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Famine Mitigation Strategy Paper

UTILIZATION AND PRESERVATION OF LIVESTOCK RESOURCES

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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.

Executive Summary

Southern Africa is still recovering from one of the worst droughts of this century. The impact of this drought on human health and the economic base of agriculture will be severe. This unfortunate event will stall economic growth and development in an area of Africa which is normally viewed in more optimistic terms then the northern portions of the continent. Despite the regions economic progress the drought impact will be similar to the patterns observed in other areas of Africa and the world. To start with, the agricultural sector of a nation in a drought is affected to the largest degree. For example, in southern Africa over 60% of the population is involved in agriculture and has been affected directly by the drought (**Figure 1.**). This does not account for the impact on employment and quality of life for urban populations.

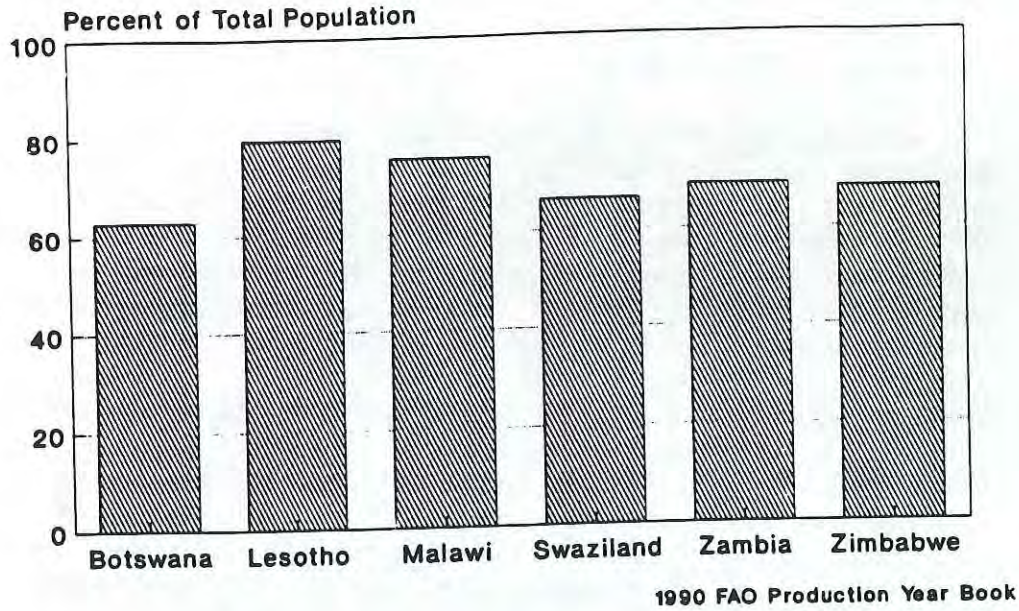

Figure 1. Percent of Population at Risk During Drought

Clearly livestock are an important component of African economies. A large portion of the agricultural population depend upon livestock for traction, improved nutrition or revenue generation. It has been shown in crop-livestock production systems that households with above average income from livestock tend to be better fed and the children better nourished. Within the continent livestock commodity output was $11.8 billion in 1988 (Winrock, 1992). This equates to a regional average of 25% of agricultural GDP.

Those involved in mitigation activities should realize that to effectively deal with relief efforts focused on livestock owners requires viewing the problem in a long term context. This is because livestock have a longer life cycle then plants. As a result when livestock are impacted by drought a depression in productivity occurs which lasts not only during the drought but it can also last

beyond the drought. A drought induced disruption of the livestock sector causes fluctuations in producers income streams and, on a national level, can result in a loss of international markets.

The critical issue for any livestock producer during a drought is how to best preserve assets. For example, how large of a reduction in animal numbers can the herd or flock withstand and still recover in a reasonable length of time after the drought has ceased. This is one of the primary criteria which should be established before starting a mitigation activity.

Complicating the assistance to the livestock sector during a drought is the perception that they are competing for resources which should be used for humans. This is a valid point. In no instance should livestock needs be placed above the well-being of the human population. However it also has to be recognized that the livestock sector is a vital resource which drought stricken people can utilize to stave off the nutritional deficit occurring in a drought and livestock provide a way for these people to reestablish themselves financially after the drought has ended. When viewed in this light there is a clear need for finding optimal combinations of donor resource allocation.

There is a general set of actions livestock producers and relief efforts can take, these include:

1. Sell all surplus stock and use the proceeds for personal requirements;
2. Buy supplemental feed for the remaining animals;
3. Sell all livestock, save the proceeds and restock later;
4. Move to another area;
5. Do nothing.

The use of these options depends upon social, economic and environmental conditions. One of the most difficult judgements to make is when should a farmer start selling his livestock. This is difficult because producers will always try to hold on to livestock in the hope that the rains are just over the horizon. Supplementation of livestock during droughts is a common and sometimes effective practice. Types of supplementation can vary depending upon natural feed-stuffs and crop byproducts. But the difficult issue is determining how much supplementation to provide and the type of livestock to invest these scarce resources in. Movement of livestock during times of drought has always been a key source of relief. However the land use situation is under going some dynamic changes which may hinder the normal migratory routes livestock producers have normally taken during times of drought. Past drought intervention strategies have been formed around the listed points and have met with varying levels of success. However these efforts lack insight as to the final outcome of the recommendation. In essence relief workers are working without clear guidance, guidance in general terms which will provide a solution of undetermined impact. Therefore they leave those trying to implement a mitigation activity in the dark as to whether or not these interventions will have sufficient impact to stave off the impact of the drought.

The following document proposes a new approach for implementing drought strategies. An approach which views livestock sector as a part of a larger production system and one which incorporates the use of computer simulation as a decision aid. It is our contention that it is no longer acceptable to assume that indiscriminate sales and/or supplementation of animals will reduce the catastrophic effects of drought on farmers. This means recommendations and actual interventions can not be generalized but must be specifically tailored to the situation which they are

to be applied. Only through simulation can the short and long term ramifications of proposed interventions be evaluated *a priori*.

Our group is proposing a three tiered approach to implementing any type of drought intervention: Information assessment, Simulation, and Field application.

The three tiers consist of an assessment of the situation using information gathered by ministries of agriculture, the information is then utilized in a group of simulation models, the results of which are then the basis for field recommendations. The recommendations are carried out either by government organizations or NGOs. At all three levels there is interaction and development of consensus among the three groups about what alternatives should be simulated and then, based upon the simulated results, which prospective interventions should be applied in the field. By taking this approach the most current information from the field can be utilized and projected as to how future conditions could impact the livestock producer.

There are considerable advantages to this procedure. First, it is cost effective, many more alternatives can be simulated then could ever be applied in the field. Second, it is an iterative process, one which allows new information to be fed into the system and evaluated. This makes it possible to update recommendations as conditions change for the better or worst. A secondary ramification of this process is that human resources can be more highly developed.

To effectively initiate this procedure, a FEWS-like activity could be established. A core team of specialists would initiate data collection procedures and team formulation in various countries. During this process training in data processing and analysis would be conducted as well as in performing simulations. After host country teams become adequately trained they would be able to operate the process from within country, with only minor backstopping requirements from external aid agencies.

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Utilization and Preservation of Livestock Resources

Introduction

Livestock play a pivotal role in economic development, for not only do they impact livestock producers income, they provide job opportunities throughout a nation's economy. However, when drought or civil unrest occurs this important component of the national economy suffers. Unlike other sectors of an economy, livestock production is a relatively long term investment. As a result, when major reductions in livestock numbers occur it takes much longer to recover from the effects of the precipitating catastrophic event. Livestock are vulnerable to drought or civil unrest because they are exposed to the harshness of the environment and relatively few contingency plans exist on how to manage this resource when catastrophes occur. In part, the livestock sector responds to disasters based upon previous exposure to such events and the severity of the current event. Because stress events occur and subside, livestock populations and productivity are very dynamic. Dynamic changes in livestock population structure and productivity make impact assessment difficult, especially during a time of famine.

It is possible to assess the losses incurred during a time of drought or civil unrest after the conclusion of the event. Toulmin (1985) quantified livestock losses due to drought in Africa **(Table 1.)**. These data clearly demonstrate that no livestock species is immune to drought and the extent to which livestock populations suffer and in turn impact the people which are associated with them. What these data do not show is that livestock losses, recovery and productivity are dynamic and change as the environmental conditions change.

The purpose of this paper is to outline a procedure for livestock mitigation activities during drought or civil unrest. Although specific actions may be well known, at present mitigation activities have not focused on the dynamic nature of the animal population and how to position the livestock population so that minimal damage is inflicted by drought or civil unrest. The proposed strategy will put forward a *modus operandi* which will permit response agencies and governments to view livestock in a holistic and long term view.

In this paper we have not attempted to present a comprehensive review of production systems and how livestock are impacted by drought and civil unrest. This rationale was chosen because livestock production in different ecozones and countries will vary. Therefore, if effective mitigation strategies are to be planned, they must be established around general principles and approaches that can be used in any situation, leaving the specifics to the actual implementors of the mitigation activity. Clearly the approach we are proposing is innovative; it has to be if the demand for livestock products is going to be met.

