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Famine Mitigation Strategy Paper

WATER RESOURCES MANAGEMENT STRATEGIES FOR FAMINE MITIGATION ACTIVITIES

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Foreword

The Famine Mitigation Strategy Papers have been developed as part of an effort by the United States Agency for International Development, Office of U.S. Foreign Disaster Assistance, Prevention, Mitigation and Preparedness Division to assist famine response agencies and personnel in developing and designing effective interventions to respond to extreme food insecurity and famine situations. In preparing these papers, input was solicited from a broad range of specialists from the international donor community, the academic community, governmental and non-governmental agencies, and independent specialists in the field. These papers provide policy makers, program planners, and project managers with basic background information and a range of approaches for developing programs and projects in the areas of early warning and response systems, rapid assessment methodologies, seeds and tools interventions, livestock interventions, water resources development, market interventions, food/cash for work programs, and in providing assistance under conflict situations.

It is becoming readily apparent that the most effective response strategies are those that identify deteriorating situations and initiate appropriate responses early on in an emerging or incipient famine process. Strategies that respond not just to the immediate symptoms of the emergency, but also to the underlying causes of this vulnerability provide the needed and often missing link between ongoing development, emergency relief, and recovery efforts. Many of the papers produced under this effort differ from traditional relief oriented approaches in that they bring a developmental approach to the provision and implementation of relief assistance.

In an era of declining emergency resources and increasing potential and actual food insecurity situations, it is imperative that we explore and test approaches that are more cost effective, provide rapid and positive impacts, strengthen and enhance local capabilities, and provide some level of sustainability once the initial resources are exhausted. Greater emphasis will also be placed on more effective monitoring of both the short term and the longer term impact of these types of interventions. We hope that these papers can serve, in part, as catalysts in the further development of policies, programs, and projects that better respond to the needs of those most vulnerable to the famine process.

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Water Resources Management Strategies for Famine Mitigation Activities

Introduction

This paper is written as a practical guide and reference to Water Resources Management for those involved in the planning and approval of projects related to drought and famine mitigation activities in Africa. This paper is based upon the experiences and written reports of project officers as well as from development journals and technical sources concerned with the design, implementation, and evaluation of Water Resources Management projects.

Water Resources Management (WRM) includes a number of interventions which can be conveniently divided by user group (people, animals, other crops,) and by intervention type (water access, water gathering and storage and water use). During periods of drought, the supply of water cannot meet the normal needs of various water user groups. There are degrees of drought. One poor rainy season could mean drought devastation for a rainfed grain crop but might not significantly affect perennial nut trees or domestic water supplies. These single year events are usually not called droughts but rather dry spells, which are of a limited scope and duration. Droughts occur over a number of years and adversely affect all user groups. It often takes as many years of average rainfall to recover from a drought as it did to cause it. When droughts follow each other over a period of many years, significant environmental changes occur. This results in the emergence of low water demand ecologies that are not as drought sensitive as the pre-drought plant and animal systems had been. When this happens, ironically, the drought ends since reduced water demand in response to the reduced supply resets the balance of supply and demand to normal. Conversely, drought can occur when new demands are placed on limited, though normal, water supplies. This is a common occurrence in the settlement of marginal lands in arid and semi arid zones. Most droughts are of this variety which feature increased demands on limited water resources and a general degradation of natural water storage through land clearing. These altered conditions magnify the effects of deficit variations in precipitation and transform dry spells into droughts.

Under conditions of drought and famine the first goal of Water Resources Management is life support. This includes the provision of enough water of good quality to meet daily human requirements (about 10 liters per person per day) and the establishment of basic hygiene and sanitation measures sufficient to prevent the spread of water and fecal borne diseases. The second goal is to rehabilitate and improve the WRM infrastructure and to increase levels of local competence in order to assure continued maintenance and development of infrastructure. As listed above, there are essentially three ways to do this. First, access to existing water can be improved by interventions like deepening wells or building spring boxes with simple gravity distribution systems. Second, collection and storage of rainwater and surface water can be improved by constructing manmade collectors and storage units such as dams or cisterns, and by reestablishing natural collectors and storage like trees and seasonal water holes. Third, water use patterns can be modified by measures such as changing crop varieties and cultivation practices or reducing herd numbers and changing the mix of animal types. The choice of intervention depends on existing physical conditions as well as on user needs, available human and material resources, and existing practices. In all cases, successful implementation depends on knowing which organizations are

normally involved in WRM activities, what their relationship is to the affected communities, and how they can help those communities to achieve the project goals.

When drought leads to famine, the list of feasible WRM interventions becomes reduced because of the loss of cattle, the abandonment of agricultural lands, and the breakup and dislocation of communities. Under these circumstances, the priority interventions are usually to secure adequate supplies of potable water and to prevent loss of life by controlling the spread of water borne diseases through improved hygiene and sanitation practices. Famines that arise from political conflict rather than drought require similar WRM interventions though their implementation can be much more difficult. In these cases, as well, it is important to involve those who are affected by water supply problems as participants in the design and implementation of the solutions. This is especially important for displaced groups who need useful work and reasons to organize in order to regain their ability to constructively respond to adverse situations.

The criteria given by OFDA for drought and famine mitigation activities require that interventions, while being relatively simple and low cost, have a measurable and broad impact on affected populations. These criteria are similar to those applied to many community based development programs which seek to design low cost interventions that are readily accepted and replicated by the program's client communities. In order to be accepted, the interventions need to have obvious short term benefits while not costing the community much in cash or labor. To be replicable, which is necessary for broad impact, the interventions need to be based on existing skills and resources. When new techniques and technologies are introduced they should be simple enough to be easily and quickly learned. This permits technology transfer within communities and locally between communities without much need of external assistance. The types of projects that have these qualities usually contain a sizable community participatory training component for promoting changes in behaviors and practices. External inputs of capital and materials are less important to these participatory projects than are skill training and the mobilization of local resources.

The time frame for participatory development projects can vary. The usual project life span is from two to five years. This includes several months for initial assessment and planning, and several months for administrative, staffing, and logistical start up activities. The skill training component usually begins with a pilot training of two days to two weeks duration. This is followed by additional training, modified as necessary, and teacher training to build a capacity for dissemination. A major goal of many projects is to completely turn over project operations to local staff and local funding by the end of the project life. It is a difficult goal to achieve because changes in project staff and project financing often occur which blur the original project timetable and objectives. Most projects are forgotten soon after their funding expires, and the gains they made in skill training and local institution building fade from the collective consciousness of the development community. When contemplating a development activity, it is therefore quite advantageous to uncover recent development history so as to identify experienced individuals and local organizations who can be of invaluable service in realizing the new project's objectives. Building an intervention on existing organizations and expertise not only saves time and money but also reinforces the community's sense of its own competence and ability to manage its environment.

Drought and famine relief interventions have strict time constraints and a strong emphasis on logistics when dealing with emergency situations. Once food distribution is underway and support levels of food availability are established, the emphasis is redirected to activities concerned with recovery and preparedness. This is when straight relief turns into mitigation with longer time horizons and greater emphasis on capacity building, and when food/cash for work programs replace direct distribution. Mitigation can be seen to fall between relief and development. By utilizing the delivery structures and contacts established by prior local development projects, mitigation activities can increase the scope of their interventions beyond the limits of relief while avoiding the time and expense involved in setting up a development project. The primary goal of mitigation activities is to prevent future disaster by establishing strategies and systems that reduce and counteract the adverse effects of drought and food shortages. Achieving this goal involves improving physical and social infrastructures to be more responsive to recurrent or emerging crises. Experience shows that reaching this goal of responsiveness requires the full understanding and participation of the people who are most affected by the crisis. Although external technical assistance is often quite valuable, the final responsibility and hope for a viable drought and famine response strategy rests at the community level. This is especially true in situations where government agencies, normally responsible for technical assistance, do not have the capacity to intervene at the local level, and might even have an antagonistic relationship with the affected communities. The successful application of external assistance depends on matching the type and scale of assistance directly to the needs and abilities of the target group. Directing assistance through local organizations and locally focused development agencies is the best way to establish an effective drought and famine response system.

