed quality: physical/ physiological qualities and genetic quality. Physical qualities are the physical aspects of seed (i.e. seed purity, seed size, and absence of inert matter). The physiological quality refers to the overall health and condition of seed and includes seed vigor, viability, and freedom from disease. Genetic qualities are specific genetic characteristics of seed. Ideally, seed should be relatively genetically uniform and adapted to produce optimum yields under local conditions.

Seed Quality — Physical & Physiological

Physical/physiological qualities are characterized by the following:

- **Near uniform seed size:** Medium- and large-size seed will have higher germination and vigor than small and immature seed. In the conditioning/processing of seed, the small seed is eliminated.

- **Minimum of damaged seed:** Damaged seed may not germinate and is more likely to be attacked by insects or microorganisms. Damaged seed is eliminated during seed conditioning.

- **Minimal weed seed or inert matter:** There is no reason to plant weeds, chaff, stones, or the dirt or seed of other crops with good seed. This portion of the seed is discarded during conditioning.

- **Minimum of diseased seed:** Discolored or stained seed can carry microorganisms that already have attacked or will attack the seed when it starts to grow. The plant may live and spread the disease to other plants.

- **High germination and vigor:** The germination rate is an indicator of the ability of seed to produce a plant. Seed vigor is the ability of seed to germinate and survive under potentially stressful field conditions and to grow rapidly under favorable conditions. The loss of a seed to germination is the last step (not the first step) in a long process of deterioration. Decrease in seed vigor and other physiological changes happens before loss of germination. (See Figure 1 Possible sequence of changes in seed during deterioration)

Seed Quality — Genetic

- **Seed of the same variety:** Seed of different varieties of the same species are often hard to distinguish once harvested. A mixture of varieties can be a problem: the varieties may mature at different times which leads to problems in harvesting, post harvest handling, and lower yields. Additionally, each seed of an undesired variety in a mixture will produce seed when it is planted and those seeds will produce more seed so that each year the proportion of the undesired variety becomes greater. Field inspection during the grown of the seed crop is one of the steps taken to insure pure seed in certified seed.

- **Adapted to the local conditions:** The growth cycle or days to maturity is critical for all rainfed crops. Crops must mature while there is sufficient moisture for crop growth. Adaptation to soil, fertility, diseases, pests, day length, and moisture regimes are all important characteristics. Plants will grow well and produce an abundance of seed only in the proper environment. It is difficult to anticipate how a variety will respond to a different agro-ecological zone until it is actually grown there.

- **Proper characteristics for use:** A crop must have the processing, cooking, color, and taste characteristics that are compatible with local preferences. Farmers have rejected many new varieties because of poor taste or cooking factors. Aspects other than the edible grain may be important since the plant may be used for other purposes after harvest, such as building material or fodder.

- **Disease and pest resistance:** Resistance to pests and diseases is highly desirable for all crops but difficult to achieve. Resistance can break down with time due to mutations and new sources of resistance are always be sought by plant breeders.

- **High yield potential:** Higher yields mean more food and income for farmers. With resource poor farmers it is important that the high yield can be achieved under low input conditions (minimal or no fertilizer and pesticides).

When seed has desirable physical/physiological and genetic qualities farmers have a better chance to grow a good crop. High quality seed is a major factor for getting a good stand of rapidly developing plants under even adverse conditions. Other factors such as rainfall, agronomic practices, soil fertility, and pest control are also crucial.

The publications of the West Asia and North Africa Seed Network, available from ICARDA (P.O. Box 5466, Aleppo, Syria) are an excellent source for more information on seed quality, and seed certification. For example the *WANA Catalog of Field and Seed Standards (Cereals and Legumes)*, published in 1995, explains the requirements for various categories of seed quality.

2.2 Seed certification

In SDMR, the concern for seed quality must address the issue of how to insure that seed delivered to farmers is of adequate quality. "Adequate quality" could be considered the quality of farmer-produced seed. This is seed that may not have a 95 percent germination rate but 85 or 75 percent. As part of the objective of the SDMR program there should be agreement on the level of seed quality desired. Seed quality standards should probably vary among crops since, for example, legumes have a much higher deterioration rate compared to cereals. There are various approaches to the seed quality issue in SDMR.

Some donors require relief organizations to purchase certified seed as a way of guaranteeing the quality of seed. Unfortunately, national seed certification systems in the GHA are understaffed, under-funded, and under-trained. Sometimes the same departments that carry out certification are part of larger organizations responsible for seed production which presents a conflict of interest. Certified seed is considerably more expensive that foodgrain (2-5 times more expensive). Depending on the funding source, relief organizations often do not want to pay for higher priced certified seed. Consequently, the value of certified seed as an indicator of high quality seed in theory is acceptable but in practice is not a guarantee that one is purchasing high quality seed.

Phytosanitary certificate, germination and purity testing: These three tests are often required for seed delivered for a seed tender when it is not certified seed. In principle, it is a good start to have these three tests. The question becomes one of knowing whether the tests are based on representative samples of all the seed in the shipment. How reliable are the tests? These tests have not been able to stop some of the problems experienced with seed for SDMR in the past.

2.3 Use of foodgrain for SDMR

Foodgrain is often used for seed in SDMR. Often the foodgrain is acceptable for seed in SDMR. However, there is an element of risk when you consider the difference between seed and foodgrain, Foodgrain can be damaged and broken seed, not of uniform size, low in germination, and a mixture of varieties and yet be acceptable for sale or consumption. That same seed would not be good for planting. Seed for planting must be able to germinate and produce a good crop. Seed suppliers often clean, sort or process the foodgrain before selling it as seed to relief organizations. This is an appropriate action, but it does not prevent other seed quality problems that the supplier may not be aware of, such as a mixture of varieties.

Physical aspects of seed quality can be determined by observation but genetic and physiological aspects must be determined by testing. Are representative samples of the seed taken and tested before the seed is purchased?

Foodgrain found in a market in a food deficit area may not have come from that area but from a food surplus that is probably a different agro-ecological zone. This foodgrain would not be of an adapted variety to purchase for SDMR.

Seed certification, germination tests, and purity tests are some of the tools that can be used to determine seed quality. Unfortunately, these tests are not enough if donor and relief organizations are committed to supplying seeds of appropriate quality to farmers for SDMR. What is important is verifying the quality of seed purchased for SDMR. The overall level of monitoring of large-scale SDMR activities and results leads one to believe that poor quality seed is used for SDMR, but due to a lack of monitoring, no one really knows how great the problem is. An important aspect of improving the quality of seed in SDMR is verification of quality by relief organizations and making seed suppliers aware that poor quality seed will be detected and rejected. Seed germination testing of representative samples needs to be done when it is delivered to relief organizations and testing at the village level when it is distributed.(See Seed Technical Notes for details on sampling and germination testing.)

3. Other seed issues

3.1 Vegetable seed

Vegetable seeds are widely used in SDMR. The rationale is that even in a small garden, vegetables can be quickly produced as long as sufficient water for irrigation or rainfall is adequate. Because of the small seed size of vegetable seed and its high nutritional value, relatively small quantities of vegetable seed in SDMR can result in improved food security.

Seed sources: The vegetable seed industry is dominated by the private sector in Africa as elsewhere. Most vegetable seed is produced by international seed companies imported into Africa by the private sector or sometimes government parastatals. There is some private, small-scale vegetable seed production in Kenya. Large-scale commercial green bean seed production is well established in the Arusha area of Tanzania (see seed source section). Vegetables are high value crops and commercial vegetable growers are inclined to purchase high quality seed every year. Diseases can be devastating for vegetable crops and purchasing seed on a yearly basis helps ensure disease-free and disease-resistant crops. Because of economies of scale, environmental requirements of temperature and humidity, isolation, and seed extraction, processing, and conditioning facilities, vegetable seed production is concentrated in certain areas of the world. The world-wide vegetable seed market can be generally subdivided into two sub-markets: one for large commercial vegetable producers and one for small commercial and individual gardeners. Vegetable seed for DMR is obtained by relief organizations in two ways:

Seed tenders: Like cereal and legume crops, relief organization issue tenders for vegetable seed. Seed tenders are not particularly profitable for vegetable seed companies but instead are ways for them to sell excess inventory. The excess inventory is still high quality seed since it has been stored in sealed containers under good storage conditions. Nevertheless, it can be seed that is several years old so it may have started to deteriorate. Some vegetable seed companies that

cater to the commercial vegetable industry prefer not to get directly involved in seed tenders for the potential legal problems that can arise due to seed liability laws.

Seed donations: Another way for vegetable seed companies to contribute to relief efforts and reduce excess inventory is through seed donations rather than writing it off. In the case of seed companies that sell seed in small packets for retail trade, it gives them a way for recycling seed rather than throwing it away, when the unsold seed is removed from the store shelves. This seed is normally of high quality but it may have started to deteriorate because of exposure to direct sunlight, high temperature and humidity and because small packets are not an ideal storage container. One of the potential problems of seed donations is that little choice normally exists for what a seed company donates and reportedly there often is a significant proportion of flower seed. Bean seed that is susceptible to rapid deterioration and not adapted to local condition is often included in donated seed. As a result, donated seed packets must be sorted before shipping to ensure that the right vegetable seed are going to the right locations. Large quantities of vegetable seed in packets are rather bulky and heavy for shipping relative to the quantities of seed involved.

There is substantial opposition in the vegetable seed industry to giving seed away under any circumstances, including for SDMR activities. The reason is that free distribution of vegetable seed can have a negative effect on the local vegetable seed distributors in the country where distribution is done. Freely distributed vegetable seed is sometimes sold and ends up on the local market in direct competition with local vegetable seed traders. This problem could be eased by distributing the kinds of vegetables and quantities of vegetable seed that are appropriate to needs.

Hybrids and open pollinated vegetables: Historically, all vegetable seed was open pollinated and based on varieties developed by public institutions such as land grant universities and USDA. With the Plant Variety Protection Act and the protection that it offers to varieties developed by private breeding efforts, vegetable seed companies have invested heavily to develop improved, high yielding, disease resistant varieties. Where possible much of the breeding efforts have been made with hybrid vegetable seed. Vegetables that are commonly, but not necessarily, hybrids include: tomatoes, peppers, carrots, cucurbits. Hybrids have higher yield and higher vigor that provide the ability to overcome stress. Sometimes hybrid vegetables are more specific in their agro-ecological zones of adaptation based on the needs of commercial vegetable growers. Hybrids protect the breeding investment by making it impossible for others to use the seed of the progeny of the vegetable seed.

Open pollinated (OP) and self pollinated vegetable seed are still the majority of the world wide market. Vegetables that are open pollinated include lettuce, peas, pumpkins and okra. OPs generally have a wider range of adaptation than hybrids. OPs have the advantage that seed from these varieties can be used as seed the next season though attention given to making sure that there are no plant diseases that can become seed borne.

Seed production: Production of vegetable seed is a much more specialized activity than cereal and legume seed production. One of the primary differences is attention to plant diseases. Numerous plant diseases can become seed borne so prevention of the development of plant diseases is a guiding principle for vegetable seed production. Control of water/rainfall late in crop maturity, environments with low humidity, and dry conditions during harvest are important to prevent the development of plant pathogens. Harvesting must be of mature fruit and wet seed

methods are used to extract the seed from the fleshy vegetables such as tomatoes cucumbers, peppers followed by drying and conditioning by specialized equipment.

Importation of vegetable seed: In each country, the particular varieties of vegetables that are adapted to the agro-ecologies of the country are generally well known. In Ethiopia, for example, vegetable seed imports are restricted to known and tested vegetable seed companies and varieties. The Horticulture Department of the Ministries of Agriculture are often involved in testing vegetable varieties for adaptability and yield. Determination of the right varieties to import for SDMR should begin with discussions with the Minister of Agriculture and the public and private companies involved in vegetable seed importation.

Recommendations regarding vegetable seeds for SDMR

- Identify the vegetable crops that are presently grown by farmers along with the adapted varieties for the agro-ecological zone where they are to be distributed.

- Food preferences among rural people are very strong. For example, vegetables are seldom eaten raw so that a leafy vegetable like lettuce may not be desirable to eat once it is cooked even though it looks like other leafy vegetable they know. Even marking the package may not work with illiterate farmers.

- Are the particular varieties of vegetable adapted to the region? In hot lowland areas cool season vegetables may not be useful. In addition, the GHA region is on the equator with short day which is a problem for plants that require long days. For example, long day onions would not produce a bulb under short day conditions.

- Are there particular diseases to which the vegetables should be resistant/tolerant?

- The vegetable seed tenders should be as specific as possible and detail the crops and varieties that will be most suitable to the region.

- Use open pollinated varieties that are cheaper and generally more widely adapted than hybrids and whose seed can be saved for the next season.

- If a seed company is donating seed it would be useful to have them do a germination tests before the seed is shipped. When the seed arrives in country and before it is distributed verify the quality of the vegetable seed through simple germination tests on representative samples.

- Insure that the seed is stored in adequate conditions before it is distributed in countries. High temperatures and humidity can lead to seed deterioration. For this reason vegetable seed should be stored in airtight container such as plastic or tin containers to preserve the seed against the deterioration caused by high humidity. Vegetable seed of poor germination and vigor due to age and/or storage conditions can have a negative effect on the families that receive them.

- Coordination between relief organization and providing quantities of seed appropriate for the farmers needs can help prevent problems of vegetable seed making its way onto the open market.

- Quantities of vegetable seed distributed: The seed distributed should provide the appropriate kinds of vegetables and quantity of seed to achieve the relief objectives. The quantity is related to the quality of the seed and the area a family and be expected to plant. Excessive seed distribution can lead to the seed being sold and higher costs for the relief effort. Vegetable seed is usually very small as is reflected in the number of seeds per 10 grams. The following table shows the minute amount of seed needed to plant 10 m^2 of each vegetable.

Vegetable Seeding Rates

VEGETABLE	Seeds per 10 grams	Seeding rate grams per $100m^2$ transplanted	Seeding rate grams per $10m^2$ direct seeded
Beets	500 - 650	----	11.0
Cabbage	2800 - 3500	3.0	------
Carrot	8000 - 10000	---	4.5
Cucumber	300 - 400	----	2.7
Eggplant	2000 - 2500	4.0	1.7
Kale	3000 - 4000	4.0	3.0
Lettuce	6000 - 10000	5.0	1.7
Melon	300 - 400	---	2.0
Okra	140 - 180	---	7.5
Onion	2800 - 3500	30.0	6.0
Pepper	1500 - 2000	4.5	2.2
Pumpkin	50 - 70	---	3.7
Radish	1000 - 1400	---	11.0
Spinach	1000 - 1500	---	13.0
Swisschard	400 - 600	---	9.5
Tomato	3000 - 4000	1.75	1.2
Turnip	3500 - 4000	---	2.5
Watermelon	100 - 140	---	2.5

Source: East Africa Seed Co., Planting Chart for Vegetables

3.2 Forage seed

Forage and native pasture species seldom require attention in SDMR. On the contrary, removal of livestock as refugees migrate with their animals usually helps pastoral areas recover from overgrazing so long as there is some precipitation. Forage species have natural mechanisms to help them survive for long periods of adverse environmental conditions including fire and years of drought. One of the mechanisms of pasture species is seed dormancy in which one or several natural systems in the seed prevent it from germinating. In most forage species the cause of seed dormancy is hard impermeable seed coats that prevent moisture from entering the seed. This breaks down gradually which means that only a portion of the seed will germinate in a given year, and portions of the seeds can survive in the soil for 5-10 years.

Problems can occur for forage plants around watering holes and corrals, where de-vegetation and soil erosion that necessitate the planting and protection of the forage until it becomes re-established. The value of forage species in the farming system should not be overlooked as it results in milk, meat, animal traction transport, and manure. In addition, forage species can be valuable for strip cropping in erosion control and nitrogen fixation by legume species that improve soil fertility.

4. Monitoring impact and results of SDMR

Methods and indicators: As is the case with extension work, post-distribution monitoring of impact and results varies. Some organizations do no monitoring or assessment at all. Reasons for lack of follow-up in this respect may vary. One organization reported that it does not do assessments or receive reports back from the field, because it feels it is too difficult to ascertain the results of an intervention after successive seasons of recurring drought. (Skivild and Alemu, LWR, Ethiopia) Other NGOs are simply physically unable to conduct post-distribution or postharvest assessments due to unstable security situations. (Franklin, World Vision, Somalia) In situations of civil unrest, farmers may be forced to abandon their land after planting but before harvest, making it difficult to assess project impact. (James, CRS)

One of the biggest challenges facing organizations who wish to do impact monitoring and assessment is the lack of baseline data. When NGOs respond to emergency situations, they sometimes find themselves in areas of which they have no previous experience or knowledge.[1] This is one reason why conducting a pre-distribution assessment is essential. A research organization operational in Rwanda, for example, was hoping to use a survey to establish the effects of germplasm stores and distributions; however, it was hindered by lack of baseline data about what had existed previously. (Buruchara, CIAT) Soniia David of CIAT, Uganda, explained how CIAT assessed the impact of seed distribution by using a combined approach of qualitative and quantitative data. The assessment began with a baseline study inquiring about issues such as varietal loss and wealth ranking, and followed this up with a formal survey. Two days of group meetings were held in the targeted villages, and eighty households were surveyed, focusing on consumption and food security issues. For future information, CIAT plans to follow a sub-sample of farmers to try and assess on-farm yields by looking at seed returns. In this case, farmers will be asked to identify impact indicators for improved varieties, such as yield. (David, CIAT)

Many organizations choose to use some form of Participatory Rural Appraisal (PRA) or Rapid Rural Appraisal (RRA) as a component of assessment, in addition to other tools such as crop establishment surveys, random questionnaires, and physical observation. (CARE Rwanda, Gitarama and Butare Ag Recovery Project Document) June 27, 1996. PRAs and RRAs may be done with project staff, agronomists, and some organizations may also include a sociologist, an animal scientist, or an agro-forester on the project team. Indicators identified by the NGO may include farmers' perceived needs, general difficulties they have encountered, and how, from the farmer's viewpoint, the NGO can be of assistance. (Hooper, World Vision, Rwanda)

Aside from doing an RRA or a PRA, organizations may survey farmers to establish germination rates in the fields and yields, in addition to farmer impressions. Survey teams may also inquire about how many people received inputs. Of these, how many planted the seed, versus eating it or selling it. Were the seeds appropriate and was the extension work accompanying the distribution sufficient and effective. (Danzoll, CARE, Rwanda)

Information may also be gathered to assess project performance as opposed to effectiveness in the field, as was done by CARE in Sudan in the Kordofan Project. Evaluations of the implementation of the project included assessments of procurement, transportation, storage, dispatch, distribution, monitoring, staff performance, counterparts, village seed committees, and other participating partners. An impact assessment was also done in terms of seed distribution, quality of extension services, and the quality of training provided to farmers and village seed

committees in the areas of pest control, storage, assessment of village seed needs, community management, inventory control, quality of storage space, standards of performance of store management sub-committees, and level of success attained in establishing village seed reserves and distribution schemes. (CARE, Kordofan, Sudan)

Assessments can also be undertaken in the field by visual verification. Darryl Jordan of CRS recommends three phases of verification, which can be done very quickly by non-technical CRS staff if necessary, as in cases of political instability,. The first is planting verification. Just because seed is distributed does not mean that it is planted. Jordan suggests checking field preparation and planting within a few days of seed distribution. Secondly, seed viability verification is important. About two weeks after planting, staff should observe rates of seedling emergence. Finally, a harvest verification is important. Some harvesting should be observed and yields recorded. Jordan notes that this is vital, as it will not only provide information about variety suitability, but may also provide early warning information. (Jordan, CRS, Angola Seed and Tools Distribution: Recommendations and Observations)

Observations gleaned from assessments should also serve to identify issues that need to be targeted should there be another intervention, or addressed with extension work. An assessment conducted by CRS Somalia not only provided insight into the problems that Somali farmers face, but also identified several potentially counterproductive farming practices that were being used. Some of the problems observed included: planting sorghum in clumps on mounds resulting in inadequate spacing between plants, insufficient thinning of sorghum plants leading to competition for water and nutrients and high rates of stalk death, high incidence of insect infestation, poor weeding practices, and overuse of land. Recommendations for future projects arising from these findings included: row planting, thinning at early stages of stalk growth, and postharvest field cleaning to eliminate food for insects that infest growing stalks. (CRS, Somalia Agricultural Rehabilitation, Proj. doc.)

For organizations that rely on local counterparts for implementation, monitoring and assessment may prove more difficult. Virtually all NGOs request follow-up information from their counterpart organizations, and some will even do their own assessments to compare. CRDA in Ethiopia will contact beneficiaries directly to see whether or not they received seed, and other relevant information. This data will then be compared with reports submitted by NGO members. (Biru, CRDA) However, organizations which rely on counterparts operational on the ground may not receive adequate feedback, as the counterpart may place a low priority on reporting during emergency operations. (CRS, Angola Emergency Operational Plan, project document) (CRS, Sudan Emergency Agriculture, project document.)

Gender issues: Very few seed projects address issues of gender. This does not mean that the NGO does not have special projects dealing with women's groups or targeting women, such as income development programs. However, very few NGOs appropriately integrate the needs of women in a dual headed household into their projects. Very rarely are men and women interviewed separately during assessments, and usually the needs of women are not heard. In situations where there are two heads of household, NGOs will almost invariably choose to work with the men. If there is only one head of household, for example a widow, then the NGO will work through her. (Turk, IRC Somalia)

This is unfortunate, because in the few cases where projects do work with women, they obtain information that would otherwise be unavailable to them. The New Sudan Council of Churches (NSCC) routinely makes a point of interviewing women away from their husbands. According to Nelson Lokombu of the NSCC, men will often give politicized answers to questions in attempts to squeeze as much as possible from the NGO. Women, on the other hand, are the ones who are doing the actual food preparation. They know what the preferred seeds are for their flavor and cooking properties. In some cases, women may even request that the NGO not distribute a certain seed because it doesn't taste good or takes too long to boil. (Nelson Lokombu, NSCC)

Throughout East Africa, it is usually women who will save the seed, and from the saved seed, will chose the best seed to be planted during the following season. Yet, it is usually the male head of household who is registered with the NGO to receive seed for an un-targeted distribution.