Because the elements of time and cost (in human and monetary terms) are important to a comprehensive mitigation activity, some may ask why be concerned about the status of the livestock population? The answer is very simple. Livestock are an extremely important vehicle for people to recover nutritionally and economically from drought or civil strife. Furthermore, in drought prone areas, livestock are more numerous and are the major income generator. Therefore, any prevention or mitigation strategy would be remiss not to include livestock.

Table 1. LIVESTOCK LOSSES DURING DROUGHT

Country/Region	Period	Species	Loss (%)
West Africa, Sahelian Region	1968-73	Cattle Sheep & Goats	12-45 15-30
Burkina Faso	1972-74	Cattle Sheep Goats Horses Donkeys	33 31 23 20 42
Chad	1984-85	Cattle	32
Mali	1968-73	Cattle	35
North Eastern Mali	1967-75	Cattle Sheep & Goats Horses Donkeys Camels	93 78 69 35 41
Mauritania	1983-85	Cattle	40-90
Niger, Pastoral Zone	1973	Cattle Goats Camels	63 33 38
Niger, Agadez Department	1968-74	Cattle Sheep Goats Camels	88 80 70 36
Ethiopia, NE Rangelands	1972-74	Cattle Sheep Goats Camels	82 50 28 36
Kenya, Maasailand	1976	Cattle	20-33
Kenya, Isiolo District	1963-70	Cattle Sheep & Goats Camels	7 >90 >95
Kenya, Turkana	1979-80	Cattle Sheep & Goats Camels	>90 80 40
Sudan, Eastern Region	1984	Cattle Sheep Goats Camels	23 12 5 7

From: Toulmin, 1985

1.0 General Principles

There are several general principles concerning livestock and crop utilization during times of drought or civil unrest which span environments and production systems. First, these types of problems must be viewed in a systems context; a system which contains people, crops, livestock and the natural resource base. In a system, all of these factors interact and are dependent upon one another to varying degrees. Therefore, the inter-relationships must be understood and appreciated if effective mitigation strategies are to be formulated. Although this principle may seem obvious, it

can be difficult to implement, for implementation means individuals working on the problem of famine mitigation must be cognizant of all the inter-related parts of the system and how they affect one another. It also means that effective solutions will only be found when people working on mitigation efforts cross disciplinary boundaries.

A second principle is one of thresholds as it relates to the range environment. People, animals and the plant community all have biological thresholds within which they function at various degrees of health and productivity. These varying levels of productivity could conceptually be viewed as a series of stair steps. The thresholds exist where a step drops down to the next lower level. On a particular step there can be varying levels of productivity, but these differences are not as great as the differences which exist between thresholds. Whether or not a system has crossed a threshold determines the type of intervention which is needed to restore the people's well being.

The difficulty, as most know, is determining where thresholds exist, and how to deal with the complex problems of human nutrition, maintaining minimal animal numbers and animal body condition, and environment; so that thresholds can be avoided or, in the case where human, animal and plant conditions have degenerated across thresholds, how to reestablish their well being as quickly as possible.

A third principle is that livestock populations are dynamic, not only in terms of fluctuating numbers but also the age composition of the herd. As will be discussed later in this paper, the dynamic nature of livestock populations will determine levels of productivity for household consumption as well as animal sales. Understanding herd or flock fluctuations will help those involved in mitigation efforts apply appropriate interventions. But the first step is to know the population structure.

The fourth general principle is that livestock are important nutritionally and economically. If agricultural economic growth, and therefore food security, is to occur in a country, livestock will have to play an important role. Simply put, without a healthy livestock sector, value added to cropping enterprises are more limited and jobs processing livestock products are nonexistent.

In addition to these general principles the development community is starting to establish more objective information about the role livestock play in the development process. Quantitative data showing the important contribution of livestock to farmer's economic status has been missing. But during the past decade this type of information has become better quantified. For example, in Mali and Ethiopia, livestock generate 71% and 80% of farmers cash income, respectively (Debrah and Sissoko, 1990; Assefa, 1990). Wilson (19??) reports that 90% of the people living in areas with less than 300 mm of rainfall per year depend upon livestock as their major source of revenue. The importance of livestock will grow as more farmers in the sub-humid zone begin to raise livestock in conjunction with their cropping enterprises. Such a trend is already occurring in much of Africa. This shift in livestock demographics and importance indicates that famine mitigation efforts will have to involve this important farming enterprise.

1.1 Pastoral Systems

Perhaps the greatest number of livestock are found in the pastoral production systems which are located in arid and semi-arid areas. In these types of environments peoples raising livestock often live a nomadic or transhumant style of life. These peoples' highly mobile lifestyles have been

adapted to move with the quality and quantity of available feed and drinking water. In normal years pastoralists sell approximately 10% of their cattle and use the proceeds to buy grain (a crop which is not feasibly grown in these environments). In such years, milk and meat provide 50% and 20%, respectively, of the dietary needs while purchased cereals and other foods contribute 30%. During dry years consumption of milk may drop to 10% as the milk cows stop lactating, the breeding herd dies off and/or as they are sold to purchase cereals for subsistence. During severe droughts people living in the drier zones must either sell livestock before the animals die, move to different areas which have better grazing, or attempt to ride out the drought accepting the loss of capital.

The primary natural constraint, resulting in low human and livestock carrying capacity, is the inter-annual fluctuations in rainfall. Despite the limitation, human and livestock populations exceed the land's carrying capacity in normal years. Concurrently destruction of perennial tree cover and crop encroachment are leading to natural resource degradation. For example, crop encroachment takes the best grazing lands even though these lands produce only marginal yields for 2 to 3 years and then the area is abandoned.

Pastoralists do have the ability to manage their resources effectively. But with encroachment upon drier lands by agriculturalist, the desire for governments to have people settled, and the placement of restrictions on key wet season grazing reserves created a situation where this lifestyle has come under increasing pressure to change. It is clear that in the process of change the positive aspects of traditional grazing systems must be maintained. For in spite of low productivity per animal, productivity of land is high and compares well with livestock production in developed countries. For example, production of animal protein per ha per year in parts of Africa is estimated at 0.4 kg, while in New Mexico and Australia average yields are 0.3 and 0.4 kg (Djiteye and de Vries, 1982). Most comparisons between traditional systems and ranches in Africa show that the productivity per ha in traditional systems is significantly higher (de Ridder, 1984). However, it is not clear if these results are biased by non-biological factors; e.g., government pricing policy, poorly managed parastatal ranches.

Major sociological trends affecting the people in this production system are:

1. Human population growth which is greater than the growth of livestock productivity and/or numbers, thereby decreasing self sufficiency.

2. Increasing encroachment of cultivation on dry season grazing reserves and land marginally suited for growing crops which puts these lands at risk of permanent loss due to erosion.

3. An increase in livestock ownership by crop farmers which utilize crop aftermaths for their livestock instead of allowing pastoralists to utilize the aftermath in dry seasons and during livestock migrations.

4. Livestock ownership is being transferred from pastoralist to external owners which increases competition for grazing resources.

5. Lack of land tenure systems which make implementation of range conservation programs difficult.

6. Absence of government grazing policy or restriction.

These trends will have major impacts on future activities and viability of the pastoral sector as we know it today. It is likely and probably feasible that this lifestyle will diminish over time. However, currently these problems must be addressed by the governments involved and the donor community as it seeks to assist in developing agriculture. Although working to resolve these problems is outside the scope of famine mitigation activities they are important to consider when trying to devise activities which mitigate famine and when the system is viewed in totality.

1.2 Agro-pastoral Systems

Agro-pastoral systems exist in different environments. These types of systems are typical of North Africa, the Middle East and the Indian sub-continent and have been described by Thompson *et al.* (1988) at the cultivated margin of the northwest Syrian steppe and by Nagy *et al.* (1989a,b) for upland Baluchistan in Pakistan. Wilson (1988) briefly describes agro-pastoral sheep and goat production systems in tropical Africa. Most agro-pastoral systems are transhumant, the producers migrate to specific grazing areas during certain seasons and return to a home base usually associated with privately owned croplands. In these systems it may be common for members of the family to be herding livestock far from the family's permanent residence, while other family members remain at the residence and grow crops. In certain areas, such as parts of western Africa, the agro-pastoral system may involve contractual arrangements between transhumant livestock producers and sedentary farmers. These situations also describe most cattle and sheep production systems in the western U.S. associated with public lands grazing. Rangelands are grazed during the crop growing season and livestock return to cropping areas after the crop harvest. The livestock utilize crops and residues and provide manure for fertilizing the next crop. In most regions of the U.S. 50 - 70% of the crops produced may be fed to livestock. The interrelationship between crops and livestock in this system contributes to food security, for by having both livestock and crop activities risk is reduced.

The fact that stationary home bases and higher potential croplands are involved may provide more opportunities for strategic interventions to improve the production systems. The major constraint, on the other hand, is often the lack of land tenure on communal grazing lands. This results in little incentive for the individual producer to properly manage grazing lands, since other producers can and will take advantage of any improved grazing conditions. There have been few limited successes where cooperative, tribal or political leadership has convinced large groups of herders to implement range management or improvement programs.

Most production systems involve mixed livestock species grazing systems. In the tropical countries of Africa , cattle are generally the dominant species with lesser numbers of sheep and goats (Wilson, 1988). However, sheep are often the dominant species in barley or wheat growing regions (Thomson *et al.*, 1988; Nagy *et al.*, 1989a). Most agro-pastoral systems include some goats.

