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Restocking Refugee Pastoralists on the Horn of Africa

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Abstract

Repeated and lingering famine on the Horn of Africa has produced enormous pastoralist refugee populations in a region where livestock production is a major form of land use. Permanently settling destitute pastoralists into pursuits other than herding has a record of failure, can disrupt host land-uses causing social and ecological problems, and can deny utilization of very large grazing areas where pastoralism may be the only ecologically and economically sustainable land-use. Herd reconstitution needs to be considered an option in relief and rehabilitation programs for pastoralists. This paper examines a design where the most proven and immediate way of sustaining stockless pastoralists--farming--can be used to facilitate restocking objectives.

With data gathered in Somalia, estimates of livestock carrying capacity are linked with: characteristics of forage resources, land area, livestock units, and frequency of good, average, and poor (drought) water years, in order to explore the possibilities for incorporating restocking into refugee rehabilitation efforts.

Introduction

The recent decades of famine afflicting Africa have had particular impact on pastoral livelihoods and livestock production. In chronically difficult regions like parts of the Sahel and the Horn, drought, conflict, and the resulting famines have decimated herds and impoverished pastoralists beyond what indigenous recovery mechanisms can quickly service; a situation which can be aggravated by some famine relief and development efforts (McCabe 1990a; Hitchcock and Hussein 1987; Hogg 1986 1983a; Toulmin 1985; O'Leary 1990). Famine-induced destitution of pastoralist populations is a problem of considerable magnitude, and results in large expenditures for refugee programs (Hitchcock and Husein 1987; Neldner 1979; Torry 1984; Oba 1985; Frantz 1975; Hogg 1983a; Clark 1985; Zumer-Linder 1986; McCabe 1987 1990a; Toulmin 1985; Little 1984; Campbell 1981; Lewis 1975). The livestock industry--a significant, and in many cases dominant part of the national economy in a number of African countries--can be severely damaged by herd loss and require very long periods of time to recover (Table 1) (Clark 1985; Bennett 1984; Campbell 1981; Biswas et. al. 1987; Toulmin 1985; Box 1971; Lewis 1975).

There has been some discussion as to the relative merits of permanently settling stockless pastoralists, or assisting them in re-establishing their herds (Toulmin 1985; McCabe 1990a; Schraeder 1986; Bassi 1990; Hogg 1983a 1983b 1986; Sandford 1982; Lewis 1975; Scott and Gormley 1980; Moghraby et al 1987; Lamprey 1983). From a development perspective, settling pastoralists permanently into exclusively farming or fishing pursuits has not been successful. From an ecologic and economic perspective the sedentarization of large numbers of pastoralists may be especially impractical considering that many farming areas are already crowded, and rangeland livestock production will be essential to many nations' ability to feed growing populations (Biswas et. al. 1987; Campbell

1981) from a land resource covering large areas with few alternative uses.

Herd reconstitution however can run into problems when drought, conflict, famine and subsequent food distribution programs undermine traditional indigenous restocking mechanisms (McCabe 1990b). These mechanisms are usually based on contributions of animals by fellow stock-owners with whom exchange relationships exist, and carries with it an assurance of reciprocity (McCabe 1990a; Hitchcock and Hussein 1987; Baxter 1975). Animal loans to completely destitute pastoralists in refugee camps do not carry the same assurance. Thus once social exchange networks between pastoralists have been disrupted, herders in famine relief camps frequently find it very difficult to return to a pastoral life. There is increasing recognition of the need to design better recovery mechanisms for refugee pastoralists given their generally reduced capacity for recovery (Toulmin 1987; Moris 1988).

Evaluations need to assess the capacity and rate with which pastoral production systems can rehabilitate themselves without external intervention, so as to have something to compare expected rates of recovery associated with external intervention, and the costs associated with these, versus the cost of prolonged famine relief (Toulmin 1987). However such recovery frequently does not occur in isolation. A number of production systems each with large numbers of participants may be attempting drought or famine rehabilitation at the same time, most likely in the same spatially limited 'agronomically high potential' areas. The recovery rates of various production systems may or may not be compatible with each other. Indigenous rates of recovery for pastoralism for example (Table 1) may entail lengthy year-around occupation of farming areas which are also important in sustaining large agricultural and growing urban populations. Incompatibilities in land use can lead to conflict and accelerate land degradation, reducing further the productive capacity of scarce land resources (Unruh 1993; Hitchcock and Hussein 1987). Thus the decision to intervene in the interests of speeding rates of recovery needs to be based on more than single production systems.

Approaches to restocking destitute nomads need to embrace and build upon in-place mechanisms within traditional institutions in order to rebuild herds in culturally relevant ways, so that maximum efficiency in restocking is ensured. Such mechanisms are part of coping strategies that have evolved to meet the challenges of existence in precarious environments given in-place cultural, ecological, and socio-political constraints and opportunities (Bassi 1990; Scott and Gormley 1980; White 1990; McCabe 1990b and the references cited therein).