Endnotes

1. The one possible exception to this is Ethiopia. All NGOs must be registered with the DPPC which assigns each an area of the country to operate in. Some NGOs may remain in the same area long enough to establish baseline census data.

Section VII.
Matching Varieties to Ecological Conditions

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1. Opportunities and constraints for matching varieties to agroecological conditions.

Generally the farmers who need seeds for disaster mitigation or recovery have few assets other than know-how, a small plot of land, and the labor of a few family members. In the GHA many such farmers have suffered recurring disasters, both drought and war. Even after recovery assistance is over, they will likely not have adequate income or credit to regularly purchase seeds, fertilizers, pesticides, irrigation water, or other inputs. Typically they will remain vulnerable to catastrophic crop failure and will place high priority on minimizing that risk.

Agencies providing SDMR need to assure that the seeds they distribute to such farmers are well adapted to the site-specific vagaries of climate, soil constraints, and pests. The farmers in most cases keep seeds from year to year, so open-pollinated varieties are generally preferable to hybrids. Farmer-selected traditional varieties from the same site are likely to be well matched to agroecological conditions, and thus are likely to provide good protection from risks. Sometimes a relief agency can get seed of those varieties from within the disaster area where seeds are to be distributed, or from immediately adjacent areas that have the same ecological conditions.

Where farmers have been using poorly adapted seeds, or where available seeds of traditional farmer-selected varieties are not adequate for SDMR, then the relief agencies must identify and procure seed of other varieties. To avoid increasing the farmers' vulnerability, these must be varieties that are well adapted to the climate, soil, moisture, humidity, pests (birds, insects, rodents), diseases, and cultural preferences at the site where the seeds are to be planted.

The best way to identify well adapted varieties is to seek the advice of farmers and agricultural agents and scientists who know the site well. In some cases, the farmers know the varieties only by local names which are not used in places where adequate seeds can be procured. And in some cases scientists who know the site cannot be located during or soon after a disaster. In these cases, the relief agency should try to learn all it can about ecological conditions at the site, and take this information to agricultural scientists who are specialists on the target crops. Such scientists can be located at national and international agricultural research centers. They can assess the agroecological conditions against what they know about the various varieties of the target crop.

Agricultural science has made great achievements developing improved varieties and assessing their performance in normal years. Unfortunately, several issues very important to SDMR have been neglected by researchers. These include:

- Identity and geographic scope of traditional farmer-selected varieties.
- Performance of farmer-selected varieties under various agroecological conditions.
- Performance of improved varieties under low input and high stress conditions.
- Names used in the seed trade for improved and traditional varieties that have been tested, and the extent to which those commercially named varieties are consistent with tested varieties from which they were derived.

Agricultural researchers can be expected to give helpful information about improved varieties that have been tested and are demonstrated to be adapted to conditions of rainfall, elevation, and soil that are similar to the conditions at the SDMR site. Some exceptional scientists in the region are also very knowledgeable about which varieties are used by farmers in which places. Most such information has either not been published or is in such obscure media that only the researchers can get it. The research organizations generally do a poor job of producing pragmatic information in useful formats and making it available to seed growers, seed dealers, or agencies that assist farmers directly. However, individual scientists are usually highly motivated to share what they know with relief agencies and others who seek them out.

In a few recent cases, research organizations have actively participated in SDMR. Their contrition has not only been to advise on what varieties are adapted to SDMR site conditions. Equally important has been to advise relief agencies on what varieties are definitely not suitable for the site conditions, thus helping the agencies to avoid causing farmers to waste their scare land and labor on seeds that will not give a crop. For example, CGIAR and NARI scientists Seeds of Hope project convinced a relief agency to cancel its plans to order tons of sorghum seed of a variety that would not have produced grain at the altitude where the seed was to be distributed.

A complementary strategy to seeking advice from agricultural researchers is to commission seed procurement and seed multiplication in places that have ecological conditions similar to the SDMR site. This can be planned using maps of agroecological conditions.

The climate and soil conditions in the GHA do not occur in regular bands across the landscape, as is the case in West Africa or the United States. Because of the complicated topography and the climate complications of the intertropical convergence zone, the soil and climate pattern occurs as a mosaic, with many small sites that are agriculturally different from the larger regions where they are located. This makes mapping climate data difficult, as parameters like temperature cannot be simply interpolated between climate recording stations.

Recently, however, advances in geographic information system (GIS) and climate modeling have enabled geographers to use data from the substantial network of weather stations in the GHA to produce maps that depict the mosaic pattern of temperature, rainfall, and potential evapotranspiration at a scale considered accurate to a level of a 5 kilometer by 5 kilometer grid.

(This means that the maps do not show the climate parameters for areas smaller than 25 square kilometers that occur within larger areas with different conditions.)

The maps of agro-ecosystems for the GHA now available have several major drawbacks. First, soil data are not available in a form that allows comparison across national boundaries at scale larger than 1 to 5 million, which is too small for SDMR purposes. Second, even at 5 kilometers by 5 kilometers, the scale of the maps is too small to reveal site-specific variation that occurs in many of the parts of GHA that are vulnerable to disaster. Third, the temperature, rainfall, and evapotranspiration models and maps now available show 30-year average monthly measures, but average conditions seldom occur. Farmers must use varieties that are adapted to the vagaries of climate, not the climate averages.

While the precision of climate and soil information on GIS produced maps is a limiting factor, the data from agricultural research organizations on the agroecological conditions to which varieties are adapted is even more limiting. For many decades, researchers in the GHA have used altitude as a surrogate for temperature when they report on variety adaptation. Altitude data are useful, but actual temperature data would be far more useful, especially for an agency considering purchasing seeds for SDMR in another country of the region, where the temperature to altitude correlation is different. Another problem is that variety screening and testing results are not published with the locations (longitude and latitude) and years of the tests.

In spite of all these caveats, the maps are useful when the relief agency is trying to identify either named and tested varieties or sites to buy seeds of unnamed varieties. The maps can significantly enrich the dialog with agricultural scientists, who, with the maps at hand, are more likely to recall important information relevant to the adaptation of varieties. Therefore, this section of the report includes three maps depicting the agroclimate zones used by researchers for three crops: beans, maize, and sorghum. Improved varieties that are matched to the zones are named. Finally, maps of agroclimate parameters are provided that are not specific to particular crops. The mosaic pattern of climate conditions is readily apparent in the maps which were produced using the 5 kilometer by 5 kilometer grided data.

2. Beans

Agroecozones have been matched to bean varieties for Africa by researchers in CIAT and cooperating NARIs. The zones are termed African Bean Environments (AFBE) and are described in detail in a paper by Wortman and Allan[1] that can be obtained from CIAT. Eight of the zones are exist in the Greater Horn of Africa countries. Definitions for those eight are described in the following table and in a diagram following the table. The bean varieties that match each zone are indicated in a table following the diagram. Following that table, the zones are drawn on a map using elevation contours and 30-year average monthly rainfall data.

Agroecozones for Phaseolus Bean Varieties in the Greater Horn of Africa

African Bean Environments (per Wortman and Allan, 1994)	**Parameters of the zones**
AFBE 1	High elevation. (> 1500 masl). Wet. (> 400 mm rain in best 3 months growing season). Low latitude.(-7° to equator to +7°). Soil not acid (pH>5.5). Two growing seasons
AFBE 2	High elevation. (> 1500 masl). Wet. (> 400 mm rain in best 3 months growing season). Low latitude. (-7° to equator to +7°). Acid soil (pH<5.5). Two growing seasons.
AFBE 3	High elevation. (> 1500 masl). Wet. (> 400 mm rain in best 3 months growing season). Mid latitude (below -7° or above +7°). Soil not acid (pH>5.5). One growing season.
AFBE 6	Mid elevation (1000 to 1500 masl) Wet. (> 400 mm rain in best 3 months growing season). Low latitude.(-7° to equator to +7°).
AFBE 7	Mid elevation (1000 to 1500 masl) Wet. (> 400 mm rain in best 3 months growing season). Mid latitude (below -7° or above +7°).
AFBE 8	Mid elevation (1000 to 1500 masl) Dry. (< 400 mm rain in best 3 months growing season). Low latitude.(-7° to equator to +7°).
AFBE 9	Mid elevation (1000 to 1500 masl) Dry. (< 400 mm rain in best 3 months growing season). Mid latitude (below -7° or above +7°).
AFBE 13	Low elevation (below 1000 masl). Low latitude.(-7° to equator to +7°).

Phaseolus Bean Agroecozones in the GHA

		Rain During Growing Season				
		Less than 400 mm		More than 400 mm		
		Latitude		Latitude		
		Middle (Below -7° or above +7°)	Low (Between -7° to +7°)	Middle (Below -7° or above) +7°	Low (Between -7° to +7°)	
					Soil acidity	
					>5.5	<5.5
Elevation	Over 1500 m.a.s.l.			AFBE3	AFBE1	AFBE2
	1000 to 1500	AFBE9	AFBE8	AFBE7	AFBEB6	
	Below 1000	AFBE13 (Low latitude only, i.e. Between -7° to +7°)				

Notes:

- Parameters for AFBE 1 and 2 are the same, except that AFBE 2 has more acid soil.
- Parameters for AFBE 3 are the same as for AFBE 1 and 2, except that 3 on non-acid soil farther from the equator while AFBE 1 and 2 are closer to the equator.
- AFBE 6 and 7 are the only wet, middle-elevation bean zones indicated for the GHA. They are separated by the latitude difference. AFBE 6 is nearer the equator; AFBE 7 is further from the equator.
- AFBE 8 and 9 are the only dry middle-elevation bean zones indicated for the GHA. They are separated by the latitude difference. AFBE 8 is nearer the equator; AFBE 9 is further from the equator.
- AFBE 13 is the only low-altitude (below 1000 meters) bean zone indicated for the GHA.

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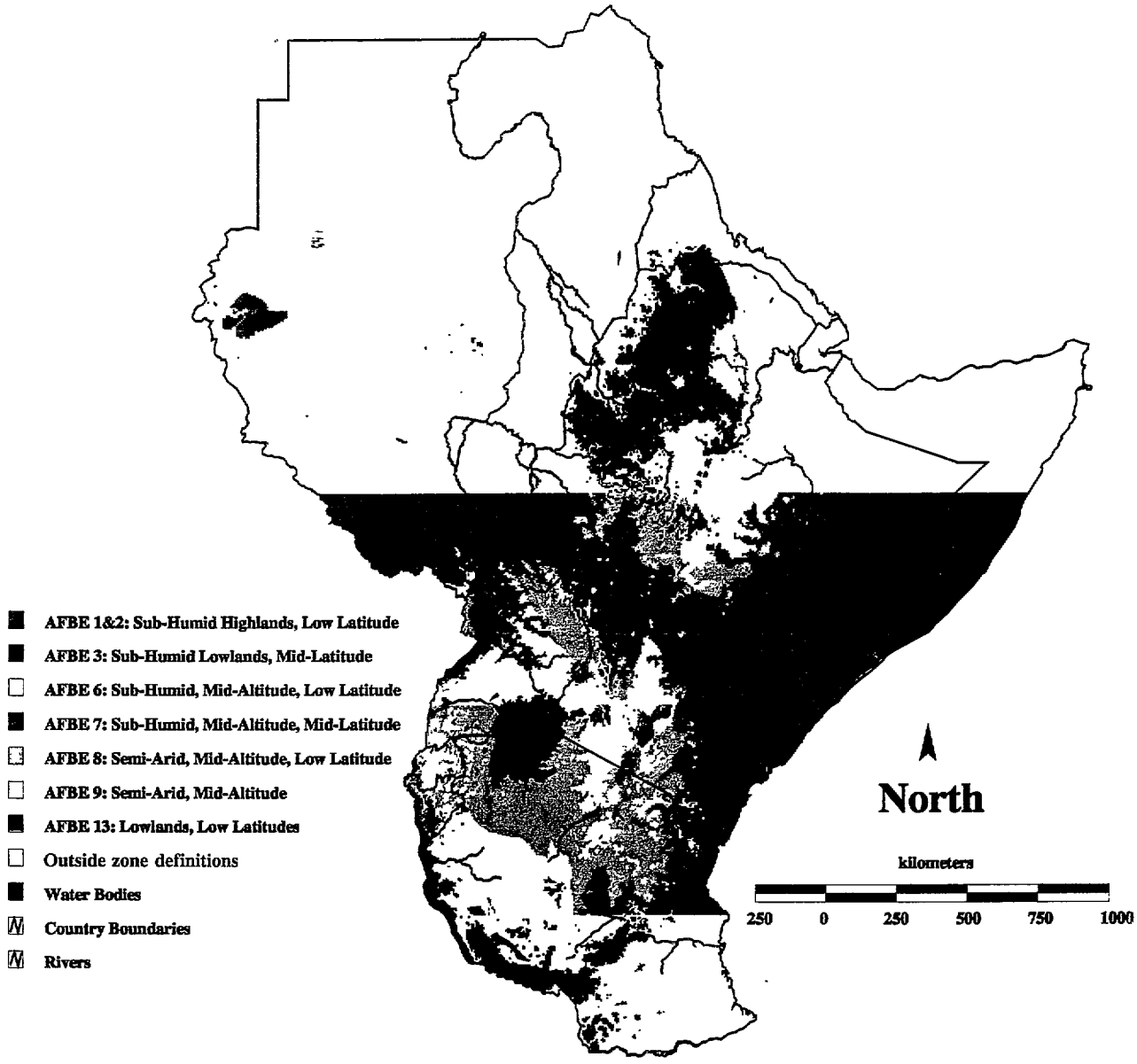
Phaseolus Bean Variety Zones
in the Greater Horn of Africa



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AFBE 1&2: Sub-Humid Highlands, Low-Latitude (<7 degrees), Precipitation above 400mm, Elevation above 1500m
AFBE 3: Sub-Humid Lowlands, Mid-Latitude (>7 degrees), Precipitation above 400mm, Elevation above 1500m
AFBE 6: Sub-Humid Areas, Mid-Altitude, Low-Latitude (<7 degrees), Precipitation above 400mm, Elev. 1000-1500m
AFBE 7: Sub-Humid Areas, Mid-Altitude, Mid-Latitude (>7 degrees), Precipitation above 400mm, Elev. 1000-1500m
AFBE 8: Semi-Arid Areas, Mid-Altitude, Low-Latitude (<7 degrees), Precipitation below 400mm, Elev. 1000-1500m
AFBE 9: Semi-Arid Areas, Mid-Altitude, Mid-Latitude (>7 degrees), Precipitation below 400mm, Elev. 1000-1500m
AFBE 13: Lowlands, Low Latitudes (<7 degrees), Any precipitation, Elevation below 1000m

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Map created by Chuck Maxa, GIS Analyst, Chemonics International, for USAID / OFDA, March 1996
Data provided by the International Center for Research in Agroforestry, Nairobi Kenya.
(J.D. Corbett, R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995)

3. Sorghum

Four agroecozones have been matched to sorghum varieties for the GHA by researchers in ICRISAT and cooperating NARIs. The zones are delimited by upper and lower limits of average annual rainfall and by upper and lower elevation. Definitions for those zones are described in the next table and in a diagram following the table. As the diagram and the map following it indicate, large areas where sorghum can grow are not yet included in this zonation scheme. It is expected that ICRISAT will continue to develop the zone-description approach. The information in these tables was provided by Dr. Sam Mukuru at ICRISAT in Nairobi. Personnel implementing SDMR should contact sorghum experts in the NARI of the country where they are operating as well as Dr. Mukuru and his colleagues at ICRISAT for information developed since these tables were compiled, and especially for more site specific information.

Agroecozones for sorghum varieties in the GHA

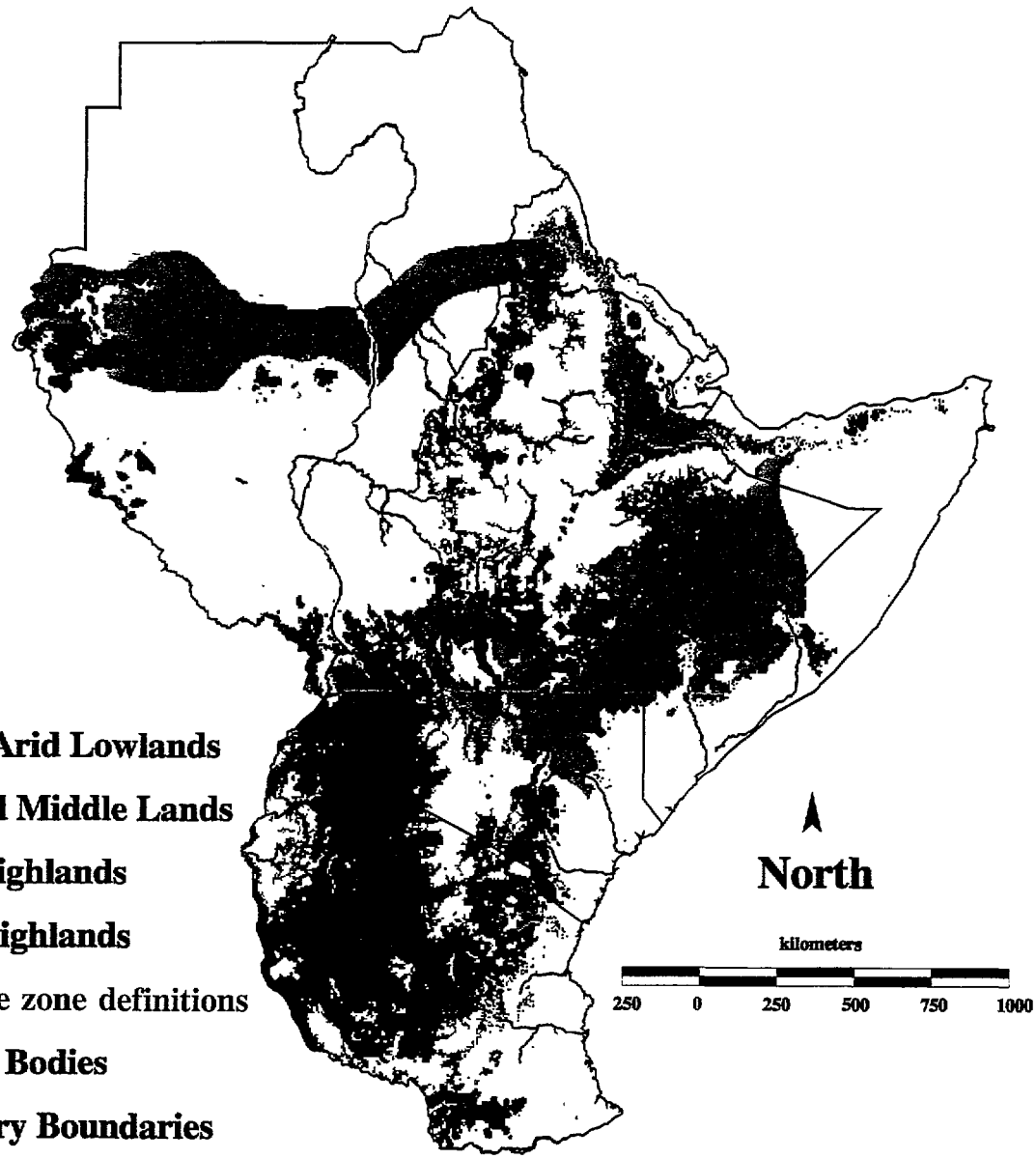
Zone	Meters above sea level	Average annual rainfall
Humid	0 to 1500	More than 500 mm
Semi-arid lowlands	0 to 100	250 to 500
Cool dry highlands	1500 to 2000	Below 500 mm
Cool humid highlands	1500 to 2000	More than 500 mm

IMPROVED SORGHUM VARIETIES RELEASED IN THE GHA

COUNTRY & VARIETIES	SORGHUM ZONES	DAYS TO MATURITY	NOTES
BURUNDI			
5Dx160	Semi-arid to humid lowlands	120-130	Brown seed
Gambella 1107	Semi-arid to humid lowlands <1600masl	120-130	White seed
ETHIOPIA			
Seredo	Semi-arid lowlands	115-120	Brown seed, soft endosperm, semi compact head
Dinkmash	Semi-arid lowlands <1600masl	93-120	Rainfall <600mm, white seed
IS 9302	Cool midlands 1600-1900masl	117-150	Rainfall >900mm, red seed, no testa
Alemaya 70	Cool humid highlands	150-160	Rainfall 870-900mm
ET 2752	Cool humid highlands 1900-2000masl	160-170	Rainfall 870-900mm
KENYA			
Serena	Humid midlands	110-115	Brown seed, semi compact head
Seredo	Humid midlands	115-120	Brown seed, semi compact head
Kari/Mtama 1	Semi-arid lowlands	90-100	White seed, drought tolerant, semi-compact head
IS 76	Semi-arid lowlands	85-95	White seed, semi compact head
E1291	Cool dry highlands	150-160	Brown seed, semi compact head
E6518	Cool dry highlands	270-280	Brown seed, loose head

COUNTRY & VARIETIES	SORGHUM ZONES	DAYS TO MATURITY	NOTES
RWANDA			
5DXx160	Semi-arid to humid lowlands	120-130	Brown seed
SRV 1	Humid lowlands	125-140	Brown seed
SRV 157	Humid midlands	125-140	Brown seed
Tura	Humid midlands	125-140	Brown seed
Amasugi	Humid midlands	125-140	Brown seed
Ikinyaruka	Humid midlands	125-140	Brown seed
BM 1	Cool humid highlands	150-170	Brown seed
BM 27	Cool humid highlands	150-170	Brown seed
MB 10	Cool humid highlands	150-170	Brown seed
SOMALIA			
PP 290	Dry lowlands	100-120	White seed
SUDAN			
Hageen Dura 1	Dry lowlands	100-120	Hybrid, white seed
Mugawim Buda 1 (SRN 39)	Dry lowlands	100-125	Variety, white seed tolerant to striga
Mugawim Buda 2 (IS 9830)	Dry lowlands	85-105	Variety, chalky white seed tolerant to striga
Feterita Wad Ahmed (CR35-18)	Dry lowlands	100-120	Variety, chalky white seed
Ingazi (M90393)	Dry lowlands	100-120	Variety, chalky white seed
TANZANIA			
Tegemeo	<1500masl	105-115	Rainfall 300-650mm
UGANDA			
Serena	Humid midlands	110-115	Brown seed, semi-compact head
Seredo	Humid midlands	115-120	brown seed, semi-compact head

Sorghum Agroecozones
in the Greater Horn of Africa



- Semi-Arid Lowlands
- Humid Middle Lands
- Dry Highlands
- Wet Highlands
- Outside zone definitions
- Water Bodies
- Country Boundaries
- Rivers

Semi-Arid Lowlands, 250-500mm Precipitation, 200-1200m Elevation

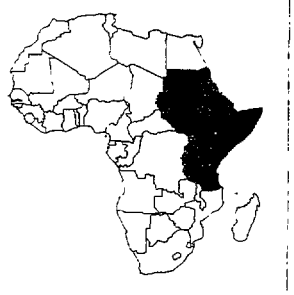
Humid Middle Lands, above 500mm Precipitation, 800-1500m Elevation

Cold Dry Highlands, 300-500mm Precipitation, 1500-2000m Elevation

Cold Wet Highlands, above 500mm Precipitation, 1500-2000m Elevation

Non-Arable Land, Precipitation not in ranges, all other Elevations

Greater Horn Countries



Map created by Chuck Maxa, GIS Analyst, Chemonics International, for USAID / OFDA, Mar. 1996

Data provided by the International Center for Research in Agroforestry, Nairobi Kenya.