This paper is divided into four main sections. The first section begins with an overview of the principles of water cycles and of natural collection and storage systems. This is followed by a brief examination of watersheds and how they are affected by human interventions. The final part of the first section looks at various WRM technical interventions and management practices used in the developing countries of Africa. The second section looks at the effects of drought on WRM technologies and practices, and at the community, government, and external agency responses to drought and famine related water problems. The third section examines the effects of economic, political, social, and technical factors on WRM practices and interventions as well as on water use patterns. The forth section develops recommendations for WRM activities by using a standard project planning methodology that identifies problems and possible solutions, sets objectives, identifies resources and constraints, and develops an activity implementation and evaluation strategy. A descriptive list of useful technical references is provided in the final section.

1.0 General Principles

Water is one of the most plentiful substances on earth, though fresh water comprises only 3% of all water. Seventy five percent of this water is locked up in glaciers and ice. Another 15% is held in deep aquifers below 800 to 1000 meters. The remaining 10% of fresh water is in active circulation. It cycles continuously between the land, ocean and atmosphere. After it returns as precipitation, it is either absorbed by plants and soil, lost as runoff, or evaporates into the atmosphere. The water that stays in place is collected, stored, and eventually released through a series of reservoirs beginning with plants, which are 80% water, and the organically rich topsoil

topsoil sponge which holds many times its own weight in water. Deeper under ground there are usually several water bearing layers (aquifers) which are recharged by infiltration and which slowly release their water into springs and streams. Taken as a whole, this system regulates and maintains available water supplies by quickly absorbing the water of infrequent rain events and then by releasing it slowly through seepage into streams and by transpiration and evaporation into the atmosphere.

Half of the water that is absorbed is stored in plants and the top 50 cm of soil. The other half infiltrates into underground storage along pathways made by roots and insects. More than half the rain that falls returns to the atmosphere and contributes to succeeding rain events. Inland forests provide almost half of the moisture for these rains as well as the bacteria around which water droplets form. Trees also provide moisture that returns during cool nights as condensation which collects on leaves and other cool surfaces, thus creating a daily subcycle of evapotranspiration returning as condensation. In fact condensation accounts for the majority of captured precipitation in coastal and mountain forests. There are even humid tropical mountain forests on islands where it never rains and all precipitation is from condensation. In desert areas, especially those near oceans, condensation can account for the majority of annual precipitation. In a well established forest there is very little runoff. Mature rain forests capture almost all the rainfall in their canopies and barely a drop falls directly to the ground. The normal runoff rate for wooded and grass areas is 10% of rainfall. Undisturbed lands in arid and semi arid zones have a 20% runoff rate. Cultivated lands, depending on soil type, allow 30% to 50% runoff. Poorly cultivated and overgrazed lands with compacted soils have a 60% to 90% runoff rate.

When land is cleared for cultivation, it not only becomes less able to prevent runoff, it also loses its ability to capture water from condensation on leaves and its ability to store water in plants and their leaf litter. In tropical climates when land is cleared and exposed to direct sunlight it quickly loses the water holding organic matter in its topsoil to oxidation. The thin topsoil is then itself lost through wind and water erosion. When the subsoil is consequently exposed to the sun, a glazed crust usually forms which prevents infiltration and the recharge of underground storage. The difference in water collection and storage capacity between degraded land like this and undisturbed land with vegetative cover is considerable. In places that receive about 15 cm of rain annually, land that cannot capture most of the meager rainfall cannot support vegetation and will tend to remain barren and without agricultural value.

This condition of severe degradation exists on a large scale in many of the drought prone countries of Africa. Although there has been a long term deterioration in the productivity of arable lands throughout arid and semi arid regions, due in part to population pressures on fragile lands and in part to 20 years of recurring droughts across the continent, little attention has been given to repairing the land through soil and water conservation measures. However, recent interest on the part of the development community in environmental protection and biodiversity has brought greater attention to land use management as part of an integrated approach to solving the problems of human settlements on marginal lands. A major part of any land use management plan is the management of the water resources within a defined watershed. Watershed boundaries can be drawn around small or large land areas depending on where the downstream boundary is set. The upper boundary is defined by the high contours that delimit the collecting area for all the water that drains through the downstream boundary point. When mapped, a watershed resembles a fan with

the handle being the downstream boundary point. The watershed for the Senegal River covers an area of more than a million square kilometers when the downstream boundary is placed at the river's mouth. The watershed for one of its tributaries might cover no more than a thousand square kilometers. Most rural villages, including their fields, have a defined watershed of no more than a hundred square kilometers.

Once the watershed is defined, interventions can be designed to improve water collection and storage capacity throughout the area and to locate the best placement for water access points. This is important for determining the type, scale, and location of various agricultural activities and for developing local drought mitigation strategies. Well managed, mixed use lands can have the same or greater water holding capacity as that of undisturbed land and more than twice the capacity of normally cultivated land. Managed resources and a diverse agriculture are essential elements of a well planned drought mitigation strategy.

WRM technical interventions can be conveniently divided into three basic activity groups. The first group includes the water supply elements of access and transport. The second group includes water collection, storage, and drainage. The third group includes practices and technologies that conserve water and water quality. Successful technical interventions depend on both a thorough understanding of local conditions and resources and knowledge of the materials and skills required for implementation. A well designed activity fits the technology to the situation and utilizes the least materials and energy necessary for success. In each of the following descriptions of WRM interventions, material, labor and skill requirements are identified, as well as the general conditions and practices that determine the type of technology to be used. Further discussions of the factors influencing the choice of interventions and implementation strategies are presented in the following sections.

1.1 Water Access

Most water supplies come from wells and most wells in the developing world are hand dug holes with a diameter of about a meter. These tap shallow groundwater tables that are sensitive to the amount of annual rainfall and to the infiltration rates of the surrounding land. Traditional wells of this kind are not usually stabilized at the top or bottom of the shaft, which results in the erosion of these edges and the eventual collapse of the well. This problem can be corrected by stabilizing the tops and bottoms of the wells with masonry or some other durable material. In stabilizing the top, a low wall or cover slab is built for safety and to exclude dirt and dung from entering the well. Bottom stabilization helps to prevent the soils in the aquifer from slumping into and blocking the well. It also allows the well to be safely deepened if the water table recedes during dry spells. To safely penetrate into the water table, capturing columns are placed in the well and sunk several meters until they hold a constant charge of water. Inexpensive capturing columns can be made of bricks assembled in the well to avoid the need for heavy duty lifting equipment. When a well passes through loose soils, the well walls can be stabilized with reinforced mortar but this is not necessary in consolidated soils. Improved traditional well construction and repair is by far the least expensive and therefore most widely applicable means for increasing access to water. These interventions require few imported materials and use locally available skills and tools. The techniques employed are built on existing practices and are easily taught to local masons.