Marketing tends to be more structured in agro-pastoral regions, but producers have little knowledge of demand and pricing strategies and thus tend to be at the mercy of experienced traders. Political

boundaries, health restrictions on animal movement and distance from producer to consumer are all major factors affecting market price. Animal health problems and undernutrition along with poor management are major constraints to production (Wilson, 1988; Nagy *et al.*, 1989b).

Although the agro-pastoral system contributes to the farmers food security, there is the potential for conflict between these people and nomadic herders. During times of drought these conflicts become more intense. Therefore, there is a clear need to work on resolving land tenure issues and developing grazing reserves and policies.

1.3 Smallholder Sedentary Systems

In these systems farmers utilize small amounts of land for cropping and have small numbers of livestock. Utilization of animal traction is high in these production systems. Sheep and goats are increasing in popularity, primarily because the small animal complements the small farm. The smallholder sedentary system is broadly found in two environments. The first occurs in a transition zone much like the agropastoral system, where traditionally livestock may have passed through at some point in the production cycle. The second environment tends to be in higher potential areas which have more than 500 mm. of rainfall. Although high potential zones are not as severely affected by drought, food security can be greatly affected by civil unrest. Examples of this situation have occurred in Mozambique, southern Uganda and the Ethiopian highlands. In smallholder sedentary systems, livestock production systems range from total confinement (with feed carried to the animal), staking animals during the daytime to graze specific sites, and herding animals that graze fallow lands or communal grazing areas.

The quality and quantity of available livestock feed constitutes a major constraint to increasing sedentary livestock production. Because of lower mobility, sedentary livestock have less opportunity to benefit from regional differences in searching for high quality fodder. Due to the fluctuation in forage quality and availability, work animals are weakest when the demand for work is greatest (at the start of the growing season). This situation worsens when droughts occur and animals are in poor condition.

2.0 Response to Famine

2.1 Management of Livestock

Livestock management has a major influence on the response of livestock to drought and civil unrest. Producers have several choices regarding how they manage their livestock during disaster situations. Ward (1978) points out that cattle owners have five courses of action to choose from during a drought situation:

1. They may sell all surplus stock and use the proceeds for personal requirements and buy supplemental feed for the remaining animals.

2. They may sell all of their stock, save the proceeds and restock later.

3. Sell all livestock and buy cereals.

4. They can move livestock to another area.

5. They can do nothing.

The responses selected by livestock owners are varied and depend upon social, economic and environmental conditions. **Figure 2.** demonstrates the sequence of events which occur during drought (Toulmin, 1985). One consequence of drought is lower animal productivity. As a result people use more grain to meet their nutritional needs. In this situation, livestock have to be sold under distress conditions at lower prices. **Figure 3.** shows how the relative price for cattle and grain change during drought conditions (Toulmin, 1985).

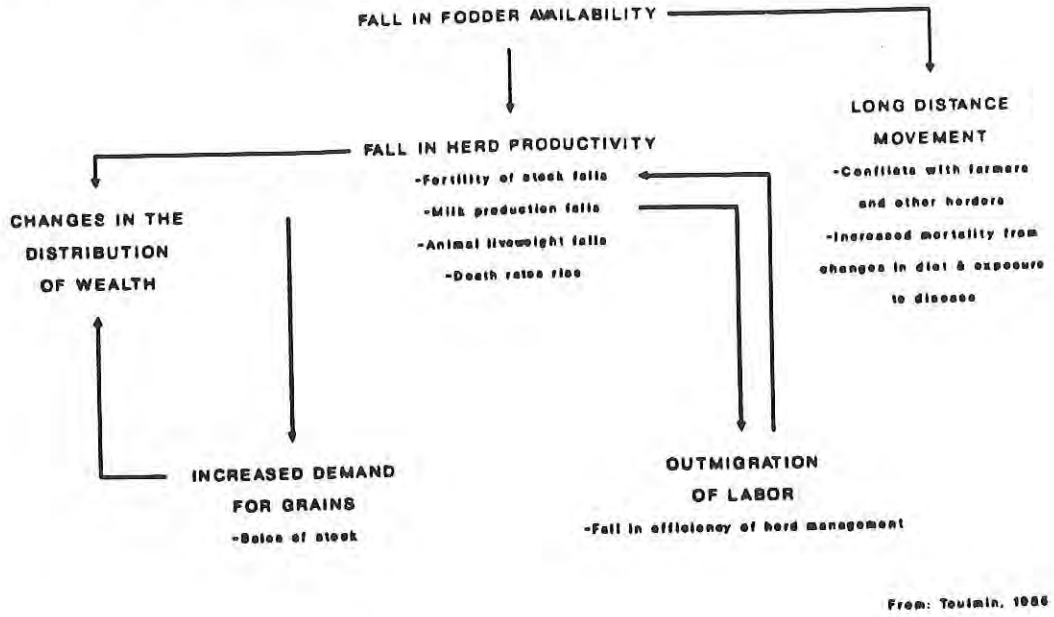
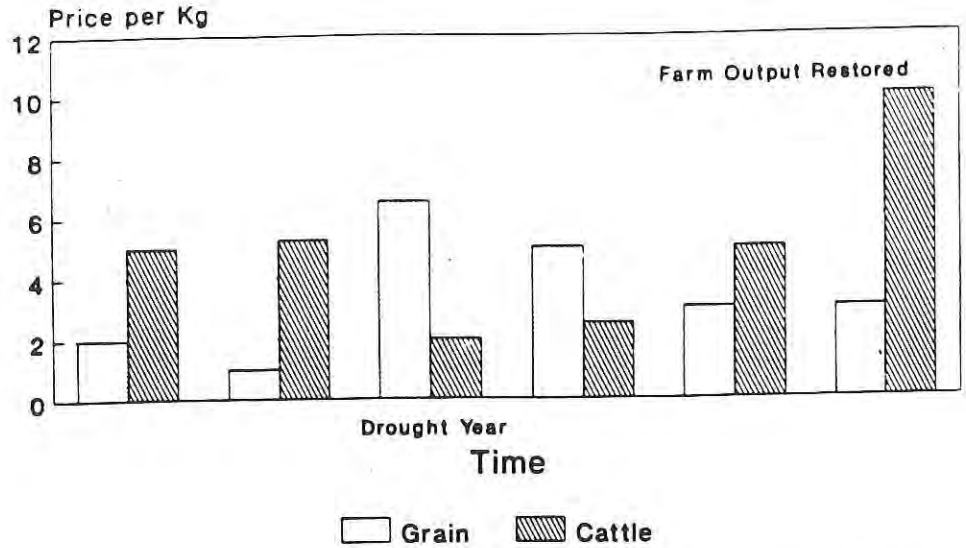


Figure 2. Effects of Drought on Pastoral Areas

In the diverse environments in which mitigation activities have to be applied the preference for different livestock species will vary. For example, Webb *et al.* (1991) reported that during a drought in Ethiopia the Dinka tried hardest to keep their oxen alive, while the Gabbra and Borana focused upon the milk and meat producing animals, such as camels and cattle. This example demonstrates the care with which interventions must be designed. For example, mitigation efforts designed to maintain oxen for plowing will have little acceptance or success with Gabbra or Borana. In other areas, such as Northern Kenya, the mitigation efforts involving small stock will be more important.

Producers can choose from a number of strategies as a drought continues to impact the livestock resource. In some cases, excess males and unproductive females are the first animals sold. As forage conditions decline, only the milk herds are kept in close proximity to the owner, with the remaining portion of the herd taken in search of better forage conditions. As the situation becomes more extreme, nursing lambs and kids are killed so that milk from ewes or does can be consumed.



From: Toulmin, 1985

Figure 3. Relative Price Movements of Cattle and Grain Before, During, and After Drought

Populations in drought prone areas have developed strategies for coping with these types of situations. Increased population pressure deprives many pastoral communities from using traditional strategies and practices which have evolved over time. This limitation comes in several forms; they can be prevented from grazing areas normally used in famine by government regulations, the encroachment of farmers onto marginal lands which at one time provided a grazing reserve or the insecurity of a grazing reserve.

With increasing human population pressure in Africa, there are more nontraditional owners of livestock. In this case, famine strategies may not exist and the opportunity for management interventions can be more easily made because traditional basis are not established. However, conversely there will be no benefit from trial and error.