(J.D. Corbett, R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995)

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4. Maize

CIMMYT and NARI scientists working in the GHA region recognize five agroecozones for maize varieties. These are characterized by altitude and average rainfall. As indicated in the first table below. The second table below indicates varieties of maize that have been released by agricultural research organizations in the GHA and the zones they are adapted to. Because most farmers in dire need of SDMR can be expected to keep seed from year to year whenever they can, open pollinated varieties are preferred over hybrid varieties. The hybrid varieties are unlikely to maintain their adaptation and other genetic characteristics when grown in subsequent generations from farmer-saved seed.

Since the characterization provides average rain rather than upper and lower limits of rain, the zones cannot be precisely mapped. The map shown after the next table is based on altitude zones with the rainfall limits placed approximately one standard deviation above and below the mean rainfall figures, using 30-year average monthly rain data.

Maize Agro-Ecological Zones in the GHA

Zone	Meters above sea level	Average rainfall per Year
Lowlands	0 to 1000	600 mm
Mid-altitude dry	1000 to 1600	325 mm
Mid-altitude moist	1000 to 1600	790 mm
Transitional Highlands	1600 to 1800	850 mm
Highlands	Above 1800	670 mm

Improved Open Pollinated Maize Varieties Released in the GHA

COUNTRY/ VARIETIES	MAIZE ZONE	DAYS TO MATURITY	NOTES
BURUNDI			
Mugamba 1	Transition/Highland		similar to Pool 9a
Lambo-1	Lowland 800masl		from Population 43
ETHIOPIA			
Beletech	Transition 1500-2000	150	Rainfall 800-1200mm
UCB	Highland 1700-2000	163	Rainfall 1000-2000 mm, very tall, not widely adapted
Alemaya	MidAlt Moist 1500-2000masl	160	Rainfall >900mm
A511	MidAlt Dry 1000-1800masl	150	Rainfall 600-900mm, from Kenya 511
Katumani	MidAlt Dry below 1500masl	110	Rainfall >600mm
KENYA			
DLC 1	MidAltDry 1000-1900masl	90	
Katamuni	MidAlt Dry	90	
Coast Composite	Lowlands below 1000masl	120	heat tolerant, leaf rust tolerant
RWANDA			
Mamasa	Highland		(Pool 8a)
Tamira	Highland	180	(Pool 9a)
ZM 607	MidAlt Moist	130	maize streak virus resistant
SOMALIA			
Afgoi Composite	Lowland	110-120	
Somtux	Lowland	110-120	

Improved Open Pollinated Maize Varieties Released in the GHA

COUNTRY/ VARIETIES	MAIZE ZONE	DAYS TO MATURITY	NOTES
TANZANIA			
TMV1 (Tuxpeno)	Lowland below 900masl	120	
Kito	MidAlt Dry	90	(Katumani)
Staha	Lowland below 900masl	110-120	Rainfall 500-850mm
Kilimo	MidAltDry 900-1700masl	110-130	Rainfall >850mm
UGANDA			
Kwanda	MidAlt Moist	120-130	some maize streak virus tolerance
Longi 1	MidAlt Moist	110-120	

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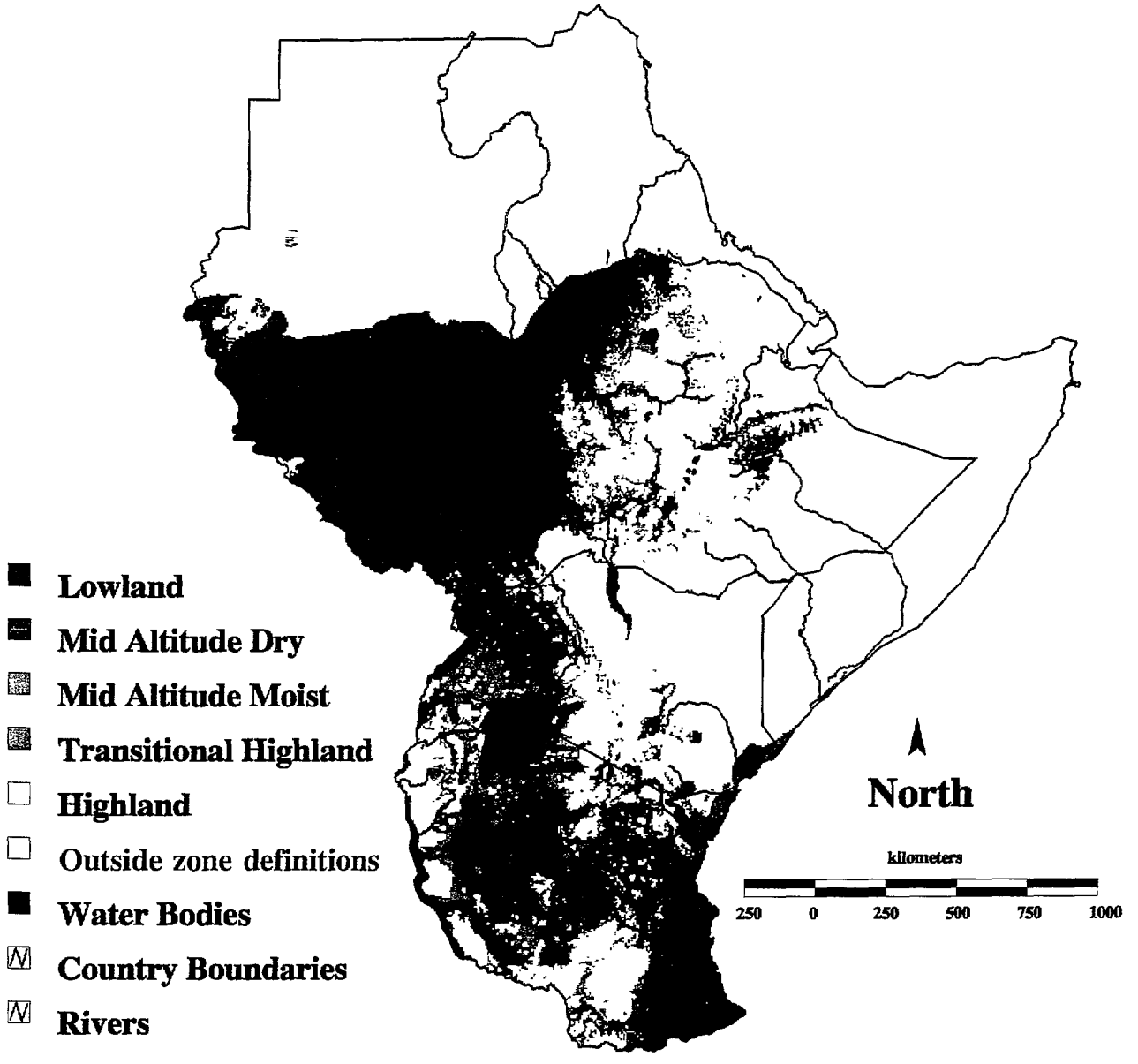
Maize Agroecozones
in the Greater Horn of Africa



Lowlands, 305-1033mm Precipitation, 0-1000m Elevation
Mid Altitude Dry Lands, 203-625mm Precipitation, 1000-1600m Elevation
Mid Altitude Moist Lands, 550-1100mm Precipitation, 1000-1600m Elevation
Transitional Highlands, 403-1225mm Precipitation, 1600-1800m Elevation
Highlands, 343-1143mm Precipitation, 1800m-Maximum Elevation
Non-Arable Lands, Precipitation out of range, any Elevation

Greater Horn Countries

CHEMONICS

Map created by Chuck Maxa, GIS Analyst, Chemonics International, for USAID / OFDA, Feb. 1996
Data provided by the International Center for Research in Agroforestry, Nairobi Kenya.
(J.D. Corbett, R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995)

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5. Potatoes

Many "Irish" potato varieties have a wide range of adaptation in the GHA, growing well from 1,000 meters up over 3,000 meters. A farmers' choice will depend on a balance between vegetative period, storage dormancy period (so that sprouted seed are available at planting time), yield, acceptability in different markets, and other features. Other things being equal, bacterial wilt becomes a more serious constraint under warmer conditions, so tolerance to that disease becomes more critical at lower elevations. It is harder to store seed potatoes in warmer places, because of pests, storage rots, and too-early sprouting, so seed supply is most critical at the warmer sites. The differences among varieties do not lend themselves to grouping potatoes into "high-elevation varieties" and mid-elevation varieties", as one does for sorghum and other crops, so maps and diagrams of agroecozones are not provided in this report. Information in the following table was provided by Dr. Peter Ewell of CIP[3].

Characteristics of Potato Varieties Released in PRAPAC Countries

No	Common Name (Yr 1st release)	Prog*	Clone	Source	Tuber Size	Skin Color	Flesh Color	Tuber Shape	Eye Depth	Vegetative Cycle (days)	Seed Dormancy (weeks)	Resistance/Tolerance		Stora-bility
												LB	BW	
1	Sangema (1980)	B, R, U, Z	800949	Mexico	Medium-large	Pink	Yellow	Oval-oblong	Moderate	100-115	10-12	Toler.	Suscep.	Good
2	Cruza 148 (1982) (Ndinamagara)	R, Z, U, B	720118	Mexico	Medium	Yellow	Yellow w/Pink	Oval	Shallow	110-130	6-8	Toler.	Toler.	Fair
3	Uganda 11 (1981) (Rutuku, 1970s) (Gahinga, 1984)	B U R	720097	Mexico	Large	Light red	Cream	Oval-round	Shallow	120-130	11-12	Mod. Toler.	Suscep.	Poor
4	Muruta	B	380506.1	CIP	Large	White	White	Round	Semi-deep	100	12	Suscep.	Suscep.	Good
5	Kinigi (1981)	B, R, Z	378699.2	CIP-Rwanda	Medium-large	Light red	Yellow	Oval-round	Deep, w/red	120-140	16+	Suscep.	Suscep.	Good
6	Muziranzara (1982)	B	378711.5	CIP-Burundi	Medium	Light yellow	White	Round	Very shallow	100-115	8-10	Resist.	Suscep.	Good
7	Kenya Baraka (1977)	B, U	800978	Scotland	Medium	Russet	Pale Yellow	Oval	Shallow	100-110	10-12	Mod. Toler.	Suscep.	Good
8	Nseko (1984)	R, Z	378699.2	Mexico	Medium-large	Light red	Light Yellow	Round	Slightly indented	100-140	16	Resist	Suscep.	Fair
9	Montsama (1980)	R, Z	720049	CIP	Medium	Red	Yellow	Round-oval	Shallow to moderate	90-105	8	Mod. Toler.	Suscep.	Good
10	Petero (1984)	R	330083.2	CIP	Large	Red	Yellow	Oval to	Shallow	120-130	16	Mod. Toler.	Toler.	Good
11	Gasore (1984)	R	Graso-28	Belgium	Medium	Red	Yellow	Oblong	Shallow	80-90	4-8	Suscep.	Suscep.	Good

Characteristics of Potato Varieties Released in PRAPAC Countries

No	Common Name (Yr 1st release)	Prog*	Clone	Source	Tuber Size	Skin Color	Flesh Color	Tuber Shape	Eye Depth	Vegetative Cycle (days)	Seed Dormancy (weeks)	Resistance/Tolerance		Stora-bility
												LB	BW	
12	Kirundo (1989)	R	8212-5	Rwanda	Large	Cream	Yellow-cream	Large	Shallow	100-110	6	Resist.	Toler.	Fairly good
13	Marita	Z				White		Oblong	Shallow			Resist.	Toler.	
14	Seseni	Z	800955	Zaire	Large	Yellow-white	White	Oblong	Shallow	100-120		Resist.	Suscep.	Fairly good
15	Victoria (1991)	U	381381.5	CIP	Large	Red	Light yellow	Round	Medium	100-110	6-8	Resist.	Toler.	Good
16	Kisoro (1991)	U	381379.9	CIP	Medium-large	White	Cream	Oval-long	Shallow	110-120	8	Resist.	Toler.	Good
17	Kabale (1991)	U	374080.5	CIP	Large	Purple-white	White	Round	Medium-deep	120-125	8-10	Mod. Resist.	Suscep.	Excel-lent
18	Mabondo (1988)	R	8212-6	Rwanda	Large	Red-white	Yellow	Round	Shallow	>120	7-8	Resist.	Toler.	Good
19	Kirundo (1989)	R	8212-5	Rwanda	Medium	White	Yellow-cream	Round	Shallow	100-110	6-7	Resist.	Toler.	Good
20	Ngunda (1992)	R	381395.1	CIP	Large	White	Yellow	Round	Shallow	100-120	10-11	Resist.	Toler.	Good
21	Mizero (1992)	R	386003.2	CIP	Medium	White w/ Violet Eyes	White	Round	Deep	100-120	8	Resist.	Toler.	Fairly good
22	Gikungu (1992)	R	381233.2	CIP	Large	Red	Yellow	Oval	Moderate	100-120	10	Resist.	Toler.	Fairly good

Characteristics of Potato Varieties Released in PRAPAC Countries (Continued)

No	Common Name (Yr 1st release)	Prog*	Clone	Source	Tuber Size	Skin Color	Flesh Color	Tuber Shape	Eye Depth	Vegetative Cycle (days)	Seed Dormancy (weeks)	Resistance/Tolerance		Stora-bility
												LB	BW	
12	Kirundo (1989)	R	8212-5	Rwanda	Large	Cream	Yellow-cream	Large	Shallow	100-110	6	Resist.	Toler.	Fairly good
13	Marita	Z				White		Oblong	Shallow			Resist.	Toler.	
14	Seseni	Z	800955	Zaire	Large	Yellow-white	White	Oblong	Shallow	100-120		Resist.	Suscep.	Fairly good
15	Victoria (1991)	U	381381.5	CIP	Large	Red	Light yellow	Round	Medium	100-110	6-8	Resist.	Toler.	Good
16	Kisoro (1991)	U	381379.9	CIP	Medium-large	White	Cream	Oval-long	Shallow	110-120	8	Resist.	Toler.	Good
17	Kabale (1991)	U	374080.5	CIP	Large	Purple-white	White	Round	Medium-deep	120-125	8-10	Mod. Resist.	Suscep.	Excel-lent
18	Mabondo (1988)	R	8212-6	Rwanda	Large	Red-white	Yellow	Round	Shallow	>120	7-8	Resist.	Toler.	Good
19	Kirundo (1989)	R	8212-5	Rwanda	Medium	White	Yellow-cream	Round	Shallow	100-110	6-7	Resist.	Toler.	Good
20	Ngunda (1992)	R	381395.1	CIP	Large	White	Yellow	Round	Shallow	100-120	10-11	Resist.	Toler.	Good
21	Mizero (1992)	R	386003.2	CIP	Medium	White w/ Violet Eyes	White	Round	Deep	100-120	8	Resist.	Toler.	Fairly good
22	Gikungu (1992)	R	381233.2	CIP	Large	Red	Yellow	Oval	Moderate	100-120	10	Resist.	Toler.	Fairly good

6. Additional Improved Varieties Released in the GHA

Additional Improved Varieties Released in the GHA			
COUNTRY, CROP, and VARIETY	**AGRO-ECO ZONE altitude & rainfall**	**DAYS TO MATURITY**	**NOTES**
ETHIOPIA Wheat			
Enkoy	1850-2800masl 500-800mm	123-132	Susceptible to stem rust particularly below 2200masl
K 6290	1800-2400masl 450-700mm	126-134	
K6295 4A	1800-2400masl 500-800mm	127-134	
ET13	1850-2900masl >600mm	132-143	
Pavon 76	Broad adapt >600mm	100-126	
Dashen	2200-2900masl >600mm	140-145	Susceptible to stripe rust particularly above 2300masl
HAR 1709	1900-2800masl >600mm	120-140	Recent release
HAR 710	200-2500masl >550	120-140	Recent release
HAR 1685	1900-2800masl >600	120-140	Recent release
Barley (food type)			
ARDU 12-60B	2200-2800masl 700-1000mm		
HB 42	>2300masl 700-1000mm		

Additional Improved Varieties Released in the GHA

COUNTRY, CROP, and VARIETY	AGRO-ECO ZONE altitude & rainfall	DAYS TO MATURITY	NOTES
Teff			
CR 37	1860-2000masl 150-500mm	82-90	Early maturing and useful for SDMR
DZ-01-196	1800-2400masl 300-700mm	80-113	
DZ-01-354	1600-2400masl 300-700mm		
DZ-01-787	1800-2000masl 400-700mm	90-130	
DZ-01-99	1400-2400masl 300-700mm	80-130	
UGANDA Cassava			
Nase 1	Mid altitude moist	12 months	cassava mosiac resistant, recent release
Nase 2	Mid altitude moist	12 months	cassava mosiac resistant, recent release
Migyera	Mid altitude moist	12 months	cassava mosiac resistant, recent release
Finger Millet			
P224	Mid alt moist >500mm	130-140	Adapted to acid soils, used also in Kenya, Ethiopia, Tanzania
Peanuts			
Red Beauty	Mid altitude moist >500mm	90	Widely used in SDMR

8. Maps of Agroecological Information

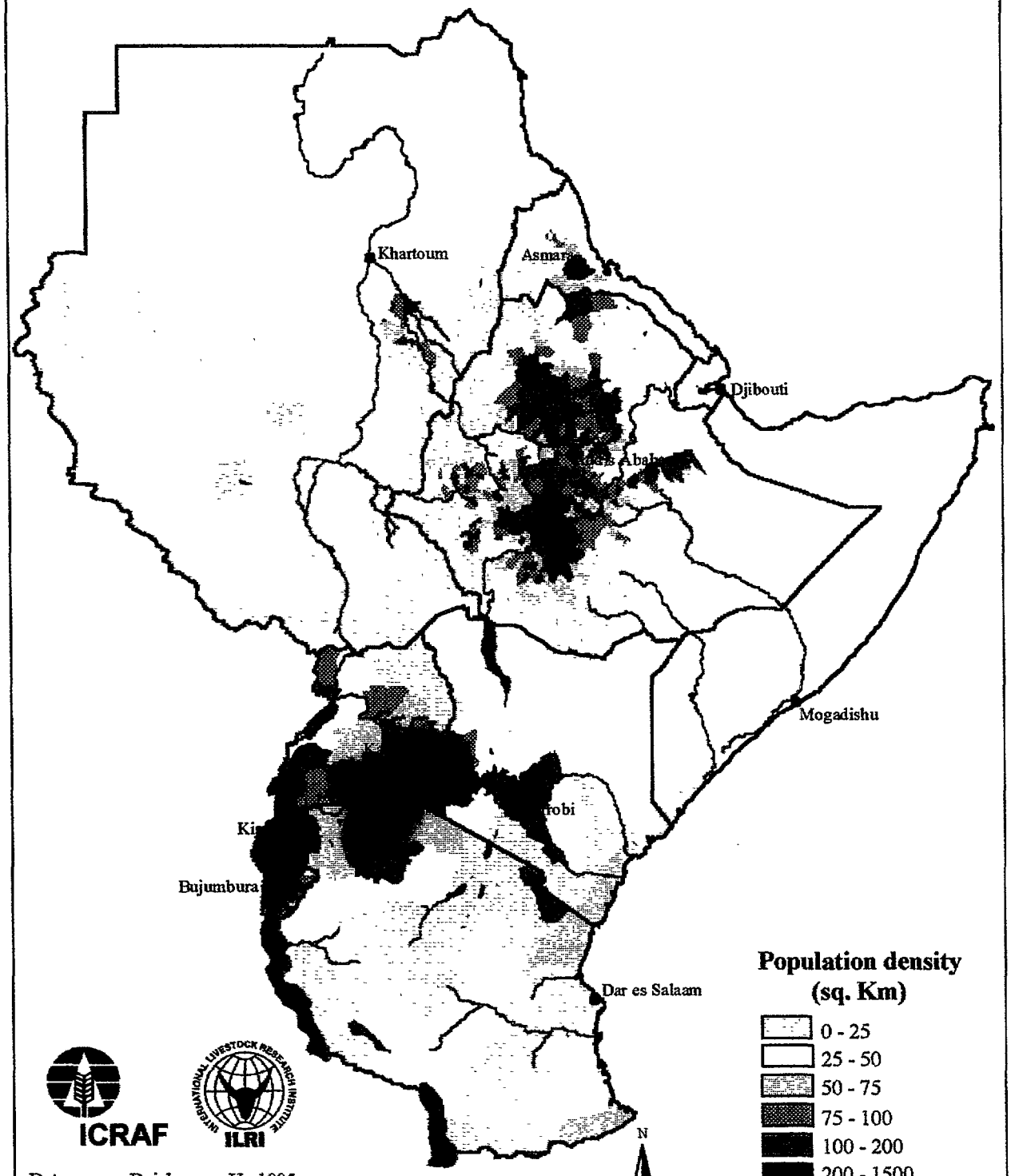
The maps on the following pages were prepared by the geographers at ICRAF for this study. The scale is too small for SDMR decision making. They are included here to illustrate the complexity of GHA agroecology, which must be accommodated in the choice of crop variety seeds, and to encourage SDMR implementing agencies to seek these types of data, from ICRAF or other sources, at a lager scale to discern agroecological parameters for the sites of their SDMR activities and for nearby sites where agroecological conditions are similar and seeds might be procured.