Improved traditional wells are the less expensive version of stabilized large diameter wells. The more expensive version built by most government water departments features reinforced concrete linings and head walls and heavy precast capturing columns. Constructing this type of well requires heavy equipment and lots of cement. The construction cost is about ten times more per meter than for the improved traditional wells described above. These heavy duty wells were the main model of the colonial period. Fifty year old examples can be found in many places. Few are still in use because of the expense of deepening them when the water table drops. When large diameter wells are mentioned to funding agencies, these are the wells that usually come to mind and are rejected for not being cost beneficial.

The large capital intensive water supply projects of the water decade favored machine drilled, tube wells. Their major advantages are that they can reach deep water tables that are not as sensitive to variations in local rainfall as are surface water tables, they provide a sealed access to potable water that is not liable to be contaminated by ground water pollution, and they can be rapidly installed and quality controlled. It is also easier to control a project and to meet production goals when the complexities of local community participation are minimized. In places with low volume, perched aquifers, shallow wells can often dry up between rainy seasons. In such cases drilled wells become the best access to year round supplies of water. Deep drilled wells require expensive imported materials and sophisticated machinery. They also have the disadvantages of being difficult to deepen if ever they go dry and of being pump dependent. When the pump breaks, which often happens within the first year after installation, the well becomes useless. Poor transport systems and inefficient spare parts distribution can delay a pump repair for several months. And there is always the question of who pays for the repair and who owns the pump. Most communities feel a greater sense of ownership and responsibility for a well that they have constructed and which they know they can repair themselves. Drilled wells are usually most appropriate in peri-urban situations where logistics are not too difficult and where water can be sold to keep the pump in repair. In rural situations, drilled wells are most effective in tandem with large diameter wells where the advantages of each offset the disadvantages of the other.

Shallow tube wells, a distant cousin to deep drilled wells, can be hand drilled using fairly inexpensive, light weight equipment. Tube wells are most effective in areas with light sandy soils and can be the best solution for remote areas where the transport of the cement needed for stabilizing large diameter wells is difficult and expensive. Because of lower lift requirements, shallow tube wells can be fitted with pumps that are fairly easy to maintain.

When available, the water from ponds and streams is used for many purposes. This presents health and sanitation problems for both people and animals. Whenever possible it is best to control access to standing water. Shallow wells placed next to ponds and streams provide earth filtered water even after the surface water is gone. In river plains the old channels which can be identified from aerial photographs usually contain a thick, sandy reservoir which can be easily tapped with shallow wells. Hand drilled, tube wells are especially effective under these conditions.

Improved access to water resources can also be achieved by improving transport techniques to reduce the time spent in fetching water and to maintain potability. Pumps, pipes, and pails are transport elements that can be advantageous when well matched to individual water point conditions and to maintenance capabilities. As noted above, a pump that breaks and stays broken for a long

time can negate the considerable investment sunk into a deep well. On the other hand, fixing the pump recovers a valuable resource. In situations where many pumps are down for lack of spare parts, an emergency distribution of repair parts can be the catalyst to renewed water access for many needy users.

1.2 Water Collection and Storage

The collection and storage of precipitation can be seen as a form of energy conservation. When the potential energy of water is held in the various surface and underground storage reservoirs of the upper watershed it can be slowly released down hill as it is needed. The natural systems in watersheds work on this principle of controlled energy flow. They collect and store the water of occasional rain events and release it slowly so it can be consistently available for life support. When these storage systems are destroyed, the energy flows become erratic, moving between the extremes of flood and drought. The most cost effective projects for improving water collection and storage are those that repair and build on natural systems.

Water collection activities can be divided into a number of categories according to where they occur along the slope of the watershed. The upper boundary of most watersheds has steeply sloped ground that can easily erode when cleared or overgrazed. This is the primary rain and condensation collecting area and should be kept in trees or other perennial vegetation. Fields further downhill should have the planting rows laid out along existing contours. In eroded fields, rock or brush lines can be placed along contours to collect and stabilize the top soil and the erosion channels can be plugged with rocks and sticks which also collect soil and keep the channels from deepening. Steep slopes are sometimes terraced to provide stable planting areas, while on shallow slopes contoured fallow strips can be used to stabilize fields. With interventions of this kind, the general objective is to place many small structures high in the watershed to break the acceleration of the soil and water moving downhill. This also helps to recharge ground water reservoirs and to restore a balanced water flow. Small scale interventions of this kind are low cost, low risk activities that show positive results within the first year of installation. They require simple leveling instruments and locally available materials and tools. There are many examples of successful community participation programs that have trained farmers in these techniques.

In the lowland areas of the watershed, small dams can be placed in drainage areas and streams to hold water or to redirect it. As with the upper watershed, several small scale structures are preferable to a single large one because the risks and consequences of failure are much less for small structures. One meter high dams, when properly situated, can inundate many hectares providing water for growing rice and fish. When gardens and orchards are planted along the banks, they can profit year round from higher ground water tables. In fact, many small dams have been built for the sole purpose of raising the water tables in surrounding wells. In dry hot environments, where evaporation rates can exceed 1.5 meters per year, it is more efficient to store water underground.

In areas of very low rainfall and largely degraded soils it is often possible to collect runoff water through the use of low walled catchments that concentrate and direct the water to growing areas. This effectively increases the available water of each rain event to levels sufficient for growing crops. Techniques of this kind have been used around the Mediterranean for centuries, especially

for establishing tree crops. The size of the catchment can vary from 20 cm^2 to 20 m^2 depending on the soil type, slope, and crop.

Included within the water collection and storage category are catchment and cistern systems. There are many varieties of these systems which date back at least to Minoan times. In rocky areas, large systems have been made by directing runoff water from barren hillsides into large, sealed underground cisterns. Smaller systems have been designed in recent years to collect the runoff from sheet metal roofs and store it in ferro cement tanks of about 10 cubic meter capacity. These systems are best suited to situations where most months see some rain or where potable water is hard to find or expensive to buy. An inground cistern measuring 3x3x3 meters can hold about 27,000 liters or enough water to supply 100 liters per day for nine months of continual use. This size cistern has been built in Southern Ethiopia using 30 sacks of cement per covered cistern.

1.3 Water Conservation

One of the important activity areas of WRM that is often ignored by concrete minded programmers is water conservation. Like energy conservation it involves the deliberate reduction of demand in response to reduced supply and the development of an emergency response strategy that gives priority to the preservation of the assets necessary for survival. To preserve family health assets this involves practices that help assure the potability of drinking water and the control of water and fecal borne diseases. Such practices include washing water carrying and storage vessels to maintain water quality from pump to cup, hand washing with soap before food preparation or eating and after defecating, washing cuts with soap and clean water to prevent infection, preparing and administering oral rehydration solution to those suffering from diarrhea. Studies show that the adoption of these simple practices has reduced infant mortality in some communities by more than half. Under conditions of famine when malnourished bodies have lowered resistance to infection the number of lives saved would be even greater.

In agriculture, water conservation includes adaptive practices such as changing planting times and planting depths to adjust to changes in rainfall patterns, changing to crops and crop varieties with lower water demands and adjusting herd sizes and animal mixes to avoid overgrazing, especially around water points. To preserve productive assets priority attention is given to the survival of perennial crops like fruit trees that require several years to mature, and draft animals and breeding stock. Drought response strategies can also include redirecting human energy to the more intensive management of the land around secure water sources to produce fruits, vegetables, and quick growing proteins instead of devoting labor and seed resources to field crops, like maize, which can often fail during droughts.