2.2 Response of Livestock to Drought and Civil Unrest

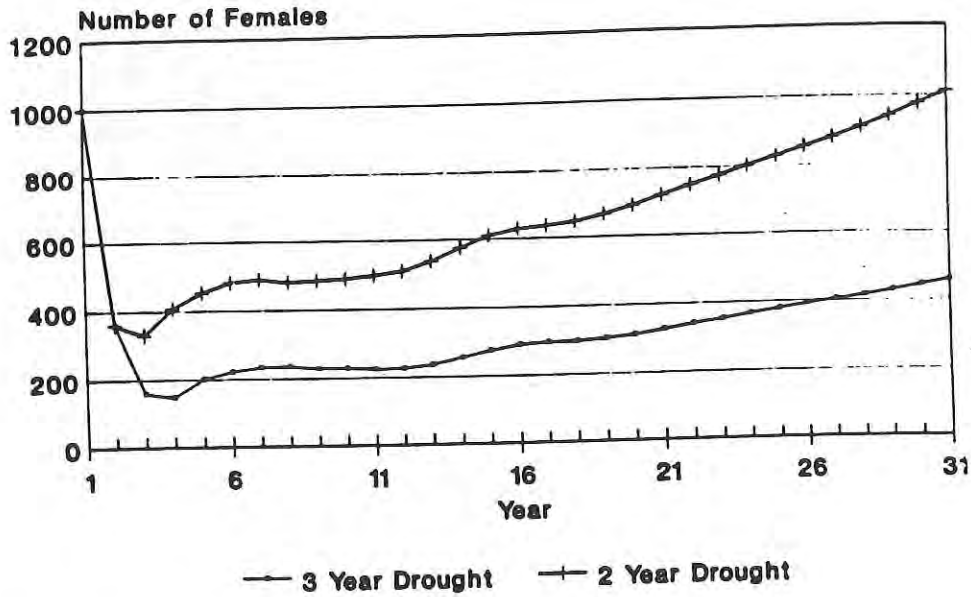
Livestock respond to drought and civil unrest by losing productivity. The magnitude of the livestock response largely determines the options available. In other words, different mitigation activities are warranted as different threshold levels are crossed. The magnitude of the response (or the loss of productivity) determines the steps necessary for livestock preservation or dispersal. Therefore in developing mitigation efforts, planners should be cognizant of the impact which drought or civil unrest can cause as well as the stage of deterioration.

Complicating the assessment of livestock mitigation efforts is the constant fluctuation of animal numbers and type of livestock. These changes occur in times of famine and during normal seasonal fluctuations. The complication occurs because the number and type of livestock have direct impact upon the utilization of the natural resource base. Therefore, fluctuation and

movement must be considered when designing mitigation activities like grazing schemes, supplementation policies, or marketing practices. It is for these reasons that the entire production system should be considered.

As previously stated, when livestock enter drought or civil unrest, the effects are essentially the same; their normal feeding habits are disrupted. As a result animals lose weight, milk production decreases and eventually stops, and reproductive and growth processes stop. What varies in these situations is the intensity and length of drought or civil unrest.

When the famine situation has ceased animal production doesn't immediately start again. Recovery rates are a function of livestock species, forage conditions, the length of the drought, and the degree to which the age structure of the population has been has been impacted by the famine. This last point is key to understanding the length of time required to recover. Dahl and Hjort (1976) provide simulated results of how long cattle populations take to recover from a 2 or 3 year drought **(Figure 4.)**.



From Dahl and Hjort, 1976

Figure 4. Long Term Drought Effects on Cattle

Herd recovery involves a time lag, during which breeding females must first re-establish body condition and then become pregnant. Therefore gestation length and the time taken to replenish body stores determines how long it will take before milk is available to farmers. Meat production has an increased time lag due to the length of time required for animals to reach slaughter age.

To help illustrate how drought and recovery times impact animal performance there is a need to examine animal performance in pre-drought, drought and post-drought situations. Simulations by Blackburn and Cartwright (1987a,b) and Zessin (1990) demonstrate the impact and time lag effects caused by drought (**Figure 5.**). These studies quantify the magnitudes of animal performance, recovery time, reproduction and mortality. In both cases the typical decrease in animal performance occurs followed by a recovery after two years.

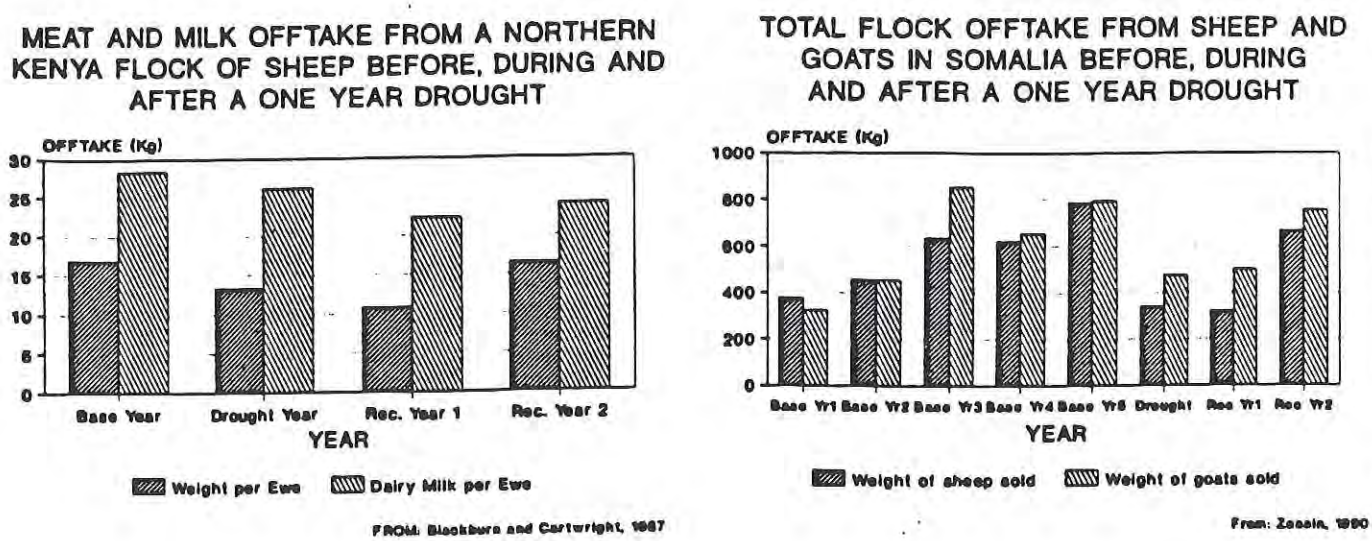


Figure 5. Response of Sheep and Goats in Northern Kenya and Somalia to Single Year Droughts of Different Magnitudes

The impact of drought or civil unrest on sedentary production systems has not been extensively studied. Blackburn *et al.* (1990) evaluated the impact of a one year drought in Western Kenya. This area is a high potential region (over 800 mm rainfall) where farmers work on small plots of land (approximately 1.5 ha) and have small numbers of animals. Although the original study dealt with a drought it may also provide an indication of what happens to livestock during a time of social unrest. **Figure 6.** shows how flock size, meat production and milk production were impacted by the drought. The interesting point is that during such a stressful time small flocks have a difficult time in reestablishing the pre-drought population and performance levels. In this study, the flock could not re-establish itself after six years. As a result, offtake in terms of meat and milk decreased 76% and 84%, respectively, from pre-drought levels.

The results presented in these three papers also provide guidance as to how pastoral and sedentary production systems vary. The pastoralist is perhaps better equipped for the drought in terms of mobility and herd size. The small farmer is more vulnerable due to the smaller number of animals

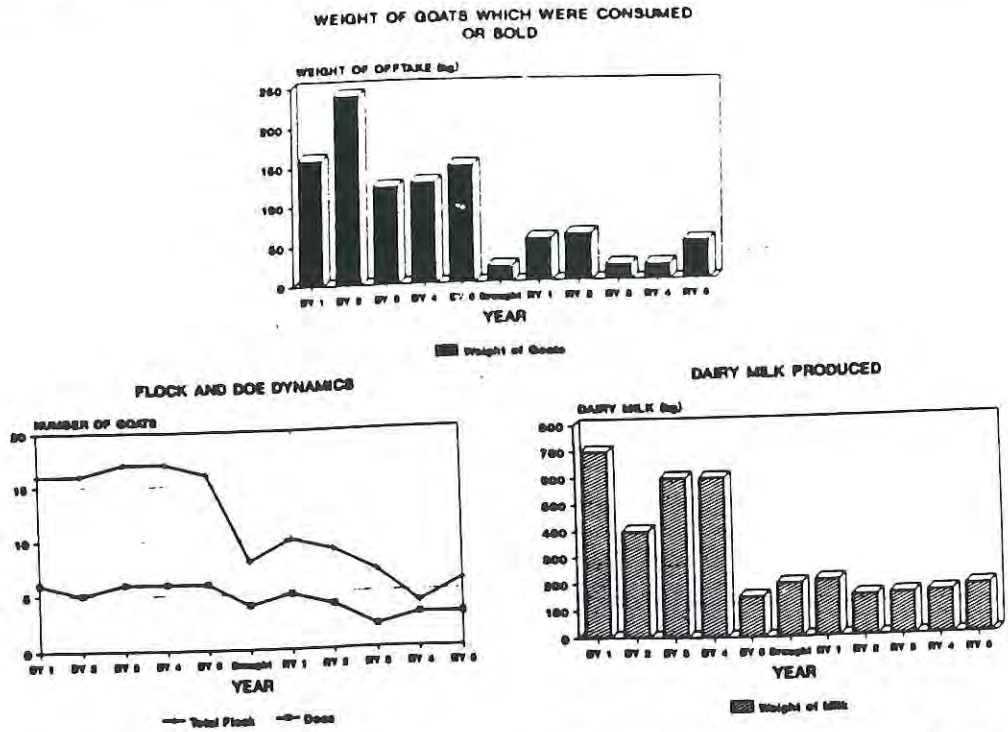


Figure 6. Impact of Drought on Sedentary Goat Production in Western Kenya

and limitations on mobility. Although sedentary farmers are subject to these vulnerabilities, their particular farming system has strengths in terms of how quickly crop aftermaths can be generated which help re-establish flock performance. The risk sedentary farms face is that their flock sizes become so small that it is more difficult for them to regenerate the desired flock size.