Endnotes

1. Wortmann, C.S. and D.J. Allen. 1994. *African Bean Production Environments: their definition, characteristics and constraints.* Occasional Publication Series No. 11. Network on Bean Research in Africa. The information on bean agroecozones (AFBEs) in this paper is from that paper. Additional information on which varieties are suitable for which zones is provided by Dr. Charles S. Wortman at the CIAT Regional Program on Beans in Eastern Africa, P.O. Box 6247, Kampala. Further information is available from: Pan-African Coordinator, CIAT, P.O. Box 23294, Dar es Salaam, Tanzania.

3. Dr. Peter Ewell of CIP provided the information on potato varieties in correspondence dated December 5, 1995. His email address is P.EWELL@CGNET.COM. Dr. Ewel also provides the following contact for more information on potatoes: Dr. N.B. Lutaladio, Coordinator, PRAPACE Network for Potato and Sweetpotato, P.O. Box 22274, Kampala, Uganda

Human Population Density



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ILRI

Data source: Deichmann, U., 1995.
National Center for Geographic Information and Analysis,
Santa Barbara, CA.

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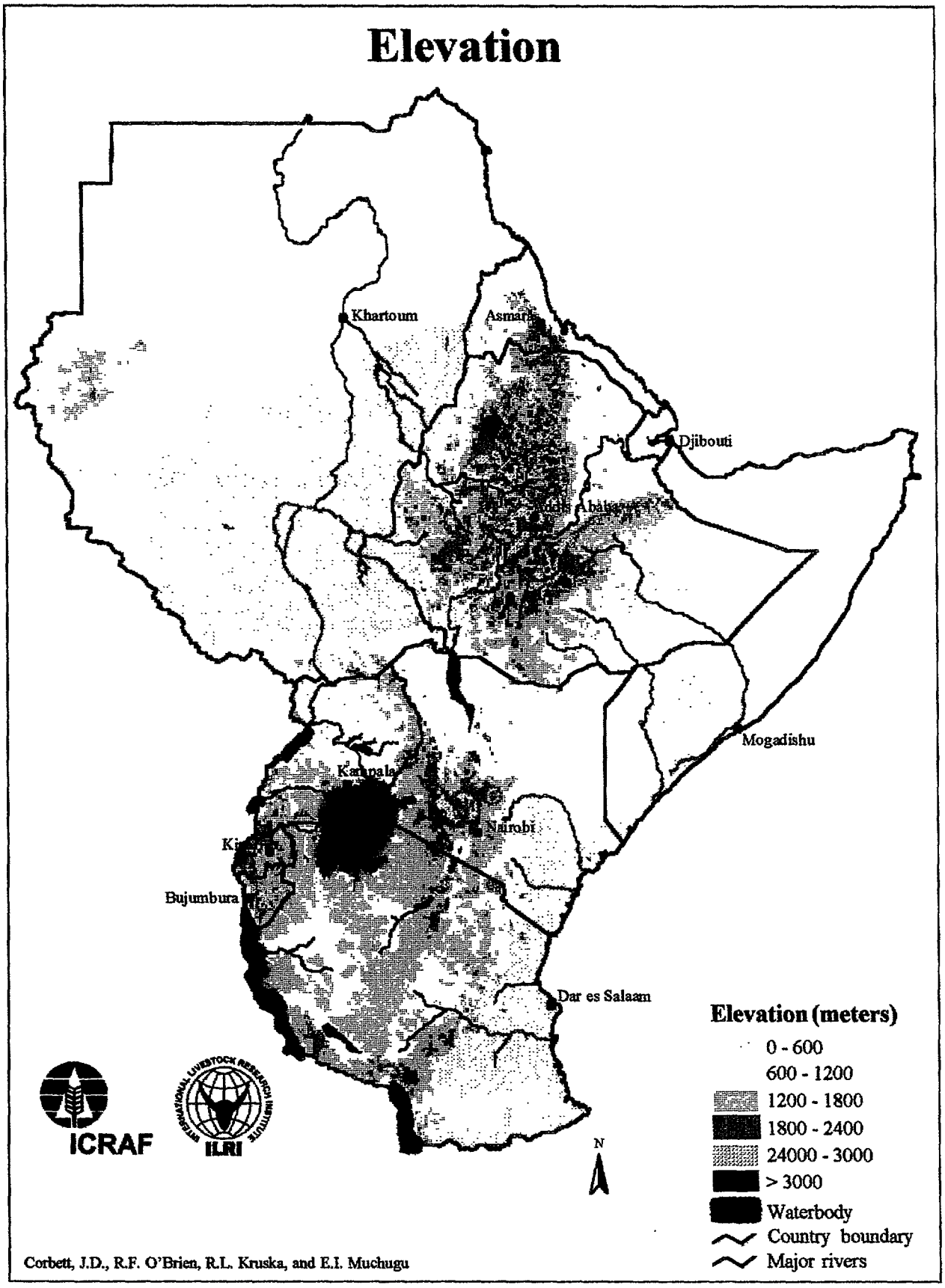
Elevation



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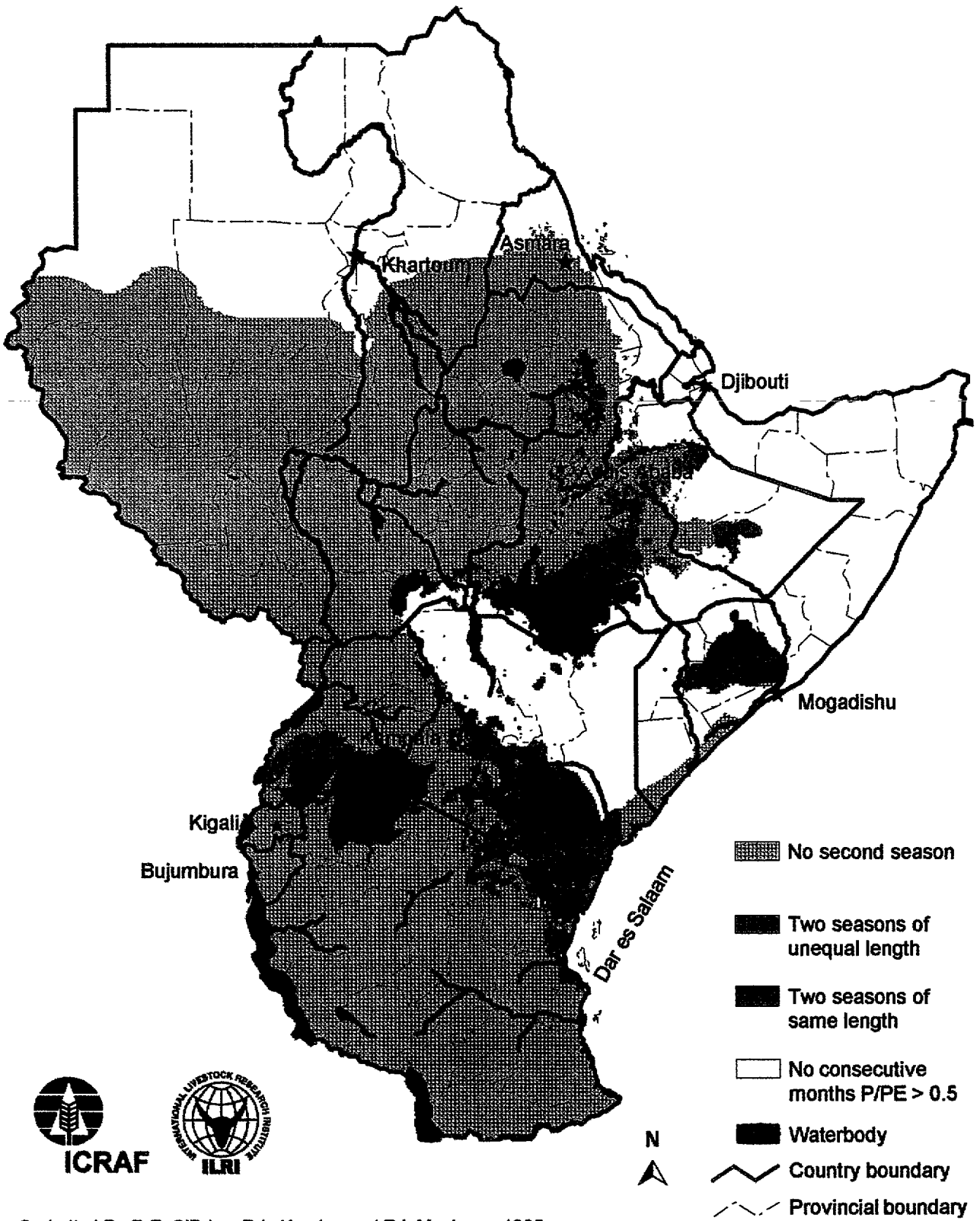
Areas With Two Seasons



Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995.

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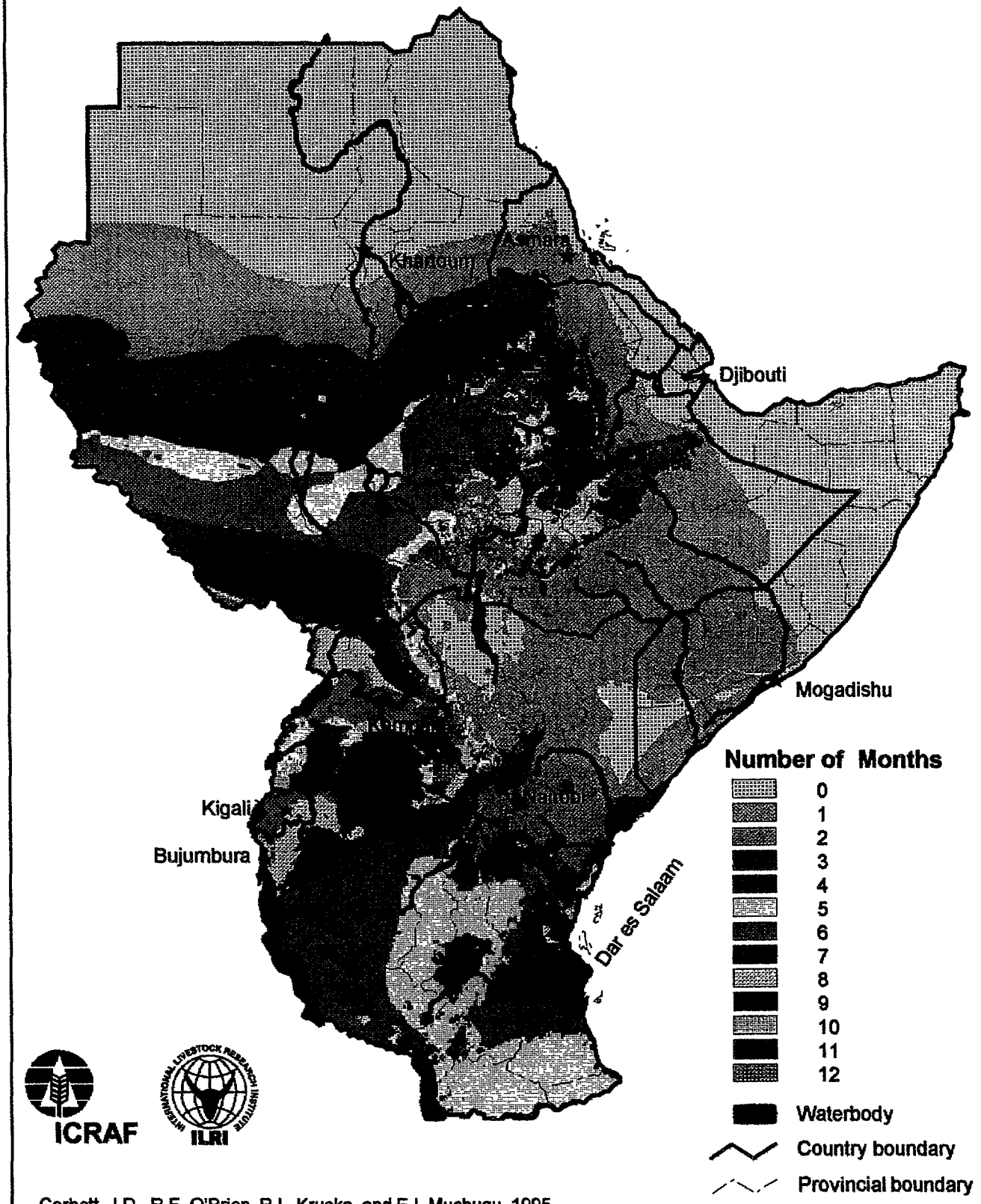
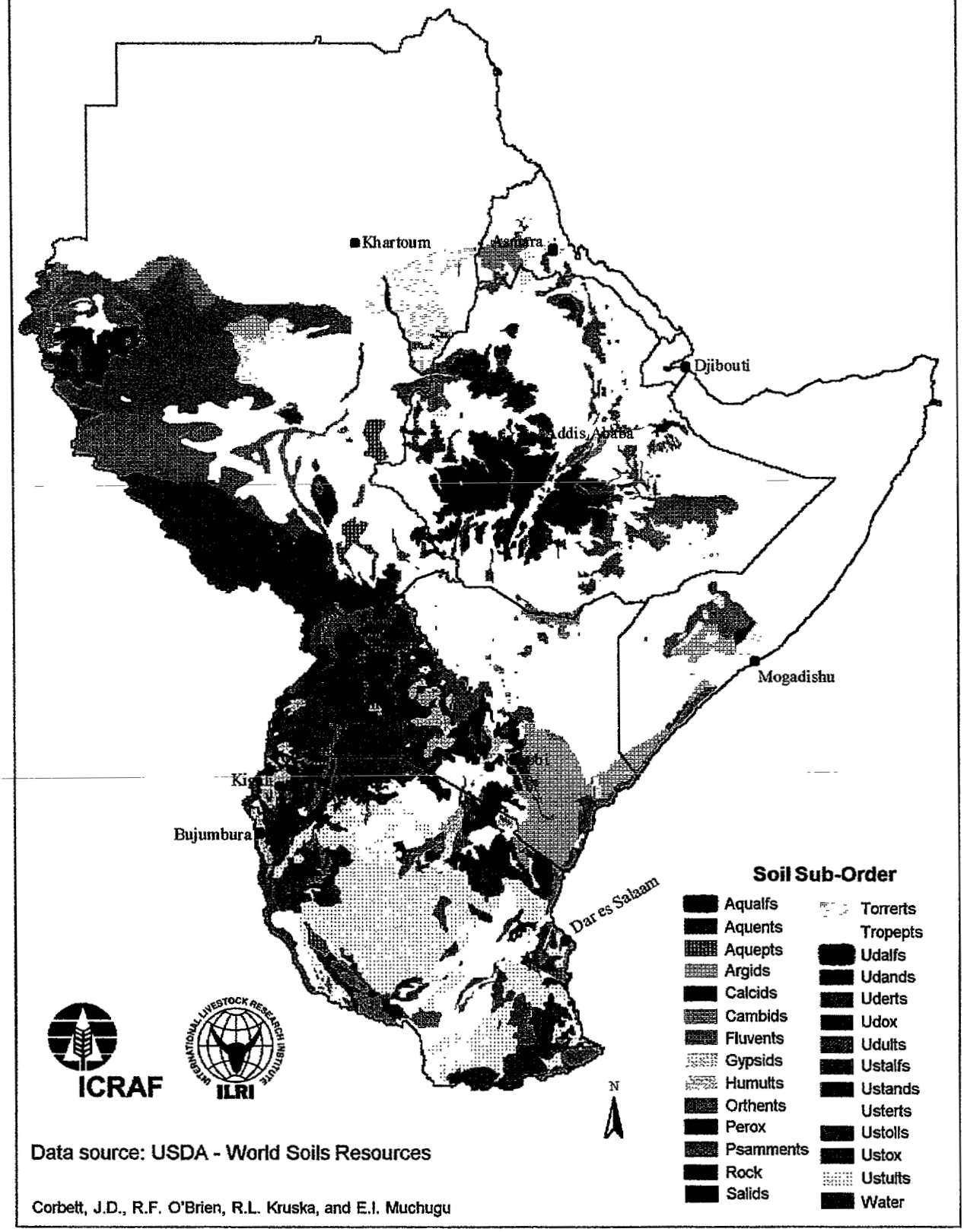
Longest Length of Period Where P/PE > 0.5



Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995.

103d

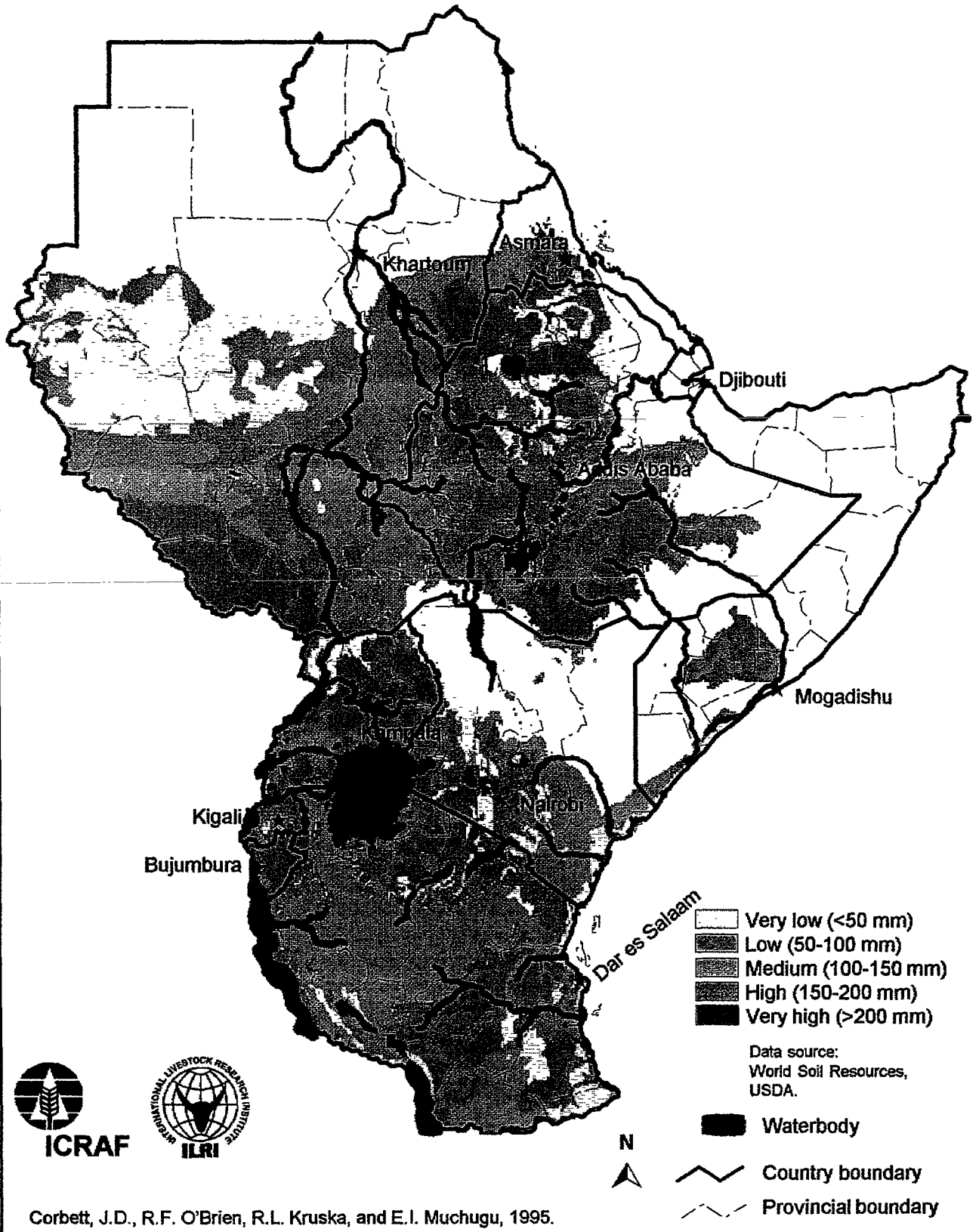
USDA Soil Taxonomy (Sub-order)



Data source: USDA - World Soils Resources

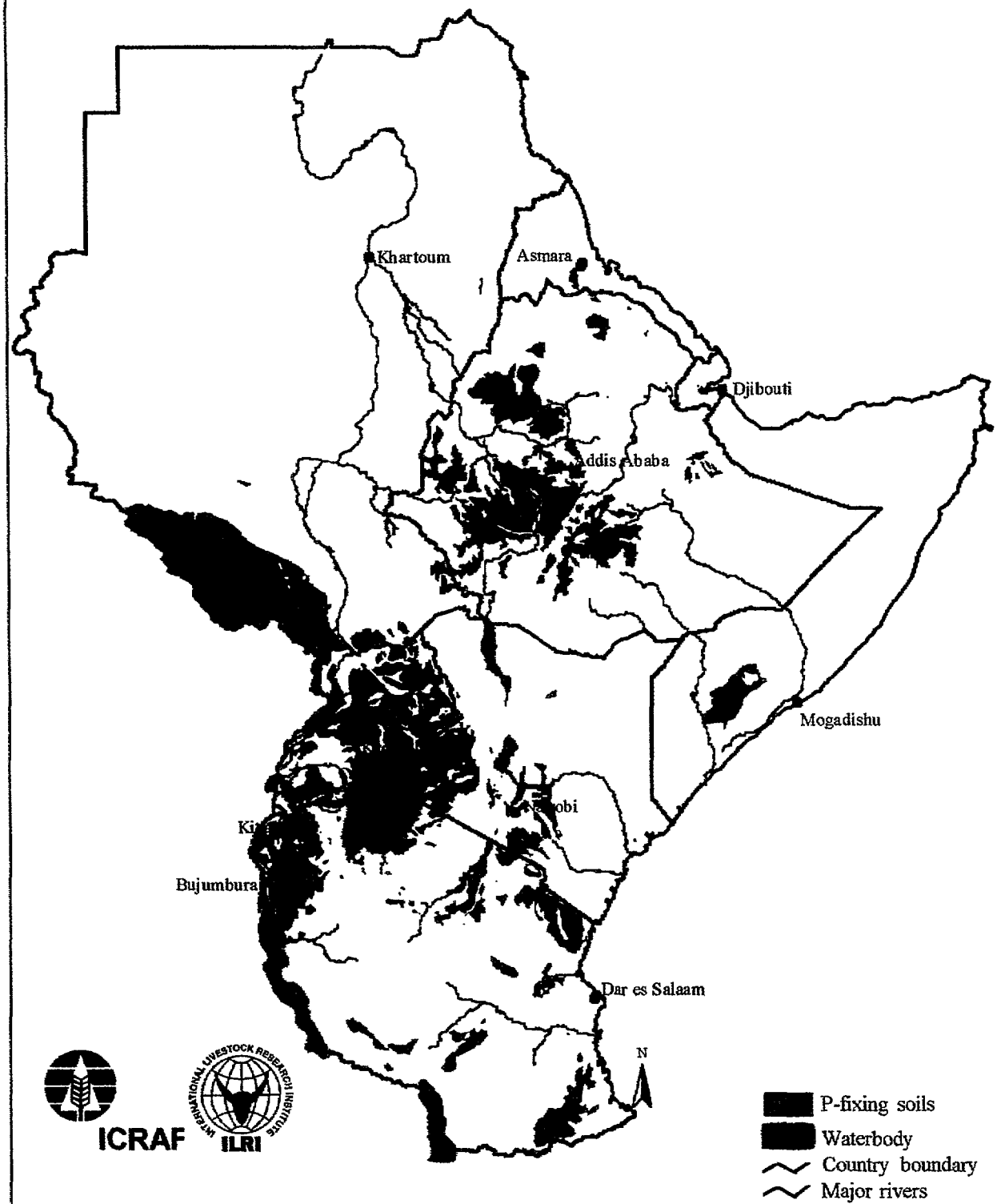
Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu

Soil Water Holding Capacity



Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995.