Most conservation improvements require few additional inputs of money or materials. They require changes in attitudes, behaviors, and practices that cost nothing but the thoughtful, active consent of the members of the client community. All interventions that seek to improve the living conditions of distressed populations require the client's active consent in order to be successful.

2.0 Responses to Drought

As drought develops water supplies become less and less available to water users. The users that depend directly on rainfall, such as annual grasses and forbs, are the first to be adversely affected. Extended droughts can cause deep rooted plants to die back and eventually to fail completely. This reduces the habitat and food sources of the local animal population and forces first the larger animals who require relatively greater amounts of food and water and eventually smaller animals to leave the drought stressed environment or perish. A very severe drought, or a series of droughts, can permanently affect the character and composition of the local environment. This occurs when life forms within an ecological system are eliminated, leaving no seed or progenitor to reestablish the species. Other elements that depend on that species for food or for propagation are themselves then placed in hazard of elimination. Though rare in nature, this process of elimination commonly occurs during land clearing and settlement activities, especially in the marginal areas of arid lands. When an existing drought resistant ecology has been altered and replaced by introduced plants and animals that are much less drought tolerant, the risk of drought triggered catastrophe becomes much greater. In fact, normal cultivation practices tend to compromise the water collection and storage capacity of the existing natural systems thereby increasing the incidence and duration of water deficit conditions. In this way drought and desertification can be seen as more often the result of destructive human activities than of periodic changes in weather patterns. The disruptive effects of forest and land clearing that occurred more than two thousand years ago around the Mediterranean are evident today and serve as mute testimony to mankind's self destructive war against nature.

The plants and animals of arid environments exhibit a variety of behaviors that enable them to survive the effects of drought. These coping mechanisms include such things as the ability of some annuals to quickly develop and set seeds which can remain dormant for many years until there is sufficient moisture for germination. Some insects and amphibians exhibit similar abilities. Many trees respond to drought by shedding their leaves to reduce water loss through transpiration. There are also many plants, such as the buffalo gourd, with root systems that can swell to store large amounts of water for long periods of time. Other drought tolerant plants have dual root systems with a deep, water seeking tap root and a large shallow mat of surface water collecting roots that can take full advantage of infrequent rains. People who have lived in arid lands for generations are usually quite knowledgeable about the water conservation and drought coping behaviors exhibited in nature. Their coping strategies are often derived from and depend on the observation of natural systems which allows them to successfully adjust to reduced water availability. Like the plants and animals around them, they can survive drought by adjusting their water consuming activities to match available supplies. They also live within the existing natural systems, getting most of their food from indigenous sources and locally adapted cultivars.

On the other hand, drought intolerant behavior does not respond to reductions in water availability. This intolerance is most characteristic of agricultural systems that employ domesticated plants and animals which are bred for productivity more than for survivability, and which depend on relatively large amounts of food and water to survive. Without consistent supplies of water they are at great risk of perishing during times of drought. The widespread practice of growing high input crops like cotton on fragile tropical dry land soils is quite risky. It is also quite dangerous to the environment since the heavy inputs of water and chemical fertilizers and insecticides required

for commercial production can easily destroy soil structure and fertility making land useless for needed food production. Cotton production is an extreme example of extractive agriculture, but almost any form of agriculture can be extractive if it degrades and destroys its growing environment. Unfortunately, modern agriculture, as it is practiced in the developed world and taught in the developing world, is, for the most part, extractive and unresponsive to the local environments on which it is imposed. Rather than being a solution to falling productivity it exacerbates the deterioration of natural drought tolerant ecologies and indigenous responsive agricultural practices thereby increasing the risk of crop failure and famine during even moderate periods of drought.

The differences between relief activities and mitigation activities define the differences between short term and longer term responses to drought. Short term responses tend to fall within the domain of crises management. They are reactive and are concerned with solving immediate problems. Longer term responses are concerned with preventative measures that are intended to reduce the adverse effects of drought. Longer term responses are often initiated before or after drought events and involve mitigation activities rather than short term focused relief activities. Within the realm of WRM, short term responses are most often concerned with assuring the availability of drinking water and with the repair of water moving systems like pumps and canals. The deepening of wide diameter shallow wells, which are the most common mode of water access, is a primary water supply activity. It is best to deepen wells during the dry season when water tables are low. The dry seasons during droughts usually have the lowest water table levels and therefore present the best opportunities to sink a capturing column deep enough into the water table to assure water supplies even during the driest of times.

However, activities of this type which attempt to improve infrastructure are only feasible as a short term intervention when the necessary materials, labor, and know how are readily available. Setting up a locally based well deepening program from scratch is a long term project which, if initiated in advance of a drought, can have a significant positive impact during a drought crises. Of equal potential impact are activities that focus on the repair of pump sets on small diameter tube wells. In almost all water supply projects that use hand operated pumps, the percentage of pumps that break approaches or exceeds fifty percent after eighteen months of operation. Because pump repair programs are usually under funded and inefficient, pumps that break are liable to stay broken for several months before they are put back into service. A tube well with a broken pump is no well at all since no water can be taken from it. Fixing a broken pump is like digging a new well. For the small cost of a washer or a chain, water can be made available where it was inaccessible before. This sort of intervention is another low cost, high impact activity that can be implemented within a short term time frame if it can build on an existing pump repair program that may need only spare parts and fuel to function.

The choice of response to a drought related problem depends on time frame and perspective. Having a short or long term time frame determines to a great extent the types of activities that will be considered. Water supply activities like those described above are the usual focus of short term interventions. Water storage and collection activities which involve the construction of dams and water conservation structures are long term interventions that are often supported by post relief, food for work agreements. Since the engineering and logistical planning for these types of projects is considerable, it is always best to maintain a file of preliminary feasibility studies which contain

information on site conditions, structural specifications, and resource requirements in order to facilitate project implementation soon after approval. Projects which focus on water use activities, including conservation, sanitation and hygiene, are, for the most part, involved in changing behaviors and practices. As such, they require an information dissemination system for implementation and can be short term or long term depending on how much attention is given to improving the efficiency of the system and the size of its audience. Here, as in most cases, successful short term interventions tend to build on existing structures and skills rather than attempting to stand alone.

The choice of intervention also depends on the perspective and objectives of the decision maker. Clearly the perspective and the objectives of a drought afflicted farmer are different from those of a government representative or an expatriate development agent. The farmer is most interested in producing whatever he can and in preserving his productive assets. His concerns are not focused on institution building or regional response planning, the likely concerns of a government worker. Nor is the farmer privy to the discussions and decisions about policy and programs that occur between government departments and expatriate organizations. When relief and mitigation activities are planned without taking into consideration the perspectives and needs of those whom the activity is meant to assist, successful implementation is impossible. When the intended project beneficiaries are included in the project planning process and are given a major role in the project's design and implementation, the chances for success are greatly increased.

3.0 ECONOMIC, SOCIO-POLITICAL, AND TECHNICAL CONSIDERATIONS

3.1 Economic Considerations

Most WRM activities involve construction and where this is the case the activity costs are calculated by estimating the quantities of equipment, labor, and materials that are required under the project design. In most situations the logistics of assembling all elements on site are difficult and costly. When imported equipment and materials are involved there is an increased likelihood of transportation related delays and interruptions in the work because of equipment breakdowns in the field far from repair parts and technicians. Because of the difficulty in keeping sophisticated equipment operational, it is often more efficient to use locally available equipment and technologies which, though slow, are repairable in the field and therefore much more reliable. In most developing world situations labor intensive rather than capital and equipment intensive construction methods are, in the end, less expensive and more efficient. Unfortunately, many international development agencies, as well as many developing country agencies, continue to exhibit a great fascination with expensive sophisticated technologies which promise miracles but usually deliver a lot of frustration. The best results still come from simple technologies that cost little and are easy to maintain and to replicate at the user's level.