In effect, animal mortality and distress sales during times of famine create "holes" in the livestock population's age distribution. The absence of these age groups contributes to the depressed performance of herds or flocks after drought or civil unrest. The impact of this loss will last until the lost age category would have exited the herd or flock. At this time, performance levels may have been reestablished but herd numbers can still be depressed. Clearly if drought or civil unrest occur at relatively frequent intervals it is possible that a flock or herd may not recover completely before entering a new period of stress, due to the disruption of animal generations. This is particularly critical for species which have long generation intervals, such as camels and cattle.

2.3 Government, Donor and PVO Assistance to Livestock Sectors in Droughts

Government actions vary between countries and in many cases they have evolved with time and experience. For example, during a 1960 drought in Botswana, the government was unprepared and unable to respond. During a 1973 drought the Botswana government campaigned to persuade livestock owners to de-stock. They took further action by increasing the quotas for slaughter from drought stricken areas. During 4 weeks 26,000 head of cattle were moved out of the drought stricken area (Ward, 1978). As part of their strategy of livestock development and drought mitigation, the government established livestock advisory centers and central storage facilities. Such actions serve as a mechanism to disseminate information, training, animal health care and marketing information. The government has also been willing to import supplementary feed, but

their experiences with it have been mixed. Although such feed can contribute to maintaining animal populations, there are logistic and equity problems. Importing supplementation tended to be too expensive and it proved to be hard to store without spoilage. Furthermore, it must be purchased in large quantities. It is also difficult to know when to order the feed. In one situation ordered feed arrived at the time when the rains did and was subsequently not needed.

During previous droughts, the donor and PVO community has been involved with trying to rebuild herds. **Table 2.** summarizes some efforts at re-establishing herder resources. With the exception of Oxfam in Kenya, herd reconstitution efforts provided only limited numbers of animals, the expectation being that livestock would only serve as a supplement to other income sources. From this information Toulmin (1985) identified three factors which should be considered in the formulation of relief strategies: choice of scale, institutional framework and the alternatives to herd reconstruction. Choice of scale refers to the number of animals to distribute, whether to distribute small numbers of animals to many families or to completely reconstruct herds for a few people.

TABLE 2. A COMPARISON OF HERD RECONSTITUTION METHODS

Scheme	Number and Animal Type Allocated	Cost/Household # Households	Framework
Tin Alcha, NE Mali	1-3 cows, 1-3 sheep	$165 200 households	Part of settlement scheme for nomads, farming schools, etc
Relance du Movement, NE Mali	5-10 small stock largely goats	$75 5,000 households	Reestablish cooperative movement among herders, gardening
Oxfam Gourma	20-30 small stock + cash	$450 45 households	Component of herder association project
Gov't Niger	1 cow, 1 sheep, 2 goats	$140	Herd reconstitution via credit
Oxfam Habbanaae, Niger	2-3 cattle plus small stock & transport animals	$150-160 300 households	For destitute herders
AID Niger	1-2 cows	$75-150 200 households	Part of range project including credit and cooperatives
UNHCR	1 cow, 1 donkey, 2-3 sheep	no data	Re-settle refugee Somalis
LMB NE Ethiopia	2 cows, 2 camels, 12 sheep & 15 goats	$300 5,000 households	Re-distribute post drought livestock population
Oxfam Kenya	50-80 small stock, pack animals, grain & equipment	$1200-1300	Pilot project

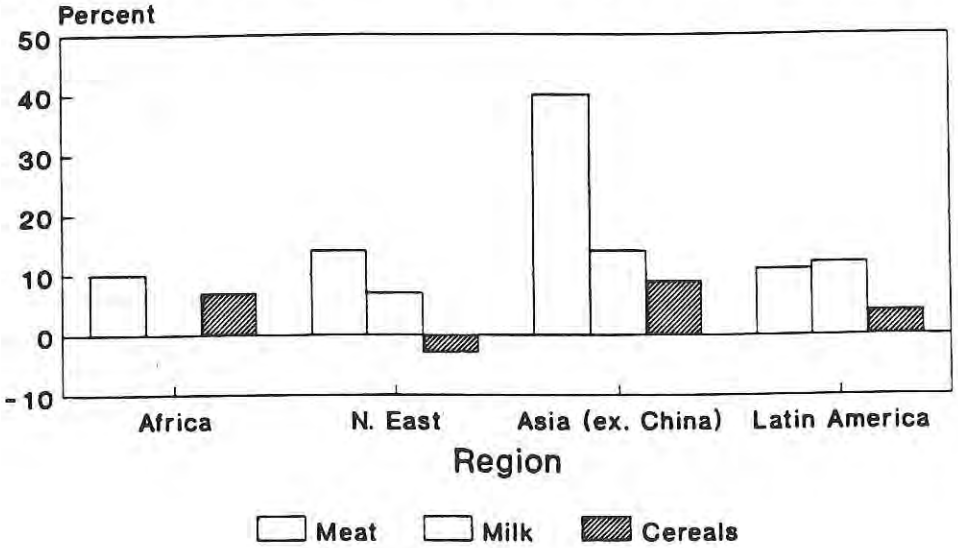
Choice of scale is determined by the spatial extension of the disaster, pasture conditions and the availability of livestock to distribute. Choice of institutional framework is based upon the form in which aid is provided (gift or credit) and also on the way it is distributed. In either case, knowledge of the community is important, as well as knowing the traditional mechanisms for coping with disaster. There are several alternatives to the reconstruction of herds. A government

can decide to do nothing, thus leaving the people to their own resources to resolve their problem. Secondly, a government could opt for some sort of resettlement plan. Third, the benefits of providing grain relief with herd construction should be evaluated. Toulmin's (1985) analysis stated that the cost of complete herd reconstruction programs are equivalent, at most, to the cost of providing a basic grain ration to people for 3 to 4 years. Herd reconstitution costs are also substantially lower than the costs of major irrigation schemes. These conclusions indicate that re-establishing herds may, in the long term, be the most economical and sustainable approach to drought recovery.

3.0 Economic Social, Political and Technical Considerations

3.1 Macro Economic Impact of Livestock Production

Globally, the demand for livestock products is increasing. In part this is related to increased income levels. As income levels increase so does the quality of diet. FAO (1987) has quantified the increase in demand for meat milk and cereals between 1985 and 2000 (**Figure 7.**). Even if economic growth slows, human population increases will continue to increase the demand for livestock and their products. This means that during drought and civil unrest livestock are an economic resource which needs to be protected to prevent major economic stagnation.



FAO, AT:2000, 1987

Figure 7. Percent Change in Per Caput Demand between 1985 and 2000

The combination of income growth, population pressure and the slow growth of the agricultural sector creates a demand for livestock products which most developing countries can not meet. **Figure 8.** shows the annual growth in imports of livestock products from 1970 to 1988. Clearly set-backs in domestic production exacerbate the situation and result in a larger trade deficit.

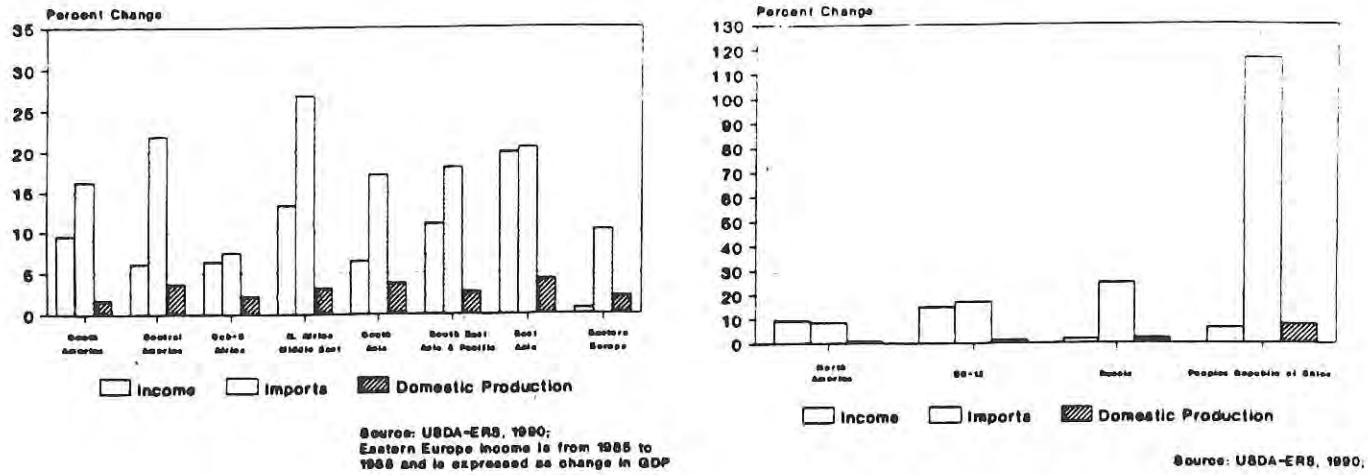


Figure 8. Average Annual Change in Per Capita GNP, Imported and Domestic Livestock Prices Between 1970 and 1978

Figure 9. presents the balance of trade for meat and milk in Latin America, Africa and Asia. With the exception of the Latin American meat trade, the developing world is accruing relatively large monetary deficits by importing meat and milk.