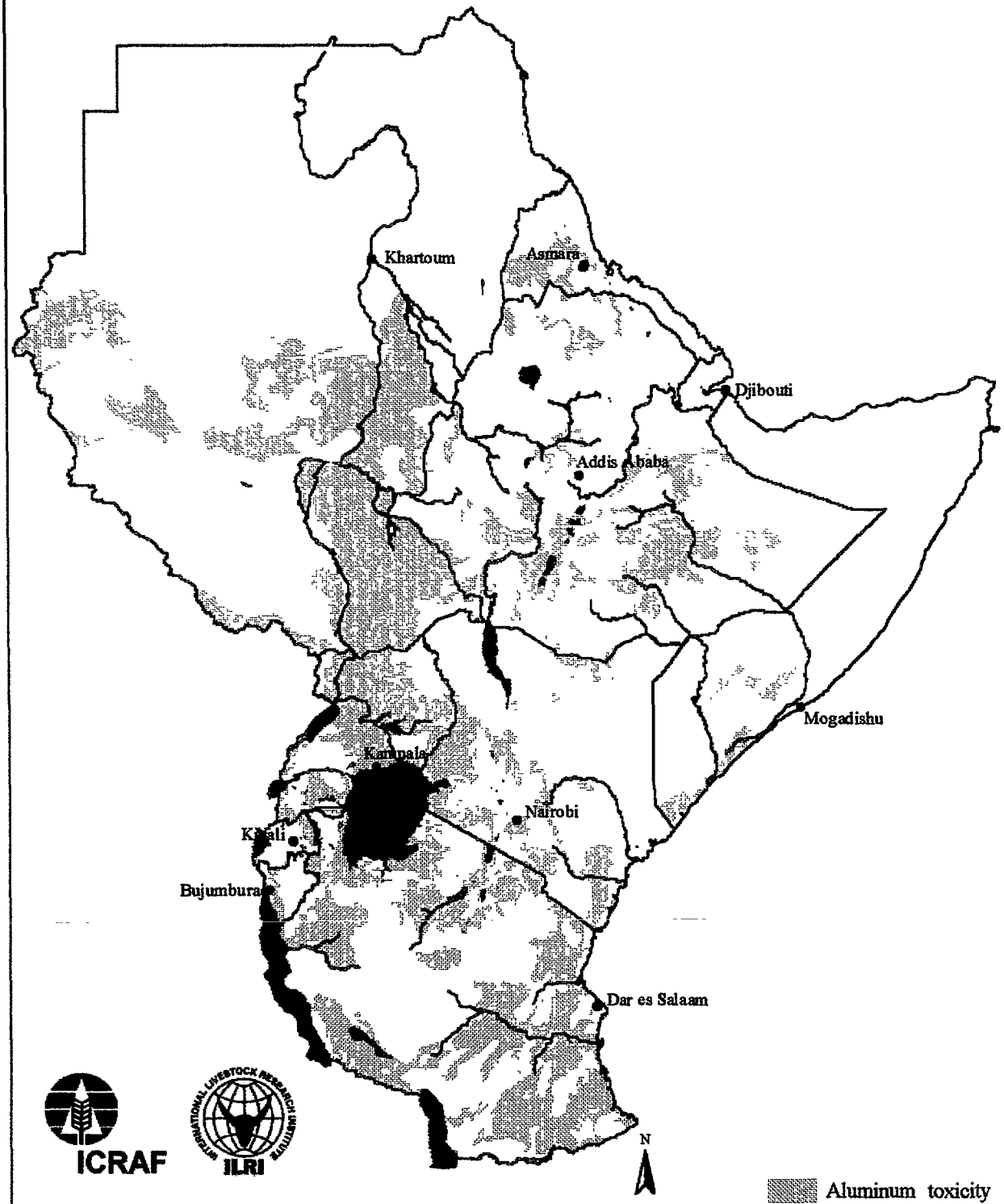
Phosphorus Fixing Soils



Data source: Sanchez, P.A., 1995; Unpublished data

103 G

FCC - Aluminum Toxic Soils

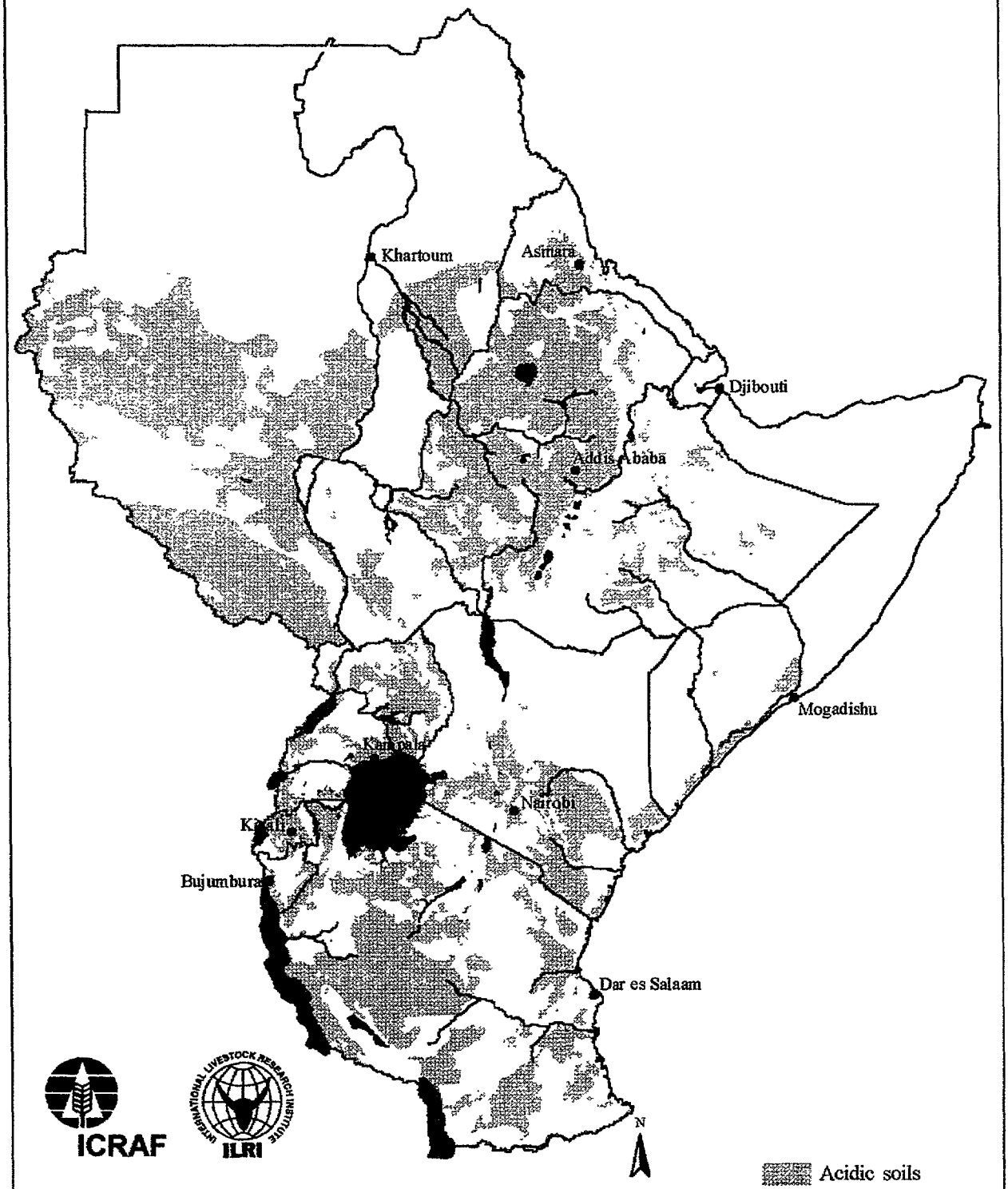


Data source: Sanchez, P.A., W. Couto and S.W. Buol et al, 1982.
The Fertility Capacity Soil Classification System

Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu

103 #

FCC - Acid Soils



Data source: Sanchez, P.A., W. Couto and S.W. Buol et al, 1982.
The Fertility Capacity Soil Classification System

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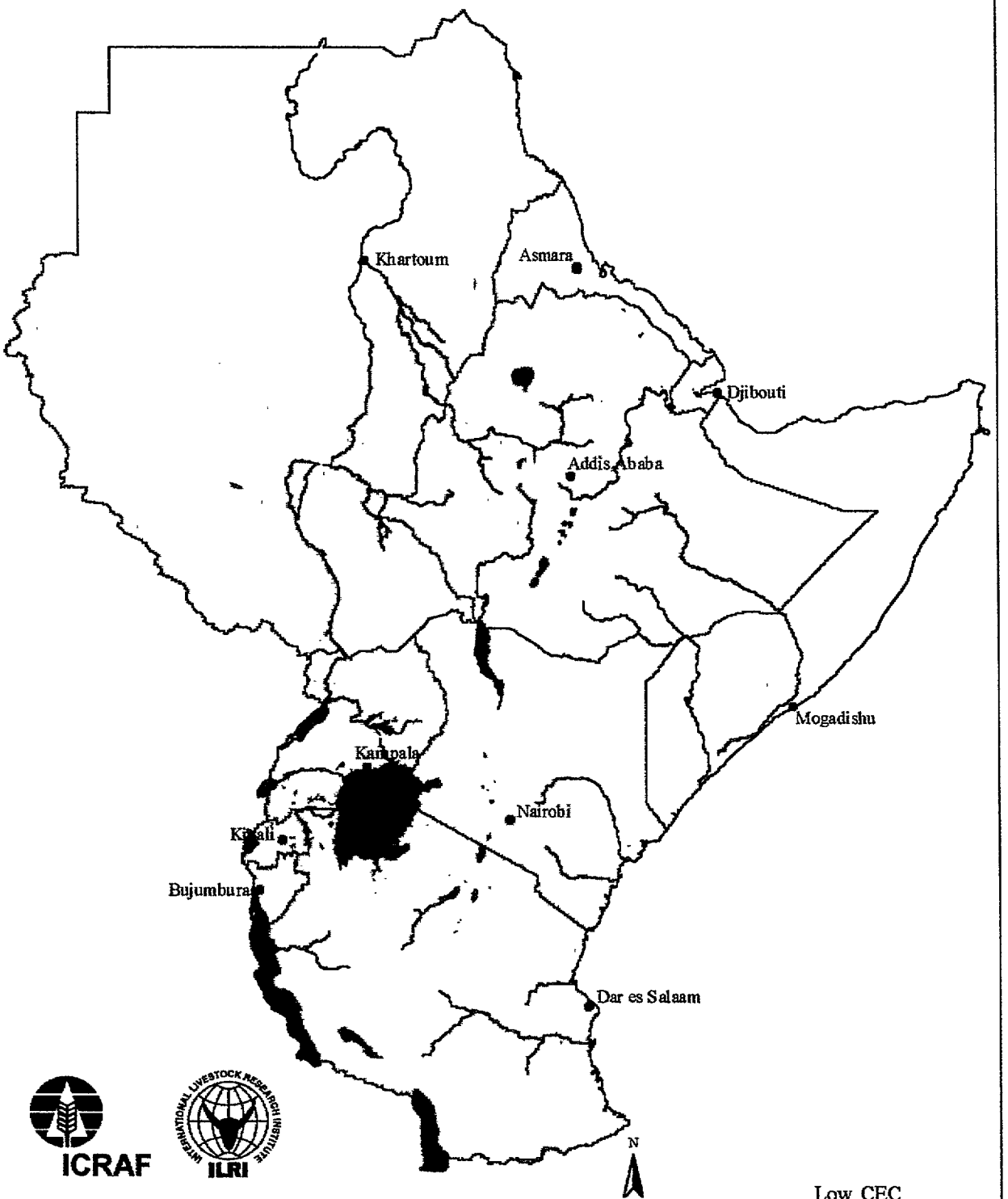
FCC - Soils with low CEC

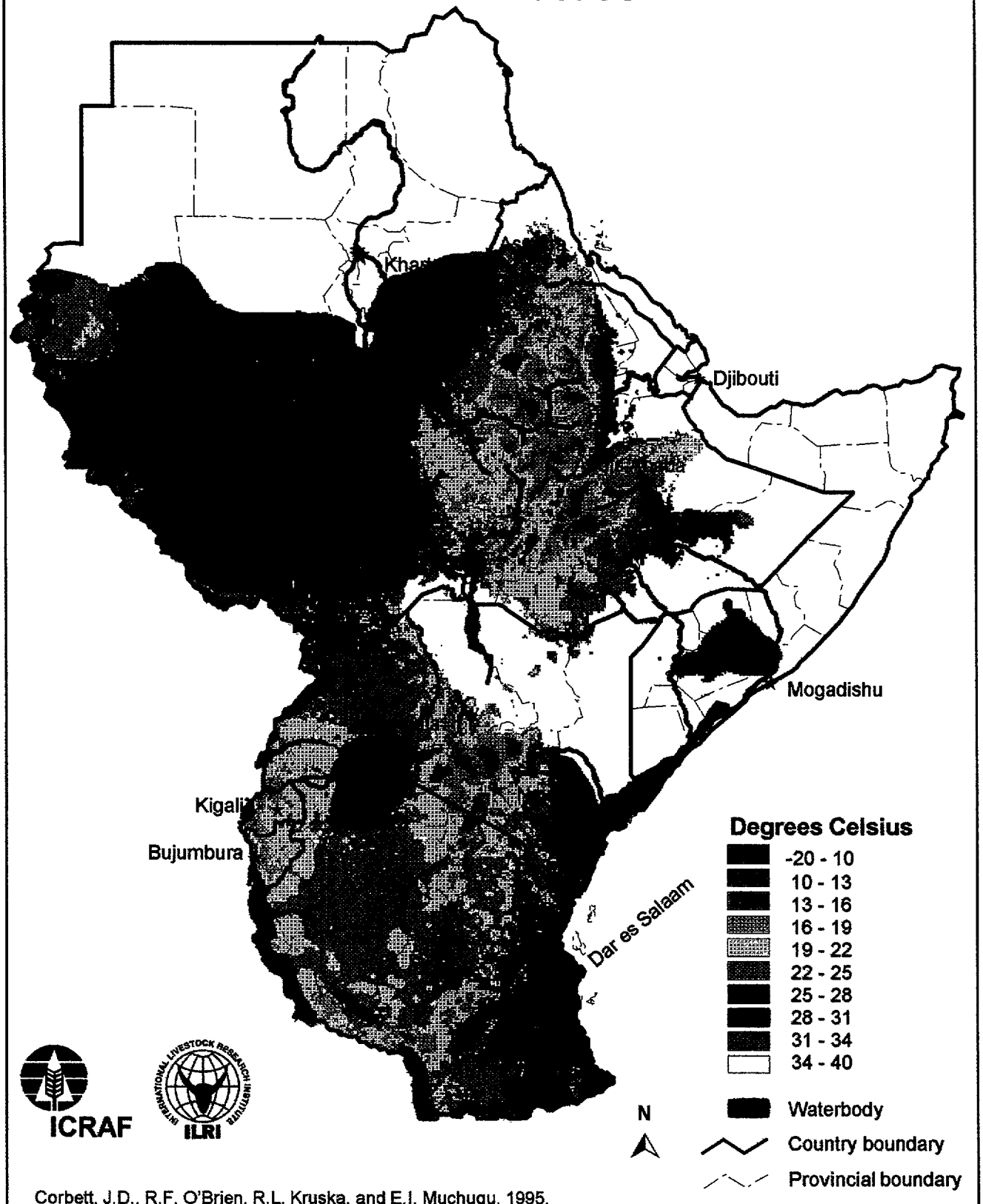


Data source: Sanchez, P.A., W. Couto and S.W. Buol et al, 1982.
The Fertility Capacity Soil Classification System

Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu

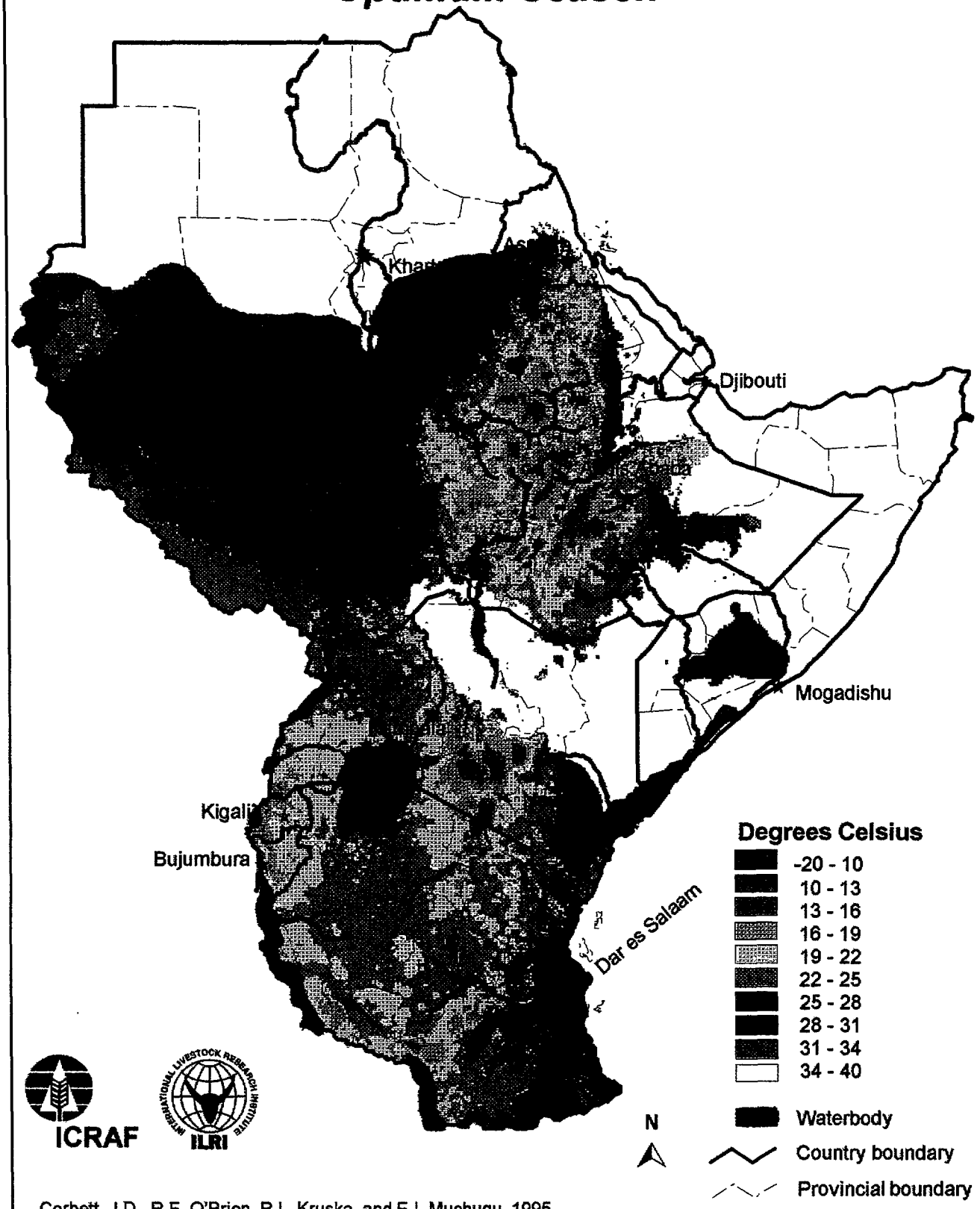
103 J

Mean Temperature -- First Three Months
P/PE > 0.5 Season



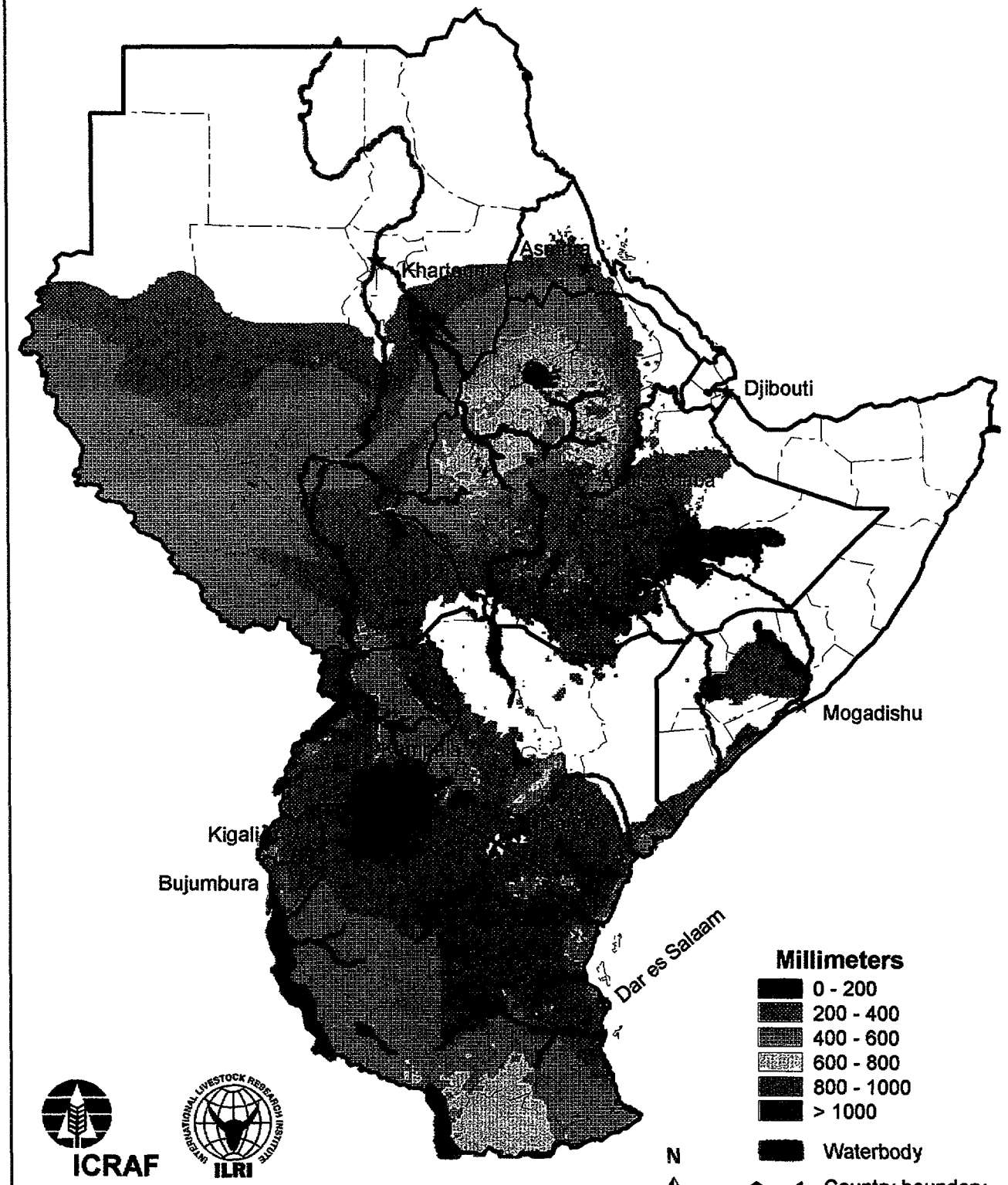
Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995.

Mean Temperature -- Five Months
Optimum Season



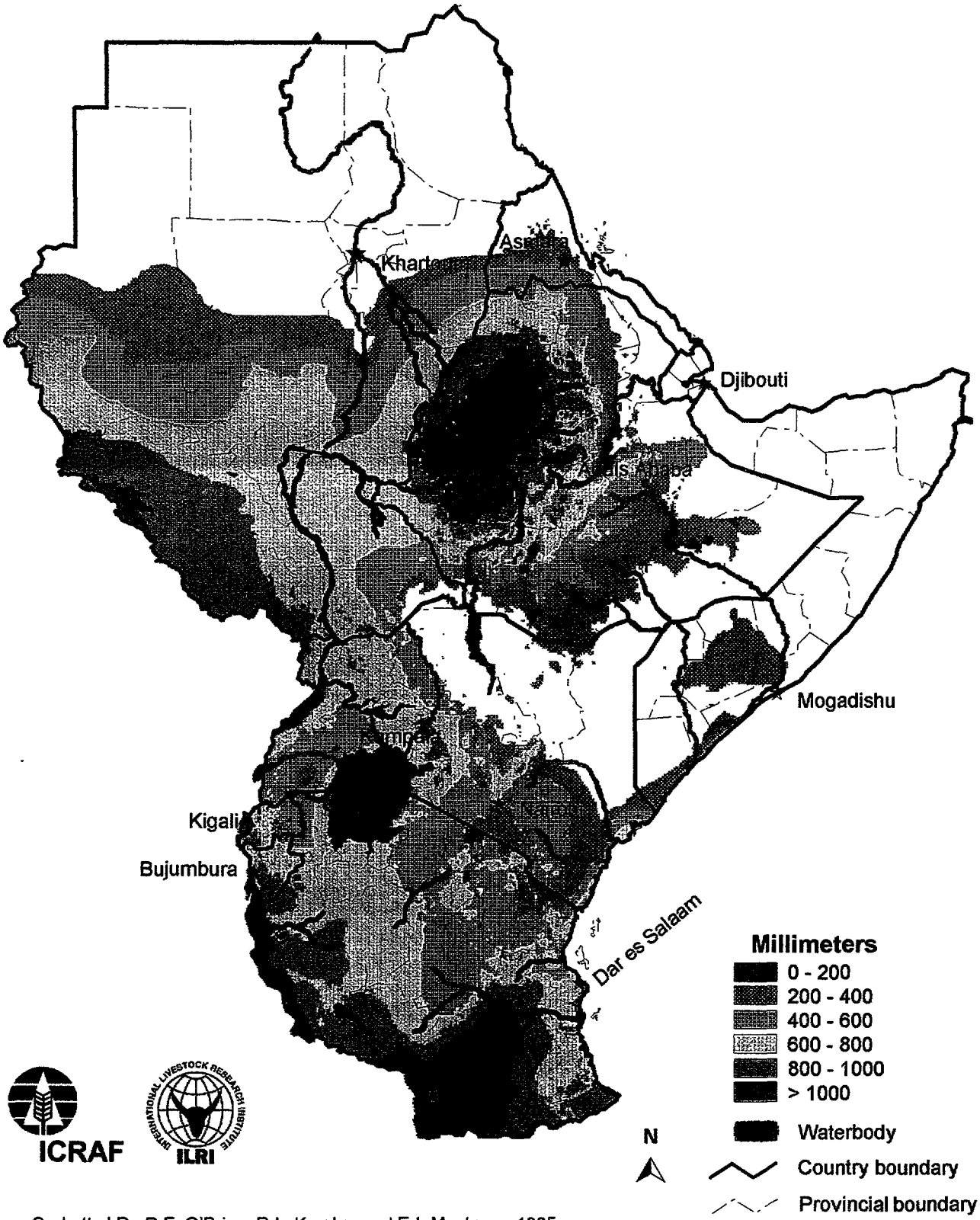
Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995.

Total Precipitation -- First Three Months
P/PE > 0.5 Season



Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995.

Total Precipitation -- Five Months
Optimum Season



Corbett, J.D., R.F. O'Brien, R.L. Kruska, and E.I. Muchugu, 1995.

Appendix 1
Seed Technical Notes

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1. Introduction

The technical aspects of SDMR (Seed for Disaster Mitigation and Recovery) can have an impact on the effectiveness of this type of relief program. Most technical aspect are well understood by agronomists on staff of relief organizations, but not well understood by other program staff. Therefore, an overview of key technical aspect of seed are provided in this section for staff and technical backstopping and use in technical training. Some material may be too detailed but is needed to provide background information to difficult technical issues.

An assumption can be made there are not seed quality problem in SDMR, but in reality seed quality problems do occur. If verification and maintenance of seed linked to high quality seed are important for achieving the objectives of SDMR, then the following concepts should be useful.

2. Seed quality

"No matter how hard I work, a good crop is not possible with bad seeds," said one Bolivian farmer.

Quality seed is critical to agriculture production: poor seed limits the potential yield and reduces the productivity of the farmer's labor. The farmer needs every possible advantage in crop production and starting with high quality seed is the first important step. There are two basic parameters to seed quality: physical/physiological qualities and genetic quality. The physiological quality refers to the overall health and condition of the seed. Genetic qualities are the specific genetic characteristics of seed; ideally seed should be relatively genetically uniform and adapted to produce optimum yields under local conditions.

Physical/physiological qualities are characterized by the following:

- Near uniform seed size
- Minimum damaged seed
- Minimum weed seed or inert matter
- No diseased seed
- High germination and vigor

Genetic qualities consist of the following[1]:

- Seed of the same variety
- Adapted for the local conditions
- Proper characteristics
- Disease and pest resistance
- High yield potential

When seed has desirable physical/physiological and genetic qualities farmers have a better advantage to produce a good crop. High quality seed is a major factor for obtaining a good stand and rapidly developing plants even under adverse conditions. Other factors such as rainfall, agronomic practices, soil fertility, and pest control are also crucial.

Judging Quality

The basic question is what do farmers think is an acceptable level of high quality seed? An answer may be the quality level that farmers can produce. A relief organization involved in SDMR should feel confident about the level of quality seed that is being provided to farmers. Physical quality parameter such as seed uniformity, inert material percentage, and discolored seed can be detected by visually examining seed samples. Closely examining handfuls of seed is the first step to better understanding the quality of seed that are being providing to farmers.

3. Seed sampling

Accurate seed testing to determine seed quality parameters such as germination purity etc. are based on seed samples taken from bulk quantities of seed or bagged seed organized into "seed lots". Sampling seed lots must be done using systematic sampling techniques. Procedures and techniques must be followed to ensure the seed samples are representative of the entire seed lot and provide accurate information used in evaluation.

Certified seed testing is based on "seed lots" which consist of a specified quantities of grouped seed. These seed lots should be uniform and been harvested from a specific seed fields. The maximum size of seed lots are actually based on the size of the seed. For example for the size of wheat seed or larger seed a lot consist of a maximum of 20,000 kgs. Seed with sizes smaller than wheat are grouped in seed lots of 10,000 kgs. In the US, seed lots are specified by a number of bags/units.

In the seed industry seed lots are assumed to be reasonably uniform, that is homogenous rather than heterogenous. For seed used in SDMR it is difficult to make this assumption. Therefore, the importance of sufficient sampling to obtaining a representative sample is extremely important.

In sampling a seed lot, a method of sequential sampling is used.

a. Primary samples are taken from either different containers(bags) or different locations if the seed is in bulk.

b. Individual primary samples are combined to form a composite sample.

c. Normally the composite sample is divided to form the submitted sample. If the composite sample is small it may be used as the submitted sample. The submitted sample is then the sample from which the working sample is derived for testing and evaluation.

Obtaining representative samples are as important as the seed testing itself and should be treated as a significant part of the overall testing procedure. Seed can segregate in containers. Inert material may be added to increase weight or broken and damaged seed to be found in bags at the bottom of seed stacks. Be sure to arrange seed containers, small sacks, plastic bags or tins with labels so one can identify lot or the location from which sample were taken. In this way if problems occur it can be traced back to its origin and a re-test submitted. Uniform quantities should be taken from the bags or containers for representative samples.

Seed inspectors and seed producers use sampling instruments called "triers" in obtaining the sample. Triers are thin, hollow and cylindrical, pointed at one end, and come in a variety of sizes or lengths. When a small sleeve-type trier is inserted into a bag of seed and the knob on the top is turned it allows seed along its entire length to enter through small openings resulting in an excellent representative sample from the bag or bulk seed. With seed packaged in paper bags the trier makes a small hole that can be sealed with tape. With some kinds of burlap or jute bags, a small trier can be eased between the bag fibers. Alternatively samples can also be obtained by opening the bag and grabbing a handful of seed preferable at the top, middle, and bottom section of the bag.

Sampling intensity varies between the guidelines of the Association of Official Seed Analyst(AOSA) used in the United States and the International Seed Testing Association (ISTA). Since the SDMR are in the international context the ISTA guidelines and their rules are as follows.

- Seed lots of five containers or less, primary samples must be taken from each container.

- For seed lots of six to 30 containers, samples at least one in every three containers but not less than five containers must be taken.

- For seed lots of 5001-3000 kg take one primary sample for each 300 kg but not less than five samples.

- For seed lots of 3001-20,000 kg take one primary sample for each 500 kg but not less than 10 primary samples.

The minimum size of submitted sample corresponds to seed size, as follows:

- Teff: 55 grams
- Millet: 150 grams
- Sorghum, wheat, maize, barley: 1000 grams
- Vegetables: seed samples consist of at least 400 seeds

Representative Samples

With a reasonable amount of effort representative samples can be taken from seed being delivered to farmers. Because of problems associated with uniformity it is recommended that each primary sample be tested as a submitted sample. Taking 10 samples from 20,000 kg of seed is not an impossible task. From these samples, test can be done that will help establish and verify the quality of the seed

4. Seed Testing

Seed testing is necessary for a number of reasons:

- To determine the quality of the seed.
- To Provide a basis for price and consumer discrimination among seed lots and seed sources.
- To Fulfill legal requirements for certified seed and allow for seed movement across international boundaries.

Three tests are routinely conducted in seed testing laboratories:

- **Physical purity test**: to determine the percentage of the pure seed, other crop seed, weed seed, and inert matter in the seed sample.
- **Incidence of noxious weed seed:** an extension of purity test to determine the rate of occurrence of certain weed seed (as designated by law or official regulations).
- **Germination test**: to measure the ability of the seeds to germinate and produce plants.

There are other seed tests that can provide additional information for evaluating seed. The following are a few examples.

- **Specific Gravity:** a high correlation exists between specific gravity and vigor level of seed.
- **Moisture content:** a direct relationship exists between moisture content and deterioration rates, susceptibility to mechanical damage, insect infestation level, and fungi attack.
- **Varietal purity:**- With some species specialized chemical methods or grow-outs for seedling evaluation are necessary to determine varietal purity. New methods of genetic fingerprinting are being used for varietal purity determination.
- **Seed borne diseases:** Standard principles and procedures are used by mycologist and phytopathologist to determine the presence of seed borne diseases.
- **Vigor Profile:** There are various types of vigor tests that include the cold test, tetrazolium test, exhaustion test(seedling growth), accelerated aging test, and the conductivity test.

5. Seed germination testing

Germination test is of paramount importance

The germination test is the most important test for SDMR to use in evaluation and gain a better quantitative understanding of seed quality. SDMR seed does not have to be 90% germination but 50% germination would not be acceptable for use as seed. Vigor testing is more difficult but the speed of germination, that is, the first or second count is an excellent indicator of seed vigor. Or in other words, if the seed is in an advanced state of deterioration. Besides germination testing, determining the seed moisture content is extremely important.

In SDMR there are a number of situation that would encourage a relief organization to perform germination tests.

- If you have experienced seed quality problems or complaints from farmers
- To re-test seed for evaluation after being previously tested. This is particularly important with crops that are prone to rapid deterioration such as legumes.

- To provide a check of the germination tests done by a laboratory if the seed appears to contain significant quantities of broken seed, inert material, other crop seed, non-uniform seed etc.

- To test seed that has been in transit or in storage for a significant period three - six months.

After obtaining representative samples of seed, the next step in quality verification is the germination testing. Seed can appear quite normal but due to rapid deterioration may not germinate. Simple germination testing will provide valuable information on one parameter of seed quality. Germination testing can be performed in laboratories under standardized procedures. Likewise, germination testing can be performed in the field by the relief organization and farmers. Germination testing is informative, educational, cheap and assures the farmer gets a good start.

5.1 General requirements for germination

Germination is defined as the emergence and development from the seed embryo of those essential structures which, for that kind of seed, are indicative of the ability to produce a normal plant under favorable conditions. There are four general requirements for germination of most seed kinds. Suitable substratum, moisture, a favorable temperature, sufficient oxygen. Light is a special treatment needed during germination for overcoming dormancy in certain kinds of seed.

5.1.1 Suitable substrata:

Sand: clean moist sand in a tray or calabash or other suitable container (with drain holes in the bottom) is excellent for germination testing of larger seeds. The top of a "BIC" pen is perfect for making 1-2 cm holes for the placement of seed in a pattern 10x10. This also provides for easer observation and evaluation. The rule of thumb for planting depth is that the depth of the seed should be twice the length of the seed. Gently cover the seed after placing one seed per hole. The only caution is that other seeds that may be in the sand may confuse the counting at germination but having the seed in a pattern will alleviate this potential problem. An advantage of using sand is that seedlings must push through the sand and this resistance is a kind of vigor evaluation. Furthermore, the materials are available even at the village level.

Cotton cloth: Commonly called the rag doll method, the test calls for a moist cloth layer underneath the pattern of seed and a moist cloth layer over the seed and rolling the cloth and seed together. It is better to place the rolled cloth on an incline to aid in evaluation of the seedlings. By orienting the rolled cloth the seedling are easier to separate and count because the shoots will grow up and the roots grown down.

Paper towels: Similar to the rag doll method only two layers of paper towels are placed under the seed with one layer on top.

Blotters: Depending on the kind of blotter, it can be rolled up like the rag doll method or with small seeds blotters can be used in the bottom of petri dishes or similar plastic containers.

5.1.2 Moisture: A sufficient supply of moisture is necessary since the first step in germination is for seed to uptake water. Moisture is normally supplied through the substratum. Excessive moisture can interfere with proper germination. On the other hand do not let the substratum dry out during germination processes. It is important to maintain the seed environment moist but not excessively wet. Sand should be covered, paper towels and cotton rags and blotters should be kept in loose sealed plastic bags or boxes. All germination tests should be checked on a daily basis to monitor moisture levels and remove moldy seed.

5.1.3 Sufficient oxygen: Excessive moisture can block the gas exchange of the germination seed. Checking the seed on a daily basis and opening the containers will ensure seed, even in plastic bags, has sufficient oxygen.

5.1.4 Favorable temperature: Most kinds of seed have an optimum germination temperature between alternating 20-30 C. This is similar to the alternating night and day temperatures present in many locations. Therefore, ambient temperatures in most locations are suitable for germination. Containers with germinating seed should not be exposed to direct sunlight because of the heating that can occur. However, inside rooms or in shaded area is suitable for conducting germination tests.

5.1.5 Number of seeds: In official germination tests procedures call for at least 400 seed to be tested in replications of 100 seeds. For SDMR the number of seeds to test should be at least 100 although 400 would be better and reduce errors.

5.2 Germinations test results:

Germination test results fall into at least four major categories that are described below. For our purposes in simple determination of germination percentage there are normal seedlings that will develop into healthy plants and all other seeds/seedlings that include abnormal seedlings, dead seed, dormant seed and hard seed.

Normal seedlings: Normal seedlings possess the essential structures that are indicative of their ability to produce a normal plant under favorable conditions. These seedling possess a normal and healthy shoot (hypocotyl, cotyledons or epicotyl) and root (primary and secondary).

Abnormal seedlings: Abnormal seedlings will not eventually develop into a healthy plant. Abnormal are all seedlings that can not be classified as normal. These seedlings often lacks a shoot and or a root. Dead seed would also be included in this category since a dead seed will not produce a normal seedling.

With the use of sand substratum, the germination test results are determined a bit differently since only the normal seedling will emerge from the sand. The abnormal, dead and hard seed will not emerge. Therefore determining germination test results is much simplified with sand substratum. However, when there are poor results on a sand substratum test it is advisable to retest using a different substratum in order to easily examine all seeds.

Seedlings are officially counted twice, that is the first count and second count or final. Seedlings are removed once they have fully germinated or if they are moldy since the fungi can spread to other seeds. The rule of thumb is that the speed at which the seedlings emerge is

indication of the vigor of the seed. Therefore, the greater the percentage of the normal seedlings on the first count the higher the general vigor level of the seed. This point is very significant for understanding seed quality. Germination tests results are reported in terms of:

- Total germination % of normal seedlings based on the average of the four replication of 100 seeds.
- Total abnormal and dormant % based on the average of the four replication of 100 seeds.
- Total hard seed % based on the average of the four replications of 100 seeds.

Methods of Testing For Laboratory Germination of Crops Seeds

CROP	Substrate1	Temp ^{0}C	First count (days)	Second count (days)	Additional
Maize	B,T,S,TC	20-30	4	7	
Sorghum	B,T,S	20-30	4	10	
Beans	B,T,S,TC	20-30;25	5	8	
Teff	P	20-35	5	14	LIGHT 3
Finger millet	B,T	20-30	4	8	LIGHT
Pearl millet	B,T	20-30	3	7	
Wheat	B,T,S	20;15	4	7	
Barley	B,T,S	20;15	4	7	
Cowpeas	B,T,S	20-30	5	8	
Lentils	B,T	20	5	10	
Chickpea	T,S	20-30	3	7	
Peanuts	B,T,S	20-30:25	5	10	remove shell

Notes:

1 Substrata: B=between blotters, TB=top of blotter, T=paper towels rolled or folded, S= in sand or soil, TS=top of soil, P= covered petri dish on top of: blotter, filter paper or sand TC= on top of creped cellulose without a blotter

2 Temperature: single numbers indicate constant temperature. Two numbers indicate alternating temperatures with 16 hours at the first temperature and 8 hours at the second temperatures

3. Light should be provided by a cool white fluorescent source of 750-1250 lux. The seed should be illuminated for at least 8 hours in every 24 hour period.