In calculating real project costs and values it is important to consider the preservation of productive assets as a major economic variable. Activities that enable local communities to remain in place and intact can help to prevent the loss, from emergency sales, of productive assets such as draft animals, land, and tools. These assets generate income and are critical to survival. Without productive assets, destitution and poverty, from which recovery is very difficult, are almost inevitable. Of equal importance to preserving productive assets is the provision of opportunities to

improve the infrastructures and production methods that are elemental to a community's subsistence and its general quality of life. This gives added value to activities based on locally available rather than imported skills and resources. The use of local inputs stimulates local economies while also increasing local self reliance and, consequently, decreasing the need for external assistance. Teaching local masons how to build low cost wells using locally available materials is almost always more profitable than simply installing drilled wells. The greater profit is in the additional wells that are built by skill trained local labor without the need of outside funding. Though skill training for increased self reliance is usually considered a long term development objective, short term interventions can promote local capacity building by supporting and building on existing projects that promote local self reliance. In calculating the economic value of both long and short term activities it is therefore important to determine whether the activity will lead to future dependence on external assistance, a net loss, or whether it will lead to self reliance through increased local competence, a value added net increase.

3.2 Socio-Political Considerations

Within the political realm of relief and development assistance, bilateral projects between national governments predominate. This results in projects that are planned at the national level, often without sufficient input from the local areas at which the assistance is aimed. It is not unusual to have project budgets that designate 80% of the budget for administrative and staff support costs and 20% for materials and actual assistance costs. The explanation for this lopsided apportionment usually includes institution building objectives that are supposed to produce competent national agencies that are able to address regional and local needs without further external assistance. This rarely happens. Projects planned at the national level tend to address national agency needs well before addressing the needs of the local communities for whom the project is intended. The first priority of a bureaucracy is institutional survival, not the delivery of development services. From a national agency perspective, acquiring vehicles for transporting staff to project areas is thus seen as being more important than delivering materials and training support to local participants. This view can be shared by donor agencies who would rather fund a vehicle that can be easily invoiced and marked with the donor's logo than fund materials and training that are more difficult to invoice, track, and evaluate. Many donor agencies are also encouraged by their respective governments to give a sizable percentage of their assistance in materials and equipment that originate in their country of origin. In the end, the purchasing and accounting requirements of the donor agency, along with the institutional bias of the cooperating national agency, usually lead to bilateral projects that are uneconomical and ill suited to the specific needs and requirements of the communities the project is supposed to assist.

Planning for a successful activity that involves community participation requires a preliminary assessment of locally available resources including skilled and unskilled labor. This can be a difficult task during times of drought and famine when labor often leaves home in search of money and food. Because of this crisis induced labor shortage, most interventions need to be small in scale and flexible in the amount of labor required. Large labor intensive projects, like dams, require advanced commitments of workers. Small projects, like hand dug well repairs, require few workers and can be adjusted in the number of wells repaired to match the available labor pool. In cases of dislocation, it is very difficult to assess the kinds and quantities of skills available within a resettlement area, but the exercise of assessing the available human resources is necessary for properly designing appropriate self help interventions and it can help in rebuilding community

cohesion. Projects that involve community participation from the outset can use the project design phase as an occasion for developing problem solving and organizational skills among community members. When a community is thoroughly involved in the planning of a project, its needs can be thoroughly addressed, promoting local participation and a sense of responsibility on the part of community members for seeing the project through to a successful conclusion. This is an important advantage in avoiding the pitfalls of village and family politics that can doom any project to failure. Though community based projects can often encounter political resistance at the national and regional levels they can easily avoid difficulties if they are portrayed as a part of the ruling power's program of local assistance. When a project that promotes self reliance and grass roots participatory democracy is seen as an exercise in building political support for the party in power it can usually gain the blessing of the government. Here small is certainly beautiful. Low-budget, low profile projects are less likely to draw the attention of resource hungry government agencies.

3.3 Technical Considerations

A review of the major physical variables that determine the type and size of WRM interventions begins with soil types. With wells, coarse sand and gravel soils make the best aquifers because they are porous and permeable. The most difficult aquifer soils are fine sands which can quickly fill in capturing columns; clay soils which are neither very porous nor very permeable; and rock which has the same properties of clay, and is difficult to dig through. Under the most difficult conditions, hand dug shallow wells may not be feasible and deep drilled wells will be required. In most situations however, improved shallow wells can provide sufficient water for basic needs. The ideal water supply system includes shallow wells for main supply and deep wells for potable water security. In the case of retention dams, sandy soils are considered poor and heavy clay soils are considered good because they prevent water loss through infiltration.

Slope is the next important physical variable and is mostly concerned with surface water control. Steep slopes are very prone to erosion and should therefore never be cleared or overbrowsed. Medium and mild slopes can be cultivated using erosion control measures such as mixed contour strip cropping and permeable contour dikes. Uncontrolled erosion ruins the fertility of upslope fields and chokes lowland ponds and water courses with silt. To properly control erosion and to preserve soil fertility, long term, integrated watershed management plans should be developed for each town or village. The major objectives of watershed management are to control runoff and to store as much water as possible for gradual release.

The third important physical variable is precipitation, which is described in terms of frequency and volume. In most arid and semi arid zones there are one or two distinct rainy periods each year followed by extended dry periods. In order to survive the dry times, indigenous animals and plants have developed water storage and conservation strategies. When rainfall patterns are severely distorted during droughts, the best strategies call for adjusting the mix of plants and animals in favor of the most drought tolerant species. Though annual rainfall patterns are to a great extent influenced by global meteorological forces, local rain events, which in most inland places account for half of the total precipitation, are very much related to local biomass levels. Deforestation greatly reduces the amount of evapotranspired water released into the air by plants. This reduces the number of local rain events and total precipitation which can easily result in local occurrences of desert like environments, as is evident in many places across the Sahel. There are many

reforestation and watershed management techniques that can be used to reverse this process, but in order for them to be successfully implemented, it is first necessary that those who live on the fragile lands of arid regions understand the impact on the environment of their normal agricultural practices. Once they understand the causes of the problem they can adopt practices which will repair and preserve the environments in which they live.

In cases where water availability is reduced, access can often be improved by deepening wells, by collecting surface runoff, or in some cases by diverting water courses. As the scale of a water access intervention increases, so does the complexity and cost of the technology. To be cost effective, expensive technologies like large pumps must operate on a continuous basis. Breakdowns are potentially disastrous. Most large scale irrigation projects attempted in the developing world have failed because of equipment breakdowns that have led to the loss of the irrigated crop. Risk management through the appropriate choice of a reliable, manageable technology is critical. It is also important to understand the potential impact of an intervention on the surrounding environment. Small scale interventions usually have minimal adverse effects while large scale interventions can often have disastrous effects on the environment. Large dams are notorious for environmental disruption as are large irrigation projects that cause salination of soils. Crops grown out of season with irrigation water are liable to attract insects and birds that have nothing else to eat. Deep wells placed in arid rangelands to supply water for cattle can often mean the destruction of the surrounding vegetation from overgrazing and trampling. These risks must be recognized and weighed against the positive effects of an intervention. In many cases it is better not to intervene even if the intervention is technically feasible. In all cases it is important to chose interventions that are compatible in type and scale with existing ecological systems.