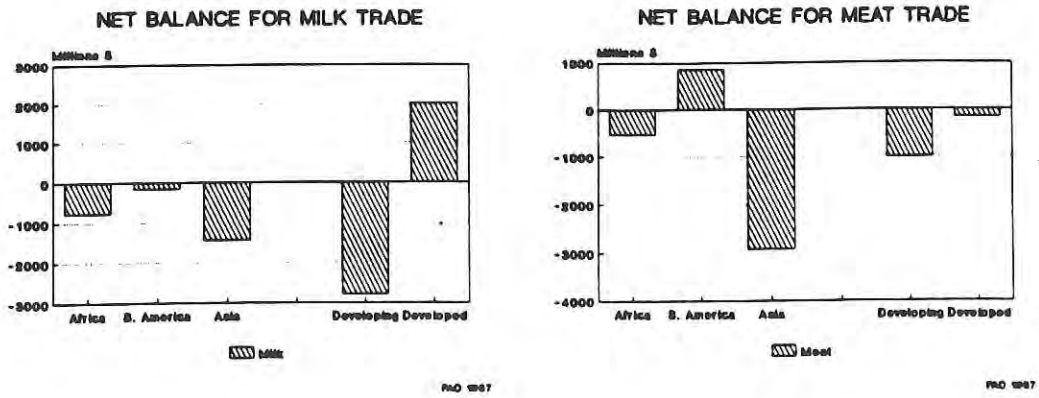


Figure 9. Balance of Trade for Milk and Meat Trade

Livestock can clearly have significant impact on national economies. Toulmin (1985) categorizes the impact of decreased output from livestock and farm sectors in terms of government budget, domestic markets and external trade (**Table 3**). In general, drought or civil unrest creates unstable market and government budgetary situations. As a result of instability, planning for government services and private industry becomes more complex. Perhaps at greatest risk is the country's export markets, because while herds are diminished and then rebuilt, competitors can capture a drought stricken country's market share.

TABLE 3. EFFECTS OF DROUGHT ON MACRO-ECONOMIC VARIABLES

GOVERNMENT BUDGET	DOMESTIC MARKET	EXTERNAL TRADE
-fall in revenues from direct and export duties -increased demand for government services, with shift to short term relief	***Livestock*** -short term fall in prices with high offtake -longer term rise in prices as herds reconstitute ***Grain*** -short term rise in prices with rising demand and fall in supply -medium term fall in prices as harvests return to normal	-short term rise in number of stock exported - medium to long term fall in exports as herds reconstitute -pressure on foreign trade balance from need to import grain and other relief supplies

3.2 Economic Impact of Livestock on Impoverished Farmers

The contribution of livestock to the economic well-being of the farmer is substantial. For example, in the Ethiopian Highlands, livestock provide 53% of the value of total farm output and more than 80% of farmers' cash income (Assefa, 1990). In Mali, livestock comprise 41% of farmers average net value and provide 71.1% of the cash income (Debrah, 1990), while in Peru landless people derived 99% of their income from animals (Quijandria, 1988).

These examples indicate that the impact livestock have on rural economies is important, but how vital is it to the poorest rural people? It is often incorrectly cited that only rich farmers have livestock. However, in a recent publication by IFPRI (1991) a very different picture emerges; a picture which demonstrates that livestock and crops are an integral part of the small farm enterprise.

Vosti and Witcover (1991) indicate how livestock play an important role in the economy of malnourished rural poor in Brazil. These researchers classified farms by production of major products and then analyzed income and nutritional well-being of the household members. **Figure 10.** compares rural poor income and the role livestock play in generating income. **Figure 10.** emphasizes a strong relationship between staple crops (corn and rice) and income generated from livestock. By increasing livestock activity (in this case dairy cattle production) farmers were able to generate more income than they could with other cropping activities. These results suggest that the benefits are approximately equal for livestock/cropping and cash crop enterprises.

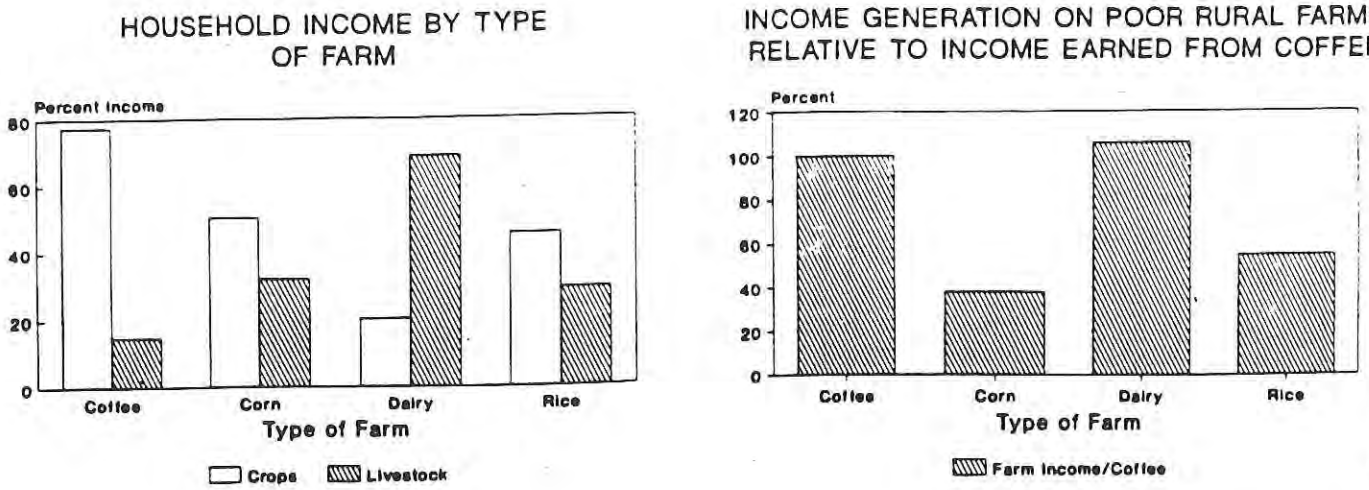


Figure 10. Income Sources of Rural poor in Zona da Mata, Minas Gerais, Brazil

Owning livestock improved the nutritional well being of the farm household. As Vosti and Witcover (1991) stated *"households deriving above average percent of income from livestock tended to be better fed and the children were better nourished"*. Families which depended upon off farm

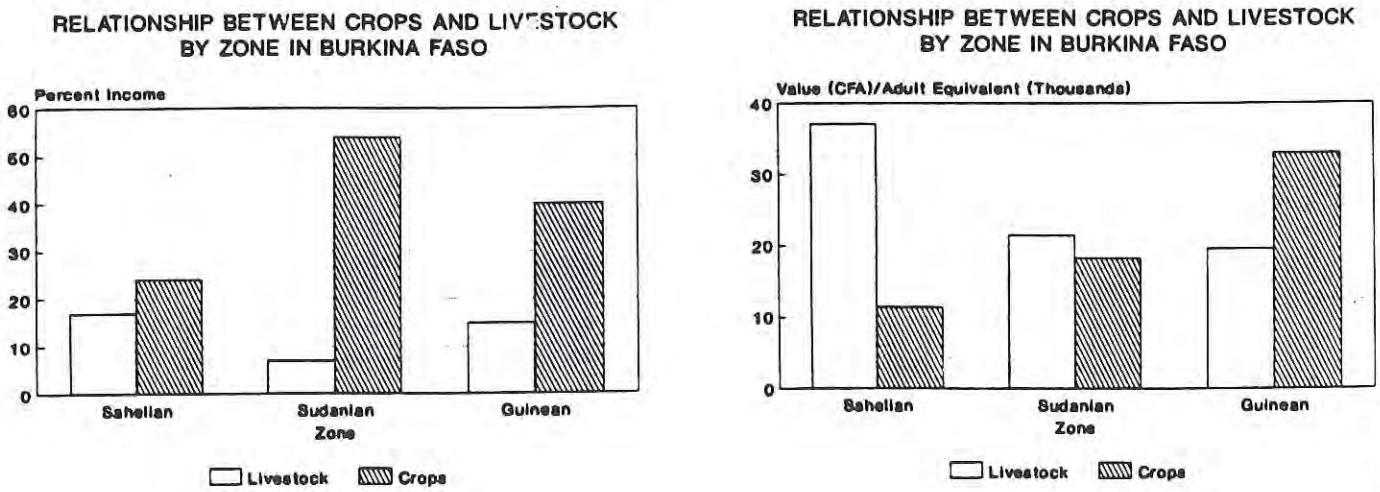


Figure 11. Agricultural Income Generation by Rural Poor in Burkina Faso

income were worse off. They showed that the ratio of crop to livestock income was correlated with child growth, a decrease in the ratio (which was an increase in the importance of livestock) resulted in a significant improvement of children's height-for-age.

An important aspect of how livestock contribute to the well being of rural poor during a drought in Burkina Faso was demonstrated by Reardon ('991). He showed that using income as an indicator alone can be misleading. In all three regions of the country, crop activities generate a higher percent of income then livestock for this group of people. However, if expressed as the ratio of livestock or crop value to adult caloric equivalents (2280 kcals/day), it was shown that livestock have as much -- if not more -- value than crops **(Figure 11.)**.