Information has been estimated since it is not included in AOSA guidelines
Source: AOSA Rules for Testing Seed

Methods of Testing for Laboratory Germination of Vegetable Seeds

VEGETABLE	Substrate1	Temp ^{0}C 2	First& Second count	Additional info.
Beets	T,B,S	20-30	3 14	
Cabbage	T,B,P	20-30	3 10	
Carrot	T,B	20-30	6 14	
Cucumber	B,T,S	20-30	3 7	
Eggplant	P,TB,RB,	20-30	7 14	
Kale	T,B,P	20-30	3 10	
Lettuce	P	20	- 7	LIGHT 3
Melon	B,T,S	20-30	4 10	
Okra	T,B	20-30	4 14	
Onion	B,T	20	6 10	
Pepper	T,TB,RB	20-30	6 14	
Pumpkin	B,T,S	20-30	4 7	
Radish	B,T	20	4 6	
Spinach	TB	15;10	3 21	
Swiss chard	T,B,S	20-30	3 14	
Tomato	T,B,P,RB	20-30	5 14	
Turnip	T,B	20-30	3 7	
Watermelon	B,T,S	20-30	4 14	

Source: AOSA SEED TESTING RULES
Notes for this table are the same as for the crops table.

6. Seed deterioration

Seed start to deteriorate soon after it reaches physiological maturity on the plant. The rate of seed deterioration is determined by a number of factors that are explained below. There are many physiological steps in the process of seed deterioration. Germination rate is affected early in the deterioration process. Germination testing only measures the last step in the process, that is the death of the seed and the resulting failure to germinate. Seed vigor could be described as the ability of the seed to germinate and rapidly develop into a seedling under optimal and sub-optimal conditions. In other words, vigorous seed are seed that have not undergone significant deterioration. This issue reenforces the significance of the first count in the germination test as an indicator of seed vigor and quality. For example, Mississippi State University conducts germination tests for one NGO to verify the quality of vegetable seed before it is distributed. They pay particular attention to the first count in the germination test and is used as an indication of the vigor and deterioration level of the seed. In this case the seed have been stored in sealed cans under suitable conditions and very few test have reveal seed of low quality of a significant portion of the seed germinate before the first count.

The vigor level of seed can never be improved after it is harvested, on the contrary, it deteriorates. Deterioration means the loss of germination and vigor which are essential for quality seed. This deterioration of the seed does not affect its quality for use as food/feed grain.

The rate of deterioration varies between crop types. The cereals generally have a slow rate of deterioration whereas legumes have a much more rapid rate of deterioration when all other factors are equal, that is temperature, humidity, and moisture content of the seed. For example legumes high in oil, such as peanuts and soybeans show a higher and more rapid rate of deterioration. Other legumes lower in oil content such as beans or cowpeas do not deteriorate as fast. Corn and millet deteriorate at a slower rate than legumes; rice has a very slow rate of deterioration in storage. There are differences in deterioration rates expressed among varieties of the same species.

The moisture content of the seed is the most critical factor affecting the rate of deterioration. It is desirable to have the moisture content below 10% but this can be difficult to achieve in some regions of the GHA. The lower the seed moisture % the slower the rate of seed respiration. The slower the rate of seed respiration the slower the rate of deterioration. Therefore, proper drying before storage is critical for minimizing deterioration during storage.

Seed moisture content initially is reduced by drying on the plant or after harvest in the sun. However, seed are hygroscopic, it will absorb moisture from the surrounding air. After the initial drying and during storage the seed absorbs moisture from the air or releases moisture to the air until it comes into equilibrium with the relative humidity of the air. Hence the term seed equilibrium moisture content is used to express this water movement. If the relative humidity is high as it is in some regions of the GHA then the seed moisture content will be high. For example, in climates such as the Sahel with low relative humidity during the storage period the seed will remain at a low moisture content, a factor for good seed storage. In tropical climates with high relative humidity during the storage period problems can develop. The seed moisture content will increase, which will increase the respiration rate and the deterioration rate. Higher seed moisture content is also favorable for insect infestation and growth of microorganisms/fungi. Special precautions are needed for seed storage under conditions of high humidity. The following table illustrates the relationship between the relative humidity and the seed equilibrium moisture content.

Seed Equilibrium Moisture Content at Various Levels of Relative Humidity (RH)

Kind of seed	RH 15%	RH 45%	RH 60%	RH 75%	RH 90%
Maize	6.5%	10.5%	13.0%	14.8%	19.0%
Peanuts	2.6%	5.6%	7.2%	9.8%	13.0%
Rice	6.8%	10.7%	12.6%	14.4%	18.1%
Sorghum	6.4%	10.5%	12.0%	15.2%	18.8%
Soybean	4.3%	7.4%	12.0%	13.1%	18.8%
Sun flower		6.5%	8.0%	10.0%	15.0%

Monitoring Moisture

Conditions at harvest vary widely in the GHA. However, the bimodal rainy season of the Lake region and moderate temperatures result in high relative humidity levels. High relative humidity means that it is difficult to dry seed crops sufficiently at harvest time, that is the equilibrium moisture content of the seed is high. Maize seed production is problematic in Burundi because of the difficulty of drying the maize sufficiently at harvest. High seed moisture content above 14% results in accelerated rates of seed deterioration. To better understand this condition, technical staff monitor relative humidity seed where are being stored. Simple and cheap sling psychrometer give an accurate determination of relative humidity. **Moisture testers in labs or portable moisture testers should be used to verify the moisture percentage of seed when it is purchased and during the period when it is stored.**

Temperature is also an important factor in storage since higher temperatures mean higher rates of seed respiration and seed deterioration. Temperature is not as significant factor as seed moisture content because sufficiently dry seed can withstand relatively high temperatures without significant deterioration.

Protection of the seed from pests, such as insects, rodents, and birds, is essential to prevent quantity and quality losses during storage. This protection includes cleanliness in the storage area and seed treatment with chemical or other acceptable means.

A concept of some storage methods is hermetically sealed storage. In this storage method the seed are well dried and sealed in storage containers such as oil drums. This will not allow the entry of air. After several months the respiration of the seed and any insects will eliminate all the oxygen and a higher level of carbon dioxide. Any insects that emerge from the seed after 2

months will die from lack of oxygen. A problem with this concept is achieving and maintaining a hermetically sealed storage environment. Also it is essential that the seed be very dry or fungi can develop as the seed reaches the equilibrium moisture content with the available air in the container.

Another concept takes the sealed storage method one step further as documented in a CIAT publication[2]. Bean seed were dried to extremely low moisture content 6.1-6.6% using silica gel. The dry seed was stored in recycled soda bottles with a screw top and sealed with wax. Germination percentage after one year was over 95%. Continued storage and testing shows that the seed are still retaining a high germination percentage. This is a simple low-cost technology for medium-term germplasm conservation that could be very useful for small reserves of seed for SDMR.

7. Seed storage

Successful seed storage begins with how the seed have been handled before storage. The key points in proper seed handling before storage are:

- Minimize insect infestation in the field and optimize seed quality by timely harvesting and removal of seed from the field. This is particularly true with legumes that are prone to bruchid attack in the field and can results in high insect infestation rates and losses during storage.

- Eliminate insect-infested seed before storage which in effect will remove sources of future infestation or contamination.

- Dry the seed sufficiently to prevent microorganism growth, insect growth, and reduce the respiration rate of the seed. In experiment in Cameroon, black plastic has been used for solar drying to produce a high temperature to desiccate the eggs of the cowpea bruchid. The result has been a reduced level of infestation during storage.

- Treat the seed with a suitable traditional or chemical insecticide to control insect infestation. At the farmer level sand or ash can be use in the right conditions. In a warehouse situation fumigation with gas such as Phostoxin is done on a periodic basis.

- After these initial steps the storage method and storage environment can have a major effect on the rate of seed deterioration.

Storage insects are a major threat to seed storage in most countries. There are two classes of storage insects: primary feeders that can attack the whole seed, and secondary feeders that can only attack damaged seed. Most storage insects are small and require close observation for detection. The essential factors in control of storage insects are:

- Several insects attack the seed while it is drying in the field; prompt removal of the seed from the field is crucial to minimize initial infestation.

- Proper drying of seed to a low moisture content has a negative effect on many insects.

- Sanitation of the storage containers, such as bags or barrels, and of the storage structure is important.

- Treating seed with non-chemical or chemical means. The appropriate storage treatment depends on the local situation, availability, and effectiveness. Traditional non-chemical means can be effective under the right circumstances.

Rodents are best deterred by having a storage area that is well organized and clean. Rodent-proof storage denies rodents a place to live and hide or denies them access to the seed.

Microorganisms, particularly fungi, can attack if the moisture content of the seed is high due to poor drying or high relative humidity. Sufficiently dry seed are less affected by fungi.

Seed storage inspection on a regular basis is an essential element of successful seed storage. These guidelines for storage inspection were developed for use with small village seed stores. Inspection at lease once a month is important and should included the following points:

- Inspect the outside of the building for drainage or erosion problems, signs of rodent paths and holes, and the presence of trash or weeds which should be removed from around the building in order to deny rodent and insects a place to live and hide.

- Inspect the inside of the building for moisture such as leaks in the roof, dampness on the floor, or water stains on the walls. Note signs of rodent activity: places of entry, feces, damage, and places to hide. Observe insect activity in the floor, walls, bags, or air, and cracks where insects can hide. Note any musty odors that suggest a mold problem.

- Keep bags of seed off the floor, moisture can migrate from the floor into the bag and can affect seed moisture content, seed deterioration rates, and seed germination. Bags should be placed on pallets or tree branches placed in a lattice on the floor.

- Inspect the seed inside the bags or storage container for insects or moisture.

- If you detect problems take immediate action to avoid the loss of valuable seed.

Seed Storage

Avoid storing seed for prolonged periods of time (more than 3 months). If seed must be stored for long periods monitor the condition of the seed through periodic storage inspections. Vegetable seed stored for prolonged periods of time must be kept in sealed plastic or metal containers. Otherwise assume that the seed will rapidly deteriorate

8. Seed import regulations

Import regulations exist as an attempt to safeguard a country against the introduction of pests, diseases, and weeds that may be contained in imports. There is a long history of the devastating effects of the introduction of exotic pests and diseases ranging for the cassava mealy bug in West Africa to the grain borer in Tanzania. Seed is one of the means by which exotic pests can be introduced into a new environment where there are no natural predators. Virtually all the countries of the world have import and export regulations for seed and other planting materials. One should be aware of the import requirement of the country to which seed is being imported. The Plant Exchange Office of the National Germplasm Resources Laboratory is a source of information on these regulations.

Phytosanitary certificate: This certificate is almost always required for imported seed to ensure that is does not contain a pest or disease. Seeds being exported should first be inspected by quarantine officials so that a phytosanitary certificate may be issued before it is exported. The issuing of the phytosanitary certificate indicates that all requirements of the importing country have been met. If importing countries conditions can not be met then the certificate will not be issued. The most commonly encountered problem is the requirement for field inspection of the parental material. Other additional declarations (ADs) such as a particular disease does not occur in the US or area of production. virus free certificate or treatment with a specific pesticide are difficult to obtain.

Import permit: Certain crops require an import permit. For example in Ethiopia only vegetable seed that is know to be adapted will receive an import permit. Additionally, when the phytosanitary conditions can not be met the importer may have to obtain an import permit which waives the unmet requirements through additional declarations such as the inspection of the seed crop in the field, treatment of the seed with fungicide or other related information.

Post entry quarantine: Often the seed is held in quarantine at the border at point of arrival in the country. The quarantine period varies. The time lost in quarantine can be a problem but the real problem with planting materials such as cassava stems or seed potatoes is that deteriorates over a few weeks of storage can be harmful.

Prohibited crops: This classification refers to crops that are normally only imported in limited quantities for breeding purposes. A special import permit is issued for entry of these crops (table 3.4) For example GHA, Kenya and Tanzania prohibit the importation of maize.

In conclusion, import regulation are used to control the entry of seed into the country for a variety of reasons.

- Sometimes normal import restriction are waived for SDMR.
- In the case of southern Sudan there is no authority to restrict the entry of seed.
- In the case of Rwanda one of the action that was first reestablished after the civil war was the import regulation for seed for SDMR.

- Import regulations are sometimes used to restrict trade in seed or commodities that may compete with national production of the same commodity.

- The validity of phytosanitary certificate is related to the capacity of the responsible body to carry out the relevant inspection and seed analysis. This capacity is sometimes limited in the GHA.

- Exports of certain crops also occurs if that crop is considered of extreme importance in the country. For example maize export from Kenya is controlled by the Government and requires an export permit.

The countries of the GHA share many of the same agro-ecological zones and crops, crop varieties pests and diseases. Streamlining selected regulations affecting the movement of planting materials would have a positive effect on commercial production and marketing of seed in the region for SDMR and commercial purposes. Particularly affected are planting materials such as cassava and seed potatoes that can deteriorate greatly during quarantine.

SEED IMPORT REGULATIONS

	Maize	Sorghum	Wheat	Pearl millet	Finger millet	Beans	Cowpea
Ethiopia	pc	pc	pc	pc	pc	pc	pc
Sudan	pc,ip	pc,ip	pc,ip	pc,ip	pc	pc,ip	pc
Somalia	pc,ip, adc	pc	pc,ip, adt	pc	pc	pc	pc
Uganda	pc	pc	pc,ip, adt	pc	pc	pc	pc
Kenya	prohibited	pc,ip, adt	pc,ip, adt	pc,ip, adt	pc,ip, adt	pc,ip, adp	pc,ip, adh
Rwanda	pc,ip, pq,adc	pc	pc,ip, adt	pc	pc	pc	pc
Burundi	pc,ip, pq,adc	pc	pc,ip, adt	pc	pc	pc	pc
Tanzania	prohibited	pc,ip, adt	pc,ip, adt	pc,ip, adt	pc,ip, adt	pc,ip, adp	pc,ip, adh

Notes:

pc phytosanitary certificate required
ip Import permit required
pq Post entry quarantine required
ad Additional declaration required as specified below
t Treated with fungicidal seed dressing before dispatch
h Seeds were harvested from fields which have been inspected during active growth and found free of virus diseases and *Pseudomonas pisi*
p *Corynebacterium flaccumfaciens* is not know to occur in the place of origin
c Parent plants were inspected during active growth and found to be apparently free of harmful pests and pathogens and a certificate that Stewart's disease did not occur in the field of origin (Stewart's disease = *Xanthomonas stewartii*, *Bacillus stewartii*, *Erwinia stewartii*, corn bacterial wilt)

Source: Information provided by USDA APHIS.

Endnotes for Appendix 3

1. Adapted from Seed Improvement Course TC130-3 Participant's Training Manual, Mississippi State University Seed Technology Laboratory.

2. Fishler, Martin. *Bean Germplasm Conservation Based on Seed Drying with Silica Gel and Low Moisture Storage* Occasional Publications Series, No.10 CIAT Colombia.

Appendix 2
Seed Sources for Disaster Mitigation & Recovery

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1. Introduction

The nature of the" market" (supply and demand) of seed for disaster mitigation and recovery creates many difficulties for providing quality seed of the appropriate varieties at a reasonable prices. This market consists of the demand side which are the relief organizations that issue large, competitive-bid, seed tenders in respond to predictable and unpredictable demand for seed for disaster mitigation and recovery. On the supply side there is the commercial seed (and food grain) industry that responds to the seed tenders. Normally seed production is contracted far in advance of its delivery but this is not the case for seeds for disaster mitigation and relief.

Section VI of this report provides further characterization of the general supply situation for seeds to be used in disaster mitigation and recovery, including the strengths and problems of using the international procurement organizations, the regional and local seed producers and suppliers, and buying directly from seed growers.

This appendix provides examples of regional and national seed producers. The examples are organized by country. The produces and suppliers included are sources that have provided seeds to NGOs for disaster mitigation and recovery in the GHA, but the authors of this report have no more information than is included here regarding each company's reliability. Therefore inclusion in this appendix is not intended to be an endorsement of the company. *Caveat emptor*!

Important listings of seed producers include:

- **WANA Seed Directory**, published by the West Asia & North Africa Seed Network (WANA). Available from the International Center for Agriculture Research in the Dry Areas (ICARDA), P.O. Box 5466, Aleppo, Syria. This directory was published in 1995. (The 1995 edition notes that a more complete directory is to be published in 1996.) For each of 12 countries (including Sudan and Ethiopia from the GHA), the directory lists the seed law implementing agency, the seed certification agency, sources of breeder and foundation seed, government seed production and processing

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companies, private sector seed production and processing companies, seed importers and exporters, licensed retail seed dealers and merchants, genetic resource (germ plasm) banks, plant and seed quarantine offices, agencies which control seed import and export, seed testing labs, referee testing labs, and seed health testing labs.

- **World List of Seed Sources,** published by FAO edited by E. Sgaravatti, Seed Service Plant Production and Protection Division. This catalogue of seed sources compiled in 1986 is the third edition and provides more than 7,000 addresses of seed producers in 150 countries. A new edition will be released early in 1996. It is a comprehensive listing by country with the addresses of plant breeding stations, cooperatives and commercial seed producers. The catalogue includes breeder, foundation, registered and certified seed producers and a listing of the crop seeds of each producer.

- **International Seed Directory:** World Reference for the Commercial Seed Industry, published annually by Seed Trade News, Dean Publishers, 9995 W 69th St. Suite 201, Eden Prairie, MN 55344; Tel (612) 941-5822; Fax (612) 941-1708. This directory includes seed producers in the developed and developing world with import and export information about each country as well as a range of information about each seed producer. Unfortunately, the African countries covered only include Egypt, Ivory Coast, Kenya, Malawi, Republic of South Africa, Tunisia, and Zimbabwe.

Examples of international procurement organizations include the following.

- Central Buyers (Netherlands)
  Tel: 31-47-50-32-880
  Fax: 31-47-50-10-700
  contact: Antonio de Olivera Managing Director, Rob Blauuw senior partner

- IPA (Ohio)
  Tel: 216-477-5020
  Fax: 216-477-1210
  contact: Michael Ridenour

- Kjaer & Kjaer
  Gronnemosevej 6
  P.O. Box 260
  DK-5700 Svendborg
  Tel: 45 62 22 11 11
  Fax: 45 62 22 44 22
  Contact: Fleming Johansen

- PANNAR (UK) Ltd
  Crossways Church Hill
  Iwerne Minister Blandford
  Dorset DT 11 BLP
  UK

- TriMed Group
  93 Grove Street, PO Box 432
  Peterborough,NH 03458
  Tel: 603 924-7211
  Fax: 603 924-9023
  Contact: Greg Spitzfaden

2. Kenya

2.1 Regions and need for seeds for disaster mitigation and relief

Kenya has diverse agro-ecological zones with a bimodal rainy season in the highlands that gives it the capacity to endure regional drought. The northern and southeastern regions of Kenya does suffer drought but this is primarily a pastoral area so that seeds are not a major part of relief effort to that area. There are some Somali refugees in northern Kenya. Kenya has not been a major user of seeds for disaster mitigation and relief. NGOs provision of seeds to farmers in Kenya has more of a development rather relief orientation.

2.2 Seed movement and trends

Nairobi serves a regional office for many relief organization in the GHA. From here relief efforts are coordinated for Somalia, southern Sudan, and Rwanda to some extent. As a result many seed supplier are based in Kenya. Kenya is also a net supplier of seed for relief efforts. Whereas southern Sudan was once supplied with seed from Uganda the routes have shifted so that seed is supplied by air from Kenya. In northern Kenya CARE is multiplying seed for use in Somalia.

Seed supply can be a precarious at times. In 1993, the Kenya Seed company had surplus stocks and they exported significant quantities of maize seed, some of which was for relief operations. In 1994 the rains were not good and resulted in reduced seed production causing a seed shortage in 1995. Complaints by the farmers cooperatives about a shortage are very evident in the press in Kenya.

Kenya has certain agro-ecologies that are good for seed production as is evident in the numerous seed companies in Kenya. A good climate for seed production implies warm but not hot temperatures, low humidity and sufficient but not excessive rainfall with a dry period at harvest time for the drying of the seed. A new proposal by the World Bank will provide KARI(Kenya Agricultural Research Institute) with the necessary resources to be a foundation seed producer of low value crop for Kenya and the region. KARI could be supply for seeds for disaster mitigation and relief in the region though they will have to compete with the commercial seed sector of the region on quality and price.

2.3 Seed producers

There are over 14 licensed seed producers in Kenya. A wide range of seed is produced in Kenya that ranges from maize, sorghum, wheat to beans some vegetables, and ornamental. Nevertheless a major portion of the vegetable seed requirement is still imported from Europe.

Kenya Seed Company was not mentioned as a significant supplier of seed for relief operations because of price and quality.

- East African Seed Company is a private seed company. They import most of their seed from Europe and the USA. Some NGOs consider them to be a reliable and competitive seed supplier.

  East African Seed Company
  Kijabe Street
  P.O. Box 45125
  Nairobi, Kenya
  Tel:214941/3,219257
  Fax: 552690
  Contact: L.V. Shah(owner)

- Hortitec produces some bean seed and flower seeds on its own farm as well as using contract growers. The company has for processing seed and repackaging seed in small packages. They have participated in bidding on seed tenders with other seed producers and suppliers.

  Hortitec
  East Shore Road
  Naivasha, Kenya
  Tel: 311-21016/69
  Fax: 311-21029
  Contact: Hans Schubach (owner)

- Kenya Seed Company Ltd Simlaw Seeds is a parastatal with a large production and processing facility at Kitali for maize seed. They also produce other field crops such as sorghum, wheat sunflowers. Most vegetable seed is imported in bulk and repackaged locally. Vegetable seed sources include J.E Ohlsens in Denmark.