4.0 STRATEGIC RECOMMENDATIONS

In the industrialized world "Drought Relief" usually refers to the economic assistance which is given to offset drought related losses. Rarely does it promote fundamental changes in agricultural practices to make them more drought tolerant and less destructive to the environment. Industrial agriculture uses its machines and chemicals to overcome rather than adjust to adverse natural conditions. The correctness and real costs of this approach are debatable and are coming under ever greater scrutiny as the long term impact on the environment becomes more obvious. It is certainly an extremely expensive and ill suited approach to agriculture in the developing world where attempts to master nature by force of machines have been largely unsuccessful. In developing countries where the majority of the people depend directly on the land for their survival, the greatest prospect for a sustainable solution to drought related disaster involves the reformation of current agricultural policies and practices to make them less extractive and environmentally destructive. This can be done by establishing realistic standards for sustainable agricultural activities based on existing natural resources and mixed production systems that produce a variety of agricultural products to satisfy both export income needs and the food, fuel, and other agricultural product needs of local communities. Drought mitigation activities should therefore focus on the widespread establishment of those appropriately scaled practices that enable people to survive and prosper in a balanced and sustainable relationship to the environments in which they live. Fortunately the food first approach of traditional subsistence agriculture, lacking

the input appetites of modern agriculture, can be readily modified to provide local food security, even during moderate periods of drought, without compromising the environment.

In most cases, establishing a drought responsive water management system requires a similar focus on appropriately scaled interventions that can adjust to existing environmental conditions. This involves modifications in all three WRM activity areas, which include the improvement of water access points, the rehabilitation of water collection and storage systems, and the modification of water use patterns to make them more efficient. Most of these modifications primarily involve changes in management practices. External material inputs are of less importance than the assimilation of alternative management techniques. In almost every case, the primary project focus is on skill training which enables local communities to plan, implement, evaluate, and manage the practices and infrastructure that assure water security even during times of drought. It is therefore important in planning an intervention to first develop a complete picture of existing water management practices as well as existing water sources and the locally available material, equipment, and human resources that are relevant to improving access to sufficient quantities of quality water.

4.1 Initial Survey and Assessment

The initial assessment should be done with the full participation of the client group in order both to assure the accuracy of information and to promote planning skills at the local level. In many instances community surveys exist which contain data relevant to water resources management, and, where machine drilled wells have been installed, useful hydro-geological profiles can often be found. Records of this kind can be used to develop the initial assessment as long as the information they contain is verified and updated as necessary with the participating client community. In order to construct a complete picture of WRM within a community, information should be collected about the people, practices, and technologies involved in water management. This can be done by using a KAP, (knowledge, attitude, practice,) or similar type format that asks questions concerning a community's general understanding about existing water resources and how that knowledge is used to access and manage those resources. By asking these questions both the interviewer and the community participants can jointly identify problems and construct solutions that will improve the quality and quantity of available water. This approach is valuable not only in planning appropriate interventions but also in improving the participating community's capacity to identify and solve its own problems. In addition, the KAP process provides both development agents and donor agencies the opportunity to compare their assessments of problems and potential solutions with the needs of the client communities. This helps to provide a clearer understanding on both sides of what should be done to improve water access and who should be responsible for the various aspects of project design, implementation, and evaluation. By establishing a sense of partnership between the development agency and the client community, appropriate activities can be planned and executed even under the most difficult circumstances. Through interactive dialogue, project evaluation then becomes a joint exercise in how to build on past successes rather than a one sided judgement of why project objectives were not achieved. Building on success is the most efficient form of development and the most successful development projects are those that focus as much attention on community organization and participation as they do on technical considerations.

4.2 Project Design

The normal project design process begins with an examination of existing conditions and practices. This is followed by the identification of needs and the establishment of project objectives that can be achieved using available skills and resources. In most cases, improving access to water resources can be accomplished through the renovation and improvement of existing water points and distribution systems, and by adjusting existing water use practices. Improving traditional systems is preferable because existing systems, through long term use, have been contoured to their site specific circumstances. They are also understood by their users and can thus be maintained by them. This is not the case with imported technologies which often prove to be incongruent with the physical and social conditions of the places where they are introduced. Contrary to common belief, traditional systems are not closed and resistant to innovation, though they do often operate under the strict laws of subsistence living that demand low risk and rapid return. Because of these restrictions, improvements to existing practices and technologies, such as deepening traditional wells or contour cultivation, which are inexpensive and require only small inputs of labor and resources to show a positive result, are the types of innovations that are most readily acceptable within the traditional context.

4.3 Activities

Within the three basic activity areas of access, storage, and use there are usually a number of low cost, low risk interventions that can greatly improve existing systems. These interventions, with minor variations, are widely applicable over many geographical and climatic zones. Their potential impact makes them good candidates for inclusion in short term activities that seek to mitigate the debilitating effects of drought on water resources. During the initial information gathering activities, particular attention should be given to determining if these interventions could be useful within the project's specific conditions and constraints.

4.4 Wells

Since the great majority of village water access points are large diameter shallow wells, low cost well improvements are one of the most important interventions. In most cases, the aquifers of shallow wells are unstable and collapse as water is extracted thus blocking access. The introduction of brick or concrete capturing columns overcomes this problem and allows deeper penetration into the aquifer, providing water access even when water tables drop during dry spells. Though they cannot always provide year round access, stabilized capturing columns can measurably increase water security and because they can be locally fabricated with commonly available materials and construction skills, the technology can be easily disseminated to local communities. The same well repair techniques are also useful in stabilizing the tops of wells to provide greater safety for the people who draw water and better water quality can be achieved by excluding contaminated surface water from washing into the well. Stabilized large diameter wells can also have significant positive impact in situations where water is taken from seasonal streams and rivers. Wells that are placed a few meters from the water course can provide naturally filtered water even when the surface source has dried up. Old channels that have filled with sand and silt are usually good places to put wells of this kind. In cases where shallow wells cannot provide water security because drought stressed, perched aquifers, which depend directly on annual rainfall recharge, dry out for several months each year, deep drilled wells may be necessary. Wells of this kind average 100 meters in depth and require sophisticated truck mounted drilling riggs and lots of expensive imported casing. Because of high drilling costs, deep well projects normally make aerial

and onsite surveys to determine the most likely places to find water. General information on aquifer profiles can often be obtained from the records of past drilled well projects, but onsite surveys are always necessary to identify well placements that are technically feasible as well as being responsive to community needs.

4.5 Pumps

In areas where small diameter wells have been drilled and fitted with pumps, surveys should be made to determine the type and condition of the pumps. Though there are increasing efforts in most developing countries to standardize pump types, a variety of pumps can usually be found in the field that are no longer being installed, but which could be returned to useful service with minor repairs. In the case of recently installed pumps it is not unusual to find half of the pumps broken within 18 months of installation. Many pumps that break remain inoperable for a long time because spare parts and repair people are hard to find. Where government run maintenance systems exist, politics and lack of funding often disable them. Under these conditions a fresh supply of pump parts and fuel to get parts and repair people to the pumps can be the catalytic elements that revive a maintenance program and double the working water access points in a region. Where pump maintenance has been privatized, making needed parts available at the local market level might be all that is necessary to put needed wells back into service. This market oriented approach can also be an effective strategy in places where low lift irrigation is possible. One of the major constraints to developing small scale irrigation in places where sufficient water is accessible is the lack of available water lifting devices that are reliable, easy to repair, and appropriate to specific site conditions. Small and portable two cycle gasoline fueled motor pumps and several types of low lift, high volume human powered pumps have been readily accepted by farmers in Africa and Asia where plentiful water can be found at depths of 7 meters or less. Potential sites for this sort of low lift irrigation include most alluvial river plains and basin areas around ponds and lakes.