Among the rural poor in Pakistan, livestock and crops contribute near equal amounts of income to the household (Garcia and Alderman, 1991), while on a national level livestock contribute to one-third of agricultural GDP. For groups with different caloric intakes, the contributions of crops and livestock to household income were as follows:

CONTRIBUTION OF LIVESTOCK AND CROPS TO HOUSEHOLD INCOME

	Calorie Consumption/Day		
Source of Income	>2400	1600-2400	<1600
Crops (%)	20.5	24.8	17.0
Livestock (%)	15.5	14.2	13.1

Clearly both crops and livestock play important roles in generating income for rural poor households. Without this important base the amount of food aid necessary to support these households would be greatly increased.

The data from these three reports suggest that livestock are critical elements of income generation and nutrition. Directly or indirectly they contribute to the growth and development of children. It is clear, especially from the Brazilian report that child development is stifled to a greater extent without livestock as part of the family enterprise. The nutrition and economic data do not provide direct insight to the relationships between livestock and cropping activities. However, such symbiotic relationships are unquestionable and affect the productivity of livestock, the sustainability of the production system, and development of human resources (nutritionally and economically).

3.3 Political Considerations

There are several political considerations which are unique to livestock. Chief among them is the ability of people and livestock to migrate in search of better grazing. Traditionally this migration could transcend national borders. However, now such migrations are not always welcome or wanted by host governments. The land use tensions which now exist in Eastern Africa are an indication of this type of problem.

Within countries, migration of pastoralists into sedentary agricultural areas has also created tension. This is particularly true in areas where the agriculturalists have started to keep their own livestock and are no longer dependent upon migrating herds fertilizing their fields. This type of problem is the currently the situation in some West African countries.

Besides competing for land, drought or civil unrest causes a disruption in the food chain to urban areas. This disruption can create higher consumer prices (and therefore consumer dissatisfaction with government polices). In addition it provides an opportunity for cheaper meat of lower quality to be imported, thereby displacing the domestic producer after the crisis situation has passed.

Because livestock production is reduced, pastoralist are forced to find employment in other sectors of the economy creating, again, human migration and displacement and taxing local governments and economies ability to cope with an additional burden.

3.4 Technical Considerations

3.4.1 Maintaining Biodiversity: Besides being kept for various social reasons (in the different pastoral, agropastoral and sedentary groups) a mixed herd of livestock contributes to maintaining plant biodiversity. In these systems maintaining mixed animal species is the rule and not the exception. This symbiotic relationship is the result of co-evolutionary processes plants and animals have passed through. By keeping a mix of different species, such as sheep, goats, camels and cattle, different ecological niches can be filled and exploited, and the producer is more likely to achieve an acceptable level of productivity. These combinations, when used with appropriate stocking rates, allow both livestock and plant community to thrive. If the animal species composition is not balanced, the effects soon become evident in the plant community. Conversely, if unhealthy trends are evident in the plant community then readjusting animal composition can improve the health of the plant community.

During the course of environmental fluctuations and civil unrest, livestock combinations can become unbalanced and consequently affect the biodiversity of plant communities. Such an occurrence has several effects. First, it influences the rate at which people can re-establish their income generation capability and, second, it impacts the recovery of the plant community. Therefore a need exists to assess combinations of livestock to determine their appropriateness and what might occur if the balances between species is changed. It is in this way that livestock combinations can be used as a tool for hastening range recovery and speeding the economic recovery of those people exposed to famine. For example, if socially acceptable, it would be more logical to distribute goats to households with marginal incomes than cattle or camels, due to goat's relative low cost and high reproductive capacity (Mace and Houston, 1989). This implies that species composition is not consistent and relief efforts should approach the problem as being a dynamic, rather than a static, process.

3.4.2 Animal Maintenance: Two key strategies for maintaining the animal population during a disaster are providing supplementary feed and moving animals. Utilization of supplementary feed requires a number of considerations. Ideally, supplements grown in the affected country should be the primary ones used. The types of feed used for supplementation can include crop residues, oil cakes, food grain brans, distillers by-products, root crops and molasses. Deciding which of these types of supplement should be used will be based upon their availability and the nutrient needs of the animal population. In addition to supplements which provide protein or energy, there is a need to provide livestock with mineral supplementation, such as salt, phosphorus, and potassium, as well.

Key problems in providing supplementation to animal populations include the logistics of moving the supplement, deciding which segment of the livestock population receives the supplement, and determining the amount of supplement needed per animal per day. As will be seen in the strategy recommendations, techniques exist which will provide insights and answers to these types of questions.

Another mechanism for maintaining animals is to move them to areas where better grazing conditions exist. However, this might not always be feasible, such as usufruct disputes, blockage of migration routes because of conflict or administrative barriers to herd movements, or other factors that restrict livestock movements. When this is the case, distress sales need to be considered as another form of livestock movement. However, such sales are usually postponed until the later stages of a deteriorating situation, resulting not only in poorer prices for the animals, but also in reduced yields from the animals sold. Marketing distressed livestock also can be hampered by logistical constraints in transporting the animals, limited abattoir capacities, and storage capacity.

A key consideration in the movement of animals is the increased possibility of disease outbreaks as herds become more concentrated around limited water and forage resources. Government veterinary services need to be able to monitor the situation and provide vaccinations and quarantine when necessary. When animals are in better body condition their immune systems are better able to resist disease challenges, so feed supplementation can play a key role in reducing the outbreak of disease.

4.0 Strategy Recommendations

4.1 General Thrust

The basic premise for preserving livestock resources in famine situations is based on the need to preserve the nutritional and economic benefits that these resources confer to their owners. In crisis situations it is essential to determine what levels of livestock losses are acceptable while still maintaining viable herds or flocks. It is this point which underscores the importance of the general principles which started this chapter. Clearly, mitigation activities must incorporate an appreciation for a systems approach, the concept of biological thresholds, population dynamics, and the economic and nutritional ramifications of mitigation activities during the crisis and after the crisis has subsided.

New approaches must be applied if the problem of livestock preservation in famine situations is to be addressed in a systems context. It is no longer acceptable to assume that indiscriminate sales and/or supplementation of animals will reduce the catastrophic effects of drought on farmers.

The development of a long term view, which leads to rational mitigation activities, requires information from the field and the use of a suite of computer simulation models. Combining these two data sources allows for the development of long term perspectives of the impacts famine and mitigation activities will have on people in crisis situations.

The strategy proposed here for the development and implementation of prevention and mitigation activities for livestock is comprised of three components. These components are information collection and compilation, simulation modelling, and development and implementation of action plans. A schematic of the goals, information generated and linkage between the different components is presented in **Figure 12.** The prevention and mitigation program outlined is clearly interdependent. The establishment of effective working relationships between organizations which

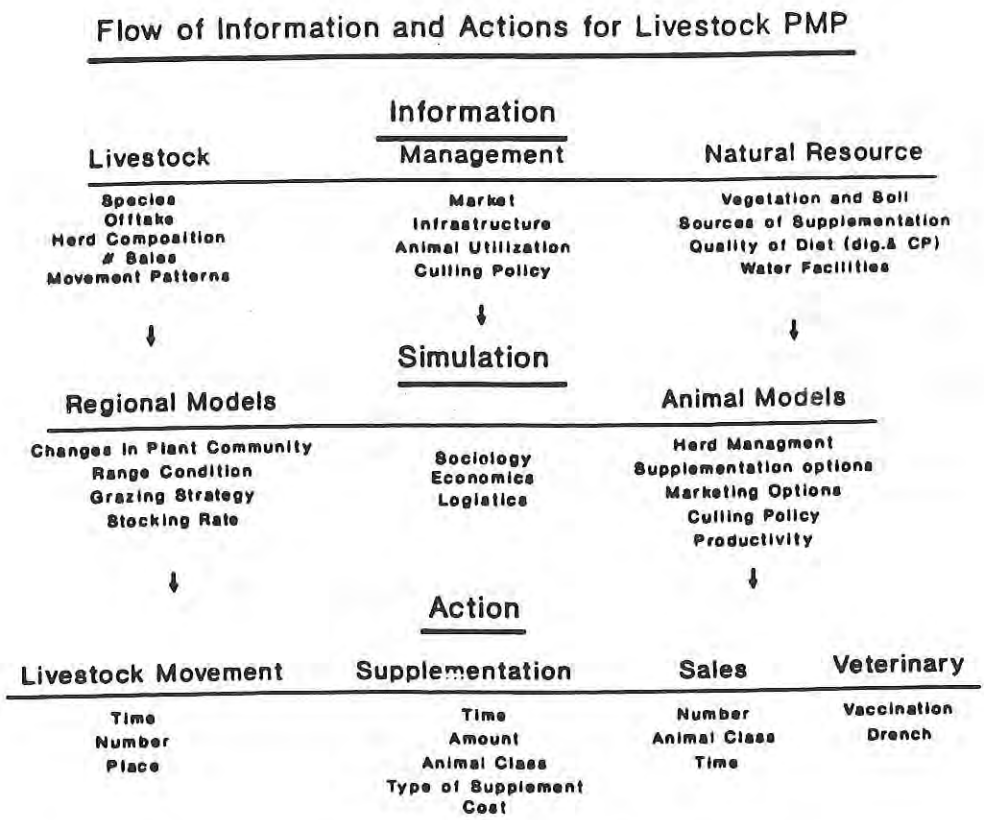


Figure 12. Flow of Information and Actions for Livestock PMP

will be carrying out the prevention and mitigation work is key to the success of this approach. By establishing such linkages, the opportunities for institution building (principally through human development) and leveraging assets (from different projects or donors) can be greatly increased.