  Kenya Seed Company Ltd Simlaw Seeds
  Utumishi House, Kirinyaga St (Wholesale offices)
  Kijabe Street(Retail sales)
  PO Box 40042
  Nairobi, Kenya
  Tel: 721718 721121,720432
  Fax: 332219
  Contact: Mr R. G. Muruki

2.4 Seed suppliers

There are many seed suppliers in Kenya. This list are but a few mentioned by NGOs

- ChemRaw Ltd. Nairobi Ph 555490, 555498, 555499 Fax 540602

- Creative Exports Limited in Nairobi, Phone 22048

- Romaka Limited Nairobi Ph 331727

- Saminico Agencies Limited Sourcing and Supplying , Phones in Nairobi: 556174 in Nairobi or 543309.

- Tri-Med Kenya Office, ABC Place, Waiyaki Way, P.O. Box 39991, Nairobi, Kenya Tel: 254 2 448315/6/7 Fax: 254 2 448318 Contact: Brian G.S. Macoum

- Uzuri Exporters Limited :Nairobi phone 748526 or 753652 or 745777 Fax 750043.

3. Uganda

3.1 Regions and need for seeds for disaster mitigation and relief

In Uganda, the agro-ecological zones can be characterized by highland in the south and savannah in the north. There have been years of drought in the north and sometimes there is a failure of the short rains in the highlands of the south. There has continued to be security probers due to rebels in the north along the border with Sudan that can negatively effect food security. In recent years Uganda has not been a user of seeds for disaster mitigation and relief.

3.2 Seed movement and trends

Uganda has been a net exporter of seed and foodgrain for commercial and relief purposes. Like Kenya it has a bimodal rainy season in the highlands of the south and at least the long rains have been good the last few years. The seeds for disaster mitigation and relief comes for the seed producer, the Uganda Seed Project, and local seed suppliers.

- Uganda has been a supplier of seed and food for southern Sudan when the road was secure but that is no longer the case

- Uganda has been a major supplier of seed and food for Rwanda and Burundi. The proximity of Uganda to Rwanda makes the transport much cheaper. As far as seed is concerned, this has been difficult because most of the agro-ecologies in Rwanda are much higher in elevation than those in Uganda except for the southwest corner of Uganda. Seeds for disaster mitigation and relief of sorghum and beans were purchased in the southwest corner of Uganda. Some maize seed that was purchase in Uganda for Rwanda by relief organizations but is only produced well at the limited lower elevation area because it was not adapted to the higher elevation agro-ecologies.

- The need for seed from the outside in Rwanda seems to be subsiding for the present. Burundi offers the possibilities of seed sales but Tanzania with its developed commercial seed sector is much closer than Uganda and it would have the edge on transportation costs.

3.4 Seed producers

- Uganda Seed Project (USP) is the only certified seed producer in Uganda. It was recently merged with the Legume Seeds Project. It is a parastatal for which there are plans to privatize. USP produces a wide variety of crop seeds that includes maize, sorghum, beans, peanuts, sesame, soybean sunflower and finger millet. As with most parstatals seed quality is often a problem since quality control and production are carried out by the same organization. USP has been an active exporter of seed some of which has been for relief efforts. For example in 1994 840,000 kg of maize were exported and only 254,898 kg was sold on the domestic market.
  Uganda Seed Project (USP)

  Kwanda Research Station
  PO Box 7065
  Kampala, Uganda
  Tel: 567212,567546,567532,567210
  Fax: 256 567211
  Contact: Fred Muhhuku, Seed Marketing Manager

3.5 Seed suppliers

- Kjaer & Kjaer is a large Danish international procurement organization. They are the sole distributor for Nissan vehicles and other equipment in Uganda. They are a large supplier of a wide range of commodities for national and international organizations. They import vegetable seeds from Vikima seed company in Denmark. At times they procure food grain on the local market when have a tender to do so but they would not be considered a significant supplier of seed for relief operations.

  Kjaer & Kjaer Uganda office
  Plot 45
  P.O. Box 12704
  Kampala, Uganda
  Tel: 256 41 251 756/7
  Fax: 256 41 251 751
  Contact: Jens Lilholm Deputy Manager

- Magric Ltd is a combination international procurement organization for equipment and a supplier for seed and foodgrain. They were very successful in providing seed to southern Sudan when the road was secure from norther Uganda. In addition the agro-ecologies are similar between Uganda and southern Sudan and predictable yearly order meant that contract growers could be used rather than hastily purchasing seed on the local market from merchants. Rwanda and Burundi have presented a difficult challenge for seeds for disaster mitigation and relief since there were large request of seed with a short delivery time line. The varieties that were being requested were not ones that were widely grown in Uganda except in the southwest corner. Nevertheless

they have provided 1,000 of tons of seed and food grain to Rwanda. They have facilities for the cleaning, grading, sorting, treating, and storage of seed.

Magric Ltd
P.O. Box 3218
Kampala, Uganda
Tel: 256 41 232 100,259-646
Fax: 256 41 244-606
Contact: Gordon Jones, Managing Director

- CEI (Commodity Export International) has focused on the sale of seed and food grain for relief operations most recently in Rwanda. CEI and Magric have a joint office in Kigali for relief operations. They purchase seed for foodgrain from merchant in the rural areas. The seed is then transported to Kampala where it is graded, bagged, fumigated and stored briefly until it is shipped. CEI has supplied maize, mixed and pure beans, wheat, sorghum, peanuts, sesame, garden peas and vegetable seed.

Plot 5 Nyondo Close
P.O. Box 10241
Kampala, Uganda
Tel: 256 41 250 212, 259 503,243 987
Fax: 256 41 244174
Contact: Karim Somani Chief Executive Officer

4. Ethiopia

4.1 Regions and need for seeds for disaster mitigation and relief

Ethiopia is a country of diverse agro-ecological zones and one that suffers recurrent drought. This phenomena has been linked not only to climatic patterns but deforestation, erosion, environmental degradation, over population, and annual crop production in areas that were traditionally pastoral. In serious drought years nearly the whole country can be affected with the north, northeast, south, southeast and southwest particularly severely affected primarily at medium and low elevations. A wide variety of crop seed have been provided for disaster mitigation and recovery, including maize, wheat, barley, teff, sorghum and various legumes that include chickpea, lentils, horsebeans, haricot beans. Even now there are pockets of drought in any year that can affect that include the highlands, mid altitude, and lowland zones.

4.2 Seed movement and trends

Except in severe drought years Ethiopia has not relied on seed imports to meet the demand for disaster mitigation. Maize seed was imported from Kenya in 1988,89,91. The Ethiopian Seed Enterprise has been the primary supplier of seed for disaster mitigation and recovery. The Christian Relief and Development Association(CRDA) which is an umbrella association of 106 international and local NGOs has played a key role in providing matching funding and arranging for purchase and transport of seed to smaller NGOs. The total of these seeds for disaster mitigation and relief including seeds tools and transport for 1985-1994 is over 66 million Bir which is over $10 million a current exchange rates. The ESE has been the primary supplier of

seed to CRDA but they have also use other seed suppliers. The logistics of moving large quantities of seed in the mountainous terrain of Ethiopia and delivery of seed on a timely basis is a major challenge. The feedback from the farmers through the NGOs indicate that seed varieties produced by the ESE don't always match the diverse agro-ecological zones of the country. In recent years seeds for disaster mitigation and relief has been confined to pockets in the various agro-ecological zones. With this scenario, the NGOs have been purchasing seed in local markets adjacent to the drought areas. In this approach there is a greater probability of getting locally adapted varieties and the transportation and timely delivery problem are ameliorated.

4.3 Seed producers

There are only 2 licensed seed producers in Ethiopia: the Ethiopian Seed Enterprise and Pioneer Hybrids. The Ethiopian Seed Enterprise was established as a parastatal but it is moving toward the status of an independent enterprise. Ethiopian Pioneer hi-bred Seeds Inc is a joint venture between the .Ethiopian Seed Enterprise and Pioneer Hybrids, a large American seed company. The National Seed Industry Agency has been established to facilitate the growth and liberalization of the seed industry in Ethiopia. A large World Bank funded National Seed Systems Project is in its initials stages and should provide a boost to the seed industry in Ethiopia.

- Ethiopian Seed Enterprise provides primary crop seed including crop seeds provided by the ESE are wheat and maize but other crops include barley, teff, sorghum, lentils, rape seed and beans.

  Ethiopian Seed Enterprise
  PO Box 2453
  Addis Ababa, Ethiopia
  Tel 61 22 66
  Contact Alemseged Aregai Acting Managing Director

- Ethiopian Pioneer Hi-Bred Seeds Inc. produces and markets hybrid maize varieties only. In addition some sunflowers seed. They have phased out of initial activities with vegetable seeds.

  Ethiopian Pioneer Hi-Bred Seeds Inc
  PO Box 1134
  Addis Ababa, Ethiopia
  Tel 55 35 04, 55 35 55
  Contact: Mr Worede, Director

4.4 Seed suppliers

- Tri-Med (Ethiopia office), Abbas Nazeralii, Tel 518-878,
- Awassa Green Wood, Mr Tadessa ,Tel 06 20 02 14
- EOPEC, Tel 11 04 27
- ODA Shares Co., Tel: 16 69 00, Contact: Hussein Ambo

5. Tanzania

5.1 Regions and need for seeds for disaster mitigation and relief

The agro-ecological zones of Tanzania are quite diverse and range from unimodal in the medium and low elevations to bimodal in the highlands. Drought conditions are usually localized. There has not been ethnic conflict in Tanzania. Consequently Tanzania has not been a country where seeds for disaster mitigation and relief activities have been undertaken. Relief activities in Tanzania have recently focused on the Rwanda refugees in western Tanzania.

5.2 Seed movement and trends

Tanzania has been a net supplier of seed for DMR. Seed producers in the Arusha area have provided substantial supplies of seed and food for Rwanda through the Seeds of Hope programs and other channels. The Arusha area will continue to be a significant seed producer for the region.

Within 150 kilometers of Arusha is one of the best bean seed producing areas in the world. European bean seed producers have been here for 30 years. Beans are particularly difficult to produce because of their susceptibility to disease. The Arusha areas has an elevation of 1400-1600 masl. Relative humidity is low, rainfall is normally sufficient, and temperatures are moderate during the growing season. Plowing begins before the short rains during December to insure that rains penetrate so that there will be sufficient subsoil moisture. Soils are warm at planting time(ideally late March) so that seed germinate and grow rapidly rather than succumbing to the damping off diseases. The rains normally stop before the extended harvest period of July-October and subsoil moisture is sufficient for pod filling. Temperatures remain moderate which is ideal for maturation and dry-down of the beans. In addition these growing conditions are also ideal for other seed crops such as maize, sorghum, and vegetable crops.

5.3 Seed producers

The Arusha seed producers represent a well organized and professional cadre that produce a world class product. Generally they use a combination of their own farms and contract growers of various sizes depending on the needs. Irrigation is used but most seed production is rainfed. Some growers practice intensive high input agriculture whereas others prefer a more extensive low input approach but the approach depends on the seed crop and business objectives. Crop rotation is extremely important in seed production to break pest and disease life cycles as well as being sound land husbandry. In bean production a 3 year cycle is preferred so that maize and sorghum and other crops are part of the rotation. Thus even seed producers that specialize in beans are involved in seed and foodgrain production of maize and sorghum. Some export bean producers would not consider growing bean seed that may introduce pathogens (such as bacteria) that can persist in the soil with the likelihood that subsequent bean seed crops could be affected/contaminated.

Cargill
PO Box 1280
Arusha Tanzania
Tel: 6877, Fax 8702
Contact: Roger Banfield Managing Director

Specialize in hybrid maize and sorghum for the domestic and regional market. Cargill produced maize seed in cooperation with CIMMYT for the Seeds of Hope project in Rwanda

Pop Vriend
PO Box 572
Arusha
Contact: Ekko Oosterhuis Seed Production Manager

Pop Vriend is a Dutch seed company and this is the Tanzania branch. Pop Vriend Tanzania is a producer, processor and exporter of vegetable seed and beans for the local and export market.

Rotian Seed Co
PO Box
Arusha, Tanzania
Tel: 7408,8208
Contact: Shauka Bruinsma Managing Director

Producer of bean seed (1000 tons annually) of propriety private varieties primarily for European seed companies for the commercial market. Rotian also produces some maize and sorghum in rotation with the bean crops. They use a combination of their own farm and large contract growers. Rotian produced some seed in cooperation with CIAT for the Seeds of Hope Project in Rwanda.

Sluis Brothers
PO Box 350
Arusha, Tanzania
Tel: 2131/8613
Contact: J.A Smit Managing Director

Produce beans(1000 tons annually) of public varieties primarily for the backyard gardeners in Europe on their own farm of 3500 hectares. They also produce seed and food beans, maize, and sorghum for the local and regional market.

Tanseed (Tanzania Seed Company Limited)
PO Box 939
Tel 3181
Arusha, Tanzania

Tanseed historically has been the parastatal seed producer and supplier. However at the present time Tanseed is up for sale so that they are in a state of transition and uncertainty. Their

seed production has dropped dramatically in the last few years. They offer a range of cereal and legumes and oil seeds that range from hybrid and composite maize, sorghum, wheat, rice, soybeans, beans, sunflower and cowpeas.

6. Burundi

6.1 Regions and need for seeds for disaster mitigation and relief

Burundi lies entirely in the highlands region of East Africa and as a result it has a bimodal or even trimodal rainy season. Though there can be a crop failure of one of the rainy seasons normally crops like bananas, cassava and sweet potatoes insure adequate food security. Recent food insecurity and need for seeds for disaster mitigation and relief has been based on ethnic conflict and not drought.

The civil crisis of 1993 created the demand for relief and seeds for disaster mitigation and relief in most of the provinces of the country but some were much worst than others. Improved security conditions in the 1995 "B season" have resulted in better food production but the situation remains uncertain despite adequate and well distributed rains. In the 1995 "A season", 90 to 95% of the cultivated land was farmed in the Northern and Central Provinces which had been seriously affected by the ethnic conflicts. However overall production was hampered by insecurity in the communes of Ngozi, Kayanza, Kirundo, Muyinga, Maramvya in the Northern and Central provinces by lack of access to land by the affected population resulting in limited crop cultivation, looting, stealing and early harvest of roots, beans and maize. The Southern providence had normal planting levels since this area was less seriously affected by the crisis.

There was a lack of seed for both Irish and sweet potatoes and cassava due to previous looting. There was also a shortage of quality maize and bean seed since the seed sector virtually ceased functioning. The situation for the 1995 season B and C were still below normal due to continued insecurity. Excessive rain in some areas resulted in crop losses due to waterlogging, diseases, and pests.

6.2 Seed movement and trends

Substantial seed of maize and beans was supplied to Burundi from Uganda in 1993. More recently The Seeds of Hope project had encouraged NGOs to purchase bean seed in Burundi for seeds for disaster mitigation and relief in Rwanda. The agro-ecological zones of Rwanda and Burundi are similar which implies that in cases of need for seeds for disaster mitigation and relief that they can be important sources for seed for each other. Historically there was a the Kajondi seed farm in the province of Burui that produced potatoes, maize and wheat. The national extension service had seed multiplication farms in each province. Unfortunately due to insecurity these sources of seed are not functional.

6.3 Seed producers

Institut Des Sciences Agronomiques de Burundi
PO Box 795
Bujumbura, Burundi

Basic seed production of legumes, potatoes and wheat.

Institut Technique Agricole du Burundi
Gitega
cereals and forage

6.4 Seed suppliers

Magric Ltd
P.O. Box 3218
Kampala, Uganda
Tel: 256 41 232 100,259-646
Fax: 256 41 244-606
Contact: Gordon Jones, Managing Director

CEI (Commodity Export International)
Plot 5 Nyondo Close
P.O. Box 10241
Kampala, Uganda
Tel: 256 41 250 212, 259 503,243 987
Fax: 256 41 244174
Contact: Karim Somani Chief Executive Officer

7. Rwanda

7.1 Regions and need for seeds for disaster mitigation and relief

As in Burundi, Rwanda has a bimodal or even trimodal rainy season. Though there can be a crop failure of one of the rainy seasons bananas, cassava and sweet potatoes insure adequate food security. Food insecurity and need for seeds for disaster mitigation and relief has been based on the civil war and ethnic conflict not drought.

The civil war of 1994 resulted in an estimated 800,000 deaths and created the massive movement of nearly 2 million refugees out of Rwanda into primarily Zaire and Tanzania and to a limited extent into Uganda and Burundi. As these population move back into Rwanda, they are provided with repatriation kits that includes food, tools, seeds, and other commodities. There were 290,000 internally displaced persons in Gikongoro as of February 1995. In these situations seeds for disaster mitigation and relief is provided to families when they reach their village

7.2 Seed movement and trends

The Seeds of Hope project lead by CIAT and in cooperation with other IARCs (CIP, ICRISAT, IITA,) and the NARI have worked with NGOs such as World Vision and CARE, and other relief organizations to facilitate the initial multiplication of improved varieties and local landraces outside of Rwanda in Kenya, Tanzania, Burundi, Uganda with NARIs and private seed producers. This cooperative approach to seeds for disaster mitigation and relief has shown how a broad range of local regional and international organizations can work together in seeds for

disaster mitigation and relief. Now seed multiplication is ongoing in Rwanda and the Service Semences Selectionnes has began again to supply seed for seeds for disaster mitigation and relief.

7.3 Seed producers

Service Semences Selectionnes
Ministere de L'Agriculture
PO Box 538
Kigali, Rwanda
Tel: 83922

With assistance from the Belgium government, the Service Semences Selectionnes of the Ministry of Agriculture is producing seed on their own farms of climbing and bush beans, Irish potatoes, soybeans, and maize. In the area of vegetable seed they produce tomato and eggplant seed and import recommended varieties of carrot leeks, tomato, cabbage and onions in 3 gram packets.

World Vision
BP 1419 Rue Kamuzinzi
Kigali, Rwanda
Tel: 75762/76791

They are producing soybeans, beans, maize and groundnuts on their own farms or with contract growers.

7.4 Seed suppliers:

Development Services Limited (DLS)
BP 2005
Kigali, Rwanda
Tel: 75977

Ets Trading link Enterprises
BP 3043
Kigali, Rwanda
Tel/Fax 82955

J. K. R. Enterprises
BP 2341
Kigali, Rwanda
Tel: 85103

Tri-med(Rwanda Affiliate)
Magerwa
Entrepot de Douance C5
BP 380

Kigali, Rwanda
Tel 250 73684/83383
Fax: 250 73684
Contact: Adrian Babault

The following two seed suppliers from Uganda maintain an office in Kigali because they have been major seed suppliers during the recent crisis.

Magric Ltd
P.O. Box 3218
Kampala, Uganda
Tel: 256 41 232 100,259-646
Fax: 256 41 244-606
Contact: Gordon Jones, Managing Director

CEI (Commodity Export International)
Plot 5 Nyondo Close
P.O. Box 10241
Kampala, Uganda
Tel: 256 41 250 212, 259 503,243 987
Fax: 256 41 244174
Contact: Karim Somani Chief Executive Officer

8. Sudan

8.1 Regions and need for seeds for disaster mitigation and relief

Sudan is the largest country in Africa with 3 distinct agro-ecological zones and enormous agricultural potential.

- The northern one third with 0-400 mm annual rainfall but where crop production is mainly irrigated

- The central savannah with 400-700 mm annual rainfall which comprises half the country and has the most important rainfed and mechanized farming. In this zone there is the western region with sandy soil relatively low rainfall and shifting cultivation of millet & sorghum, and periodic drought. The eastern region with clay soils, higher rainfall and most of the mechanized agriculture of sorghum, sesame and oilseeds.

- The southern zone with high rainfall (750-1500 mm) covering one sixth of the country with small scale mixed cropping of tropical crops.

The 3 significant agriculture sectors of Sudan cut across the 3 agro-ecological zones. There is the modern irrigated area of 1.5 million hectares in the central and northern regions. The

mechanized rainfed area with 2.5 million hectares in the eastern, southern and central regions. The traditional rainfed area of 4 million hectares in western Sudan.

Sudan is the only country in the GHA that exports food (400,000 tons of sorghum in 1995) because of its substantial area under irrigation and mechanized agriculture. Cash crop exports include cotton, peanuts and gum arabic. There are problems equipment, equipment maintenance, fuel needed for irrigation and mechanized agriculture and input credit for farmers. Despite these positive factors there is chronic problems with food insecurity and the need for seeds for disaster mitigation and relief. The long running civil war in Sudan has created insecurity in southern Sudan and an ongoing need for SDMR despite the favorable agro-ecological factors. There is some need for seeds for disaster mitigation and relief in the west of Sudan due to drought..

8.2 Seed movement and trends

For several year seed were supplied to southern Sudan from Uganda. Recently due to the insecurity in northern Uganda and shifts in the areas of conflict, seed is supplied by airplane directly from Kenya. The food insecurity situation is very changeable since intensity and location of the conflict has a very negative effect on what would otherwise be food surplus region in southern Sudan. Innovative programs are under way to encourage food production for barter so that the food can be used for relief efforts in other areas of southern Sudan. Similarly seed multiplication is being undertaken to produce adapted varieties to encourage self sufficiency and avoid the high cost of shipping seed by airplane.

8.3 Seed producers:

The National Seed Administration is the central government agency with two branches There is the Plant Propagation Administration(PPA) responsible for the multiplication and distribution of seed. There is the Seed Certification Administration (SCA) responsible for seed certification and quality control.

The PPA has eight main seed stations covering most of the country. Each station has it own farm machinery, seed conditioning equipment and storage facilities. The seed multiplication includes wheat, sorghum, legumes, groundnuts, kenaf, vegetables, and fodder.

Hudeiba and Dongolla in the north
El Girba and Sumsum in the east
Sennar in the central region
Sennar west, Tozi central
Abbasia west

Gezira Seed Unit
Rahad Agricultural Corporation
New Halfa Agricultural Corporation
Mechanized Farming Corporation

There are no seed producers for southern Sudan. There are a number of seed producers for northern Sudan which do not supply seed to southern Sudan.