4.6 Distribution

Newly inhabited areas, such as relief stations and squatter settlements, can experience water supply problems that are related to lack of transport. In a common scenario, the government does not want to construct wells or lay water lines in unofficial settlement areas for fear of making them legitimate. At the same time, there is not enough equipment or funding to supply water by motorized tanker, so the displaced are left to their own devices and the ravages of dehydration. In situations like this the introduction of human or animal drawn water tanks of moderate capacity can greatly improve the amount and quality of water available to individual households. By making these cisterns available to people within the affected community, the local economy can be stimulated and the general sense of self reliance improved. In areas where reliable shallow aquifers exist, a good secondary activity to support improved distribution could be the self help construction of stabilized large diameter wells. Since the skills needed to construct these wells can be quickly learned, a self help well project can build community self reliance while creating needed infrastructure. As with any community development project, it is important to have as a primary objective the fostering of a sense of ownership and responsibility within the client community for the wells, pumps, water carriers, and other devices that are part of the intervention. This is the best way to assure that the project will have a lasting impact.

4.7 Hygiene and Sanitation

Among the most life threatening problems found in squatter settlements and relief camps are epidemic diseases many of which are either water borne or spread through improper hygiene. During a water crises people are less likely to wash, which can result in increased instances of oral-fecal transmitted gastrointestinal diseases. This can cause prolonged cases of diarrhea and dehydration which can be fatal, especially to malnourished infants. Because these diseases pass primarily from dirty hand to mouth and not so much from dirty water to mouth, the quantity of water available for washing as well as for drinking and cooking is actually more important to health maintenance than the quality of water consumed. Improved water access remains the first most important health conserving activity. In addition to securing adequate water supply the most effective interventions for reducing the spread of communicable diseases are those that help people improve their hygiene and health maintenance practices. This can be done inexpensively through a public health education campaign that stresses the importance of basic practices such as hand washing with soap before eating or preparing food, fecal waste control, and preparation of oral rehydration solution. Primary health care information of this kind can be disseminated as part of food distribution programs and during vaccination campaigns. It is worth noting that primary health and hygiene are often seen as priority needs by local communities, yet receive little attention in development and relief projects. This incongruity is due, in part, to the tendency of project planners to lump together all health issues which relegates preventative health to an inferior position below curative health and far from priority status. In reality, self help primary health practices are one of the best intervention areas for saving lives and for promoting community self reliance. Seen in this way, primary health interventions including hygiene and sanitation display the low cost and high impact characteristics of an effective drought and famine mitigation activity.

4.8 Collection and Storage

In drought prone areas the collection and storage of rain water is an important drought mitigation activity. There are many ways to do this, varying in scale from 20 centimeter wide water collecting planting pockets to roof runoff collecting cistern systems to dammed reservoirs holding a million cubic meters of water. The most appropriate type of intervention depends on climate, soil types, topography, and existing practices. The least expensive and most successful interventions are relatively small in scale and use existing skills and resources. It is usually best to store water close to where it is collected in order to conserve energy and to allow for a more complete recharge of the ground water storage system that provides for the slow release of water downhill. Hillside storage systems can be constructed by placing a network of shallow trenches on the contour to direct runoff water to small storage ponds from which it can be released for irrigating downhill fields or orchards. The most efficient water reservoirs avoid losses from evaporation and percolation. An example of a reservoir with these qualities is the sand tank, which is made by placing an impervious rock wall across a natural runoff channel in a rocky area high in the watershed. The basin created by the wall is soon filled with water saturated sand which inhibits evaporation and allows clean water to be drawn from an outlet pipe at the base of the rock wall. In less steep areas, small dikes made of packed clay or mortared rock can be placed across seasonal channels to slow down runoff water and recreate the inundation patterns of normal rain years allowing the surrounding ground water table to be recharged to near normal capacity. In many cases, a subterranean barrier of packed clay or plastic sheeting can be installed below the dike to a depth of about 3 meters in order to inhibit subsurface runoff and to increase the reservoir capacity of the surrounding ground water table. Most moderate sized reservoirs require a lot of

hand labor and are consequently good food/cash for work construction projects. On a smaller scale, covered cisterns can be constructed above or below ground to store rainwater harvested from roofs or hillside catchments. The major limiting factors for cistern construction are the cost and availability of the cement, sand, and steel needed for their construction. In places where ground water is difficult to find and where some rain falls during most months, cisterns can be cost effective sources of potable water.

4.9 Watershed Conservation

Wherever sloping land is cultivated erosion can become a serious problem. However, through good management, the precious topsoil can be kept in place and the runoff water that would otherwise erode the soil can be controlled and either concentrated into growing areas or spread out for even infiltration. Soil conservation systems that prevent erosion by placing barriers along contours to collect and hold soil also slow down runoff water which increases infiltration rates and humidity levels around the barriers. This is well illustrated by the action of contour brush lines that collect silt, organic debris, and moisture to create shaded growing environments where grasses, forbs, and other pioneer plants can flourish in the midst of an otherwise barren landscape. Other types of contour structures made of rock, earth, or vegetation have similar effects in producing enhanced growing environments by catching soil, seed, and water. In relatively flat areas with infrequent rains, low ridges can be laid out in "V" or "U" shapes to collect sheet runoff and concentrate it into growing pockets with microclimates several times more humid than the surrounding area. Small scale collection systems of this kind are easily demonstrated and can quickly show positive changes, especially in arid regions.

The principle strategy of water conservation is to keep the natural reservoirs throughout a watershed charged by promoting absorption and by preventing excessive runoff. The various low cost interventions that help to charge the watershed include soil stabilization with trees and vegetative strips on steep slopes; contour ridges, permeable barriers, and holding ponds on mild slopes; and small irrigation and retention dams in the lowland watercourses. Where erosion is a severe problem, upper watershed structures should be placed before installing lower watershed dams to prevent silting. In order to minimize the risks of structural failure and to assure appropriate scale, all interventions should be designed with the intent of reestablishing the water collection and storage characteristics of the watershed before it was damaged by poor agricultural practices and drought. In addition to these parameters, the labor and materials requirements of any activity should correspond to available resources. Effective environmental rehabilitation often requires repair activities in several areas of a given watershed. It is therefore best to place any single drought mitigation activity within the context of a watershed management plan that is long term and comprehensive. There are many good reasons for developing long term watershed management plans with local community participation. In addition to the technical advantages of correctly fitting interventions to specific site conditions, a long term plan provides a variety of appropriate food for work activities that can be easily implemented during times of drought without risking the usual project stopping problems of what to do, where to do it, and who stands to benefit disproportionately from the work. The process of designing a management plan with full community participation is in itself a valuable exercise for it greatly improves the organizational abilities of the participating community and its ability to plan and manage meaningful drought mitigation activities on its own. Though the type and size of intervention will vary according to site and situation specific criteria, the principle of promoting community self reliance through community participation remains an elemental aspect of all water resources management activities.