4.2 Information Needs

Famine mitigation requires information and information management. Today the capabilities exist which will allow mitigation teams to quickly analyze and utilize animal and forage resource data. Key to this process is establishment of data collection prior to emergency situations. If we are going to start making informed decisions, data collection procedures must be established and there must be a free flow of that information.

Basic livestock data needed for assessment are presented in the following table.

LIVESTOCK	MANAGEMENT	FORAGE
Animal numbers by species Flock or herd composition Animal weights Body Condition Mortality rates Milk production levels Normal offtake rates Number of sales Movement patterns	Market infrastructure Animal Utilization Culling Policy Market policy (producer and national) Breeding practices Decision for movement Social considerations Species choice	Vegetation & soil maps By-product use Sources of supplementation Quality of diet (dig & c.p.) Water facilities

Just as important as descriptive data on livestock populations in the target area is the dynamic assessment of these data: knowledge about trends is vital. From this analysis the information will be fed-forward to the simulation component to make projections of prolonged drought effects on animal populations, determine the size and scope of required mitigation efforts.

The information collected provides useful indicators as to the status of livestock populations and the forage base. But what is needed is a mechanism to put this information into context. What is needed is a way to add depth to the information and this is why the information will be utilized in simulation models. By using the combination of field information and simulation, an up-to-date picture of the situation can be generated, as well as possible relief scenarios. This approach is necessary because no one knows for certain how long a drought will last or how severe it will become. By combining information with simulation it will be possible to dynamically reassess policies at any point in time.

Collecting the specific information has always been difficult. In the past the information was never collected before the drought, or if it was collected it was never analyzed and made available to potential information users. However, over the past decade the information base of national agricultural research services (NARS), internationai agricultural research centers (IARCS) and, to some extent, the donors has improved. Because information is not only vital to prevention and mitigation activities but also to national ministries of agriculture, the operation, function and sophistication of data collection and reporting needs strengthening. It would seem that this is an opportunity for various AID bureaus to be linked together in an effort of common benefit.

4.2.1 Operationalizing Data Structure: One scenario of structuring the information would be to establish baselines for the country. Data could be collected by agricultural ministries and evaluation performed regularly. Action points would be determined by deviations from the normal fluctuations in the data base or when other indicators start to appear threatening. Decreasing deviations from the baseline would be separated into two categories; a warning level and an emergency level. Once conditions decline to the warning threshold, simulations would be run to project future trends and options available to producers at that time. Further deteriorations to the emergency level would result in more relief oriented interventions being simulated, evaluated and implemented in the field. A strong commitment by governments and donors to support data collection, processing and evaluation is required to establish this type of structure.

4.3 Simulation

The next phase of response in a livestock prevention and mitigation program (LPMP) is to utilize the indicator information and devise strategic and tactical interventions. The most expeditious way of accomplishing this, while considering the major underlying concepts of viewing the system as a whole and understanding threshold levels, is through the use of simulation models. The primary rationale for using simulation models is their ability to provide insights into alternative interventions and to explore future impacts of interventions. Furthermore, use of simulation models saves time and resources.

Computer simulation is the only technology which can adequately assist in developing tactical and strategic plans of the nature discussed in this paper. It is also the only tool which can project the results of a mitigation activity. In other words, with this tool the following types of issues can be addressed:

1. The level of supplementation required for different classes of livestock sufficient to maintain livestock populations,

2. The impact of supplementation on herd composition and performance after the time of crisis,

3. The numbers and types of animals which should be sold while still maintaining viable numbers to re-establish herd or flock productivity,

4. Provide estimates of the amount of offtake (meat and milk) possible from a herd of flock before, during and after a drought.

In essence this tool becomes a prime source of information which can help plan and direct mitigation efforts. This tool also has practical applications for the design of longer term sector development approaches.

The simulation models used will depend upon the information generated by the first phase of the program. This will allow the models to be parameterized to the specific location in which they are to be applied. Therefore, the simulated response and consequent recommendations for mitigation activities will be tailored to the current, site specific situation.

Several types of simulation models will be needed to develop recommendations for LPMP programs. The models must be mechanistic in structure in order to provide insights into the biological response of animals and plants. It is essential that the animal models used be capable of simulating each individual animal in a flock or herd, as well as the dynamics of the flock or herd. These models must also have the flexibility to emulate the management systems which will be encountered. Models which are not based upon biological mechanisms will not be useful in this effort. Likewise spreadsheet programs, disguised as models, will not provide the needed realism to be useful. This also excludes models which are principally driven by stochastic processes and have virtually no biological feed-back mechanisms.

There will be a need for models which simulate the range or watershed at a regional level. These models will be primarily concerned with evaluating large land areas used for grazing. It will then be possible to evaluate herd response to potential mitigation options, such as destocking or creating grazing reserves, and also predict the effects on the health and viability of the range resource and any successionary changes that may occur. It is possible for these models to be linked with satellite information on vegetative condition. These models will not be used in evaluating disaster situations in ecozones which have a higher productive potential (e.g., humid or subhumid zones). They will not be used to establish herd or flock recommendations for individual producers, this activity will involve a second group of models.

The second suite of models, which will be most heavily used, are designed to provide recommendations at the producer level. These models simulate animal performance in any environment and account for differences in nutrition, management, genotype and social utilization of livestock. This collection of models will help establish much of the logistical requirements needed in an LPMP program. With them it will be possible to determine supplementation levels and the class of animals which would benefit most from that type of intervention.

These selected models will be used to simulate various scenarios of changing environmental conditions and interventions. With these models it will be possible to project the long term outcome of LPMP interventions. *In other words, what will be the status of the livestock sector after the drought or other type of disaster has subsided.* This will enable those in the field to apply the optimal intervention combinations.

Generating model results is only the first phase of LPMP intervention development. The simulated results have to be interpreted, and the economic, social and logistical concerns will have to be addressed. Once these factors have been taken into consideration, a comprehensive plan of action for the field can be designed and put in place.

The use of the simulation models does not stop with a first assessment. As the drought or famine continues there will be a need to constantly reevaluate the interventions being practiced and make any necessary adjustments. A constant re-evaluation of the social acceptability of the interventions will have to be considered as adjustments are made.

4.4 Action

The simulation process integrates directly into the action phase of the livestock prevention and mitigation program. As a result of the interaction between all components of the LPMP effort the field teams will have specific directions and goals to implement in the current situation. The field team will be responsible for implementing and encouraging the adoption of interventions. This segment of the effort will play a valuable role not only in implementing recommendations but providing feed-back to the simulation and data processing groups. As a result of this effort new information can be collected concurrently in the field and used by the simulation and data collection components to reassess the situation and refine the current set of interventions.

4.5 Application By Production System and Environment

The proposed program can be applied in any environment and production system. With it the impact of short or long term interventions can be made. For example, some short term interventions to be evaluated might include the following:

Establishing grazing reserves for nomadic and agro-pastoral people.
Culling different classes of animals.
Pursuit of optimal marketing strategies.
Livestock crop integration.
Changing herd composition.
Improved use of crop residues.
Supplemental feeding.
Impact of quick response fodder crops.
Movement of livestock.

Optimal marketing strategies are needed to help protect the livestock resource during drought. Often when drought occurs there is massive destocking of all livestock. Although destocking may be called for, it should be discriminatory. That is, a specific class or classes of animals should be sold and specific classes should be maintained. Determining which animals to sell is important for maintaining some level of productivity during a drought and for positioning the her or flock for the fastest recovery after the drought has subsided.

In any of the situations where this strategy is to be applied there will be a need to know the capabilities of the people and their goals and objectives. For incorporating this important sociological aspect with the proposed technical approach will strengthen the sustainability and acceptability of any proposed intervention.

Although not specifically listed in **Figure 12.** are the policy ramifications of the simulated activities. While the simulations will provide guidance for field interventions they can also serve as an information base to evaluate and change government policies dealing with the livestock sector. Clearly in drought conditions very serious disruptions in the market place occur. In some situations these disruptions are magnified by inappropriate pricing policies governments have established. By demonstrating the impact or potential impact on the livestock sector these policies have, opportunities could be created to alter undesirable practices.

Using simulation in conjunction with field activities also provides an opportunity to address policies dealing with land use and tenure, marketing organizations and measures which will lower livestock producer vulnerability to future drought (e.g., grazing reserves, fodder banks).

4.6 Why This Approach?

This type of approach is essential if prevention, mitigation, and preparedness efforts are to have meaningful impact. ***There are no global recommendations for a specific situation. It is our contention that simulation models are the only technology which can be pulled off the shelf and utilized.*** The key to effective interventions on the livestock population will be knowing what is happening to the population and where the population will be at the end of the disaster -- simulation will address this critical issue.

The approach that has been outlined will provide those in the field with a road map of how to intervene. But it goes beyond a simple road map because the distances have been quantified. Access to quantitative information will unlock many of the unknowns of disaster mitigation and long term impact.

It may seem that this strategy has neglected traditional aspects of famine relief. For example we have not discussed in depth the types of feed which could be utilized in emergency supplementation. The type of feed may be important, but the critical question is how to use that feed and the effect it has. Previous efforts have not focused upon the more strategic use of feed or other intervention activities and that gap is what this strategy will fulfill.

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