REFERENCES

The books and papers mentioned below are the major reference materials consulted in developing this strategy paper. These references share an emphasis on development through community participation and the promotion of improved local competence through education and practical experience as the keys to successful and replicable interventions. This approach to development is becoming ever more accepted as the major international funding agencies channel more of their support through NGOs that use community development type methodologies in order to improve the efficiency of delivering support to targeted groups. Given the time constraints and the activity criteria of low cost and high impact that OFDA drought and famine mitigation activities have, the best vehicles for quickly delivering aid to needy populations are the NGOs currently active in the targeted areas; and the best way to collaborate with those NGO's is by helping to extend or broaden existing activities rather than attempting to establish new activities which would require a lot of time and start up costs. A general understanding of the particular technical and organizational aspects of community based water resource management activities that have been successfully implemented can help field agents determine ways in which material and funding support can enhance existing activities. The materials described below provide that practical information.

Project Identification: More than thirty years of development activities in Africa have provided a lot of information about the types of projects most likely to succeed. Unfortunately the majority of project interventions have fallen far short of their stated objectives and this has resulted in an equally large body of project review material that tries to explain the reasons for failure. Among the few reviews that deal with reasons for success is a book by Paul Harrison titled The Greening of Africa which was published in 1987 through IIED. Mr. Harrison was one of the first development project observers to clearly delineate the common characteristics of successful projects. In most cases strong local participation, low cost, high return, and easy maintenance were the crucial elements that produced interventions that were easily and quickly disseminated often without additional external inputs. The key indicator of success was the extent to which the participating communities adopted and adapted project interventions to their normal practices. Mr. Harrison also delineates three intervention stages based on the existing levels of wealth, risk tolerance, education, and infrastructure that determine the appropriate types and sizes of projects. Since the book concentrates on rural development projects, great emphasis is put on soil and water conservation activities for subsistence agricultural communities. However, the basic principles of community participation and appropriate interventions built on current practice hold true for town and city environments as well. Other studies that identify the elements of successful projects include the four volume Opportunities for Sustained Development assessment report published by USAID in October, 1988; and the Water and Sanitation for Health Project review "Lessons learned from the WASH Project: Ten Years of Water and Sanitation Experience in Developing Countries," 1990.

Programming and Evaluation: Among the several books and papers that focus on community based project design, implementation, and evaluation, Two Ears of Corn, by Roland Bunch of World Neighbors, first published in 1982, remains one of the best practical guides for grass roots development programming and evaluation. Based on over twenty years of rural development experiences in Africa, Asia and South America, this guide clearly describes the necessary steps in designing and carrying out small scale, community based projects that build local self reliance and teach individual farmers how to choose and adapt alternative management techniques and

technologies to their needs. Among the important observations discussed are that viable projects start small and follow a detailed programming plan that involves local participants from initial information gathering through planning and implementation to evaluation. Mr. Bunch gives high priority to teaching local farmers the project planning process and other related skills such as small scale experimentation and farmer to farmer extension. This emphasis on building the local capacity of communities to design and manage development projects, using to the greatest extent possible local knowledge, materials, and expertise, is also a basic premise of the community education training manual Helping Health Workers Learn by David Warner and Bill Bower, first published in 1982. Though this book is mainly concerned with nonformal, community based health education, its basic approach to development through community participation is relevant to many technical areas. It explains in detail how to use the KAP, (knowledge, attitude, practice,) method for self assessment and project planning. It also considers the politics of hunger and poverty and suggests ways to encourage local communities to take responsibility for their own development.

Health and Sanitation: The standard manual for community based primary health care is Where There Is No Doctor by David Warner, first published in English in 1977. It was first written in Spanish as part of a rural health network project for isolated mountain communities in Mexico and has since been revised and translated into English, French, Portuguese, Arabic, and several other major languages. Its dissemination to isolated communities in developing countries around the world is actively encouraged by The Hesperian Foundation in Palo Alto, California. In addition to information on how to recognize and treat commonly occurring diseases, there are sections on nutrition, potable water, basic hygiene, and sanitation. This book has been widely used and accepted as a basic guide and reference by rural communities engaged in improving the quality of their hygiene and health care. Making copies in the appropriate language available to drought stressed communities can be a valuable high impact activity in itself. Used as a reference, it can facilitate the formation of local community health and sanitation groups, as it contains some of the information on nonformal health education techniques that are presented more fully in the companion book Helping Health Workers Learn. There are a number of good technical references on human waste disposal, the most relevant of which deal in depth with various latrine designs. A good book in this area is Sanitation Without Water by Uno Winblad and Wen Kilama, MacMillan Press, 1985. Written for field use, it first describes the disease prevention reasons for improved sanitation and then presents several widely used latrine designs with clear diagrams and simple assembly instructions. It is published by the Swedish International Development Agency in several languages including French, Portuguese, and Spanish.

Water Wells: For large diameter, hand dug wells one of the most thorough and clearly written manuals is Hand Dug Wells and Their Construction by S.B. Watt and W.E. Wood published by Intermediate Technology Publications, 1977. Based on the traditional and improved well construction practices found in India and West Africa the book covers basic groundwater principles, standard large diameter water well design, and the specific steps involved in the construction and maintenance of hand dug wells. The book also covers a variety of alternative construction materials and techniques that can be advantageous under certain conditions where standard materials are unavailable or where soil conditions are difficult. For hand drilled, small diameter wells, the Peace Corps' Wells Construction, Manual M-9, covers various techniques including rotary, point driven, and sludger methods, in addition to sections on large diameter hand dug wells and standard hand pumps. These two manuals provide a reference for comparing existing well construction techniques with possible alternatives to find the most appropriate solutions for specific conditions.

Pumps and Irrigation: The subject of choosing and installing hand pumps for domestic water supply is covered in the two water well construction manuals described above. Long term field assessments are available from UNDP and The World Bank on the performance records and maintenance requirements of the most often used pump models. Technical manuals for individual models with sectional diagrams and parts lists are usually available from pump suppliers or the government water division. The best available guide to hand pumps and other water lifting devices is Water Pumping Devices by Peter Frankel, published by Intermediate Technology Publications in 1986. This book provides all the formulas, monograms, and cost benefit criteria used to calculate the type and size of water lifting devices best suited to a given water source and a desired use whether for potable water supply or irrigation. It is especially useful as a source of alternative solutions to the problems of moving water reliably and efficiently. IT Publications also offers a book titled Small Scale Irrigation by Peter Stern, 1979, that provides additional information on irrigation design parameters for forced and gravity fed systems. Together, these two books can help field technicians design appropriate irrigation systems that fit existing physical and technical conditions.

Watershed Management: The area of water resources management includes soil and water conservation, forest management, water harvesting, and surface water control. Since the devastating droughts of the early 1970s in the Sahel, an increasing number of small scale development projects have dealt with the effects of the drought exacerbated degradation of the environment. Recently, regional organizations, such as the Club du Sahel and CILSS (International Committee for Fighting Drought in the Sahel), have published collections of drought mitigation project experiences that have been aimed at helping local groups adjust to chronic shortages of water and impoverished environments. The lessons learned from projects such as those described in Le Sahel en Lutte Contre la Desertification and Metiers de L'eau du Sahel, Eau et Terres en Fuite are certainly valuable for planning new projects in surface water control and dry land agriculture. One of the best general references for watershed management in arid lands is titled Permaculture by Bill Mollison. It provides detailed explanations of how natural systems work, how they are destroyed by improper agricultural practices, and how they can be regenerated through integrated reclamation activities. It also contains a wealth of conservation and low input production strategies that can help assure local food security even during times of drought. A number of studies, like the United Nations Environment Programme report Rain and Stormwater Harvesting in Rural Areas, have been published on traditional and improved methods of surface water control in different regions around the world. It remains the continuing task of locally oriented development agencies to network the existing information about water harvesting and storage techniques. This will greatly assist rural communities to reverse the degradation brought on by poor land management practices.