Agricultural and Restocking Objectives

Generally farming has been considered the primary and most immediate way to sustain stockless pastoralists (Oba 1990; Bassi 1990; O'Leary 1990; Hogg 1983a 1983b 1986). In times of famine and stock loss, temporary farming activities can form an important part of traditional coping strategies (McCabe 1987 1990a; Hogg 1983b 1986;

Hitchcock and Hussein 1987). However one of the most often observed problems in settling destitute pastoralists onto agricultural schemes is that they continue to accumulate livestock, often to the detriment of the objectives of the project (Young 1985; Hitchcock and Hussein 1987; Hogg 1982 1983a 1983b 1986; Little 1983; McCabe 1990a; Pollard 1981; Barnett 1977; Schraeder 1986; Sorbo 1979). However if it is recognized that herding needs to become viable again for such populations, then agricultural projects need to be designed with this in mind. Rehabilitation efforts for pastoralists can utilize this preference to invest in livestock for purposes of restocking and herd recovery. While approaches to doing this may be ill-defined, one strategy is to study how proven, working constructs in culturally and ecologically similar situations might be applied (Phillips et al 1989).

The study presented here considers a design where farming patterns could be geared toward facilitating livestock restocking. Following a brief discussion of forage resources in cultivated areas, the displacement problem on the Horn, and the study area in Somalia, this paper quantitatively explores the livestock carrying capacities involved in small farmer subsistence agriculture, and the opportunities for restocking which these may present.

Fodder availability and land area

Neldner (1979) describes the importance of securing adequate land area in the settlement of rural refugees in Africa, particularly when both agricultural and grazing lands are needed. Spatially limited cultivable areas can often be crowded with subsistence and cash crop agriculture, development projects, refugee camps, and resettlement schemes. In a design involving subsistence cultivation and restocking going on in adjacent locations, large areas would be needed for both farming and grazing in regions where such an abundance of land is most likely not available. This is why multiple use of land allocated to refugee pastoralists must be considered. This study examines the potential for multiple use of land allocated to pastoralist refugees.

Efforts to restock pastoralists engaged in 'refugee agriculture' could consider connecting the number and type of livestock supplied to pastoralists in restocking programs with the quantity and availability of fodder resources produced on land allocated to each household, which must also be able to provide subsistence to pastoralists themselves through annual crop production. Such a design would ideally be able to operate given the more frequent droughts in the region, especially since land allocated to refugees is often in marginal areas where frequent drought can have a significant impact on crop production, and because drought can be a primary cause of livestock losses in restocking schemes (Mace 1989).

Use of crop residues as a forage resource can have several advantages over natural forage. First, crop residues may be less vulnerable to drought than nearby grazing areas. And unlike cultivated land, pasture areas can have unclear, or unenforceable tenure rules, and in crowded regions, can easily become overgrazed and attract large numbers of livestock during dry seasons and drought. Second, in natural riverine areas where grazing land is available the woody component may be quite high, resulting in a comparatively low carrying capacity (Jahnke 1982). Third, a number of crop residues are higher in nutritional value, and produce more consumable dry matter per hectare than natural grassland vegetation (Jahnke 1982). And finally, increases in crop (and hence crop residue) production through the use of irrigation, levelling, fertilizer, and crop varieties are not available for grazing lands.

The Horn of Africa

Of Africa's drought and famine stricken regions the Horn is the most severely effected (Pearce 1991). Due to their fragile arid and semi-arid ecologies and multiple theaters of conflict, Ethiopia, Somalia, and the Sudan have in recent decades been chronically afflicted by drought, famine, and social unrest with millions becoming displaced, and hundreds of thousands starving or migrating to refugee camps (Refugee Reports 1991; Refugees 1990; Ibrahim 1991; Unruh 1991; Cutler 1984 1991; Tolba 1986; Torry 1984; Lewis 1975; de Troyer 1986; Clark 1985; Eldridge et al 1986). The Economist (1991) estimates that over half of Africa's hungry reside in these three countries.

Somalia

Livestock production and refugee pastoralists

Prior to the current famine, livestock production was the primary economic activity in Somalia, comprising approximately 50% of the gross domestic product and more than 80% of the export revenue (Handulle and Gay 1987). About 55% of the national population participated in nomadic pastoralism, while 80% of the population was engaged in livestock raising of some kind (Conze and Labahn 1986; Handulle and Gay 1987). As the most important agricultural enterprise in the country, transhumant pastoralism will continue to be the basis for food production for future populations (Bennett 1984; Lewis 1975; Box 1968 1971; Biswas et al 1987; Conze and Labahn 1986).

The number of refugee pastoralists in Somalia is considerable. A series of droughts and wars in the 1970s and 1980s and the resulting livestock mortalities expanded refugee numbers at that time to between one-quarter and one-third of the entire population (Magan et al 1983). Currently conflict and drought in Somalia and the subsequent disruption of food distribution and relief efforts could put the entire population at risk (Refugee Reports 1991). It remains to be seen if the present peace efforts underway can lay the foundation for the rehabilitation of production systems capable of sustaining the population.

The Study Site

Location and environment

The study area is located in southern Somalia, in the lower Shabelle flood plain in a political unit called the Lower Shabelle Region. Approximately 100 km south of the capital, Mogadishu (Figure 1), the study site is located adjacent to the Shabelle river, and covers approximately 8,500 hectares, ranging from erratically irrigated to rainfed. The site resides within what was once an Italian irrigation scheme (Figure 1), which has deteriorated considerably over the past several decades.

The Lower Shabelle Region is generally regarded as the most attractive area for refugee resettlement in the country (Young 1985). The farms and refugee camps of this region are located close to the Shabelle river on a complex alluvial flood plain. The region is classified as semi-arid, and precipitation is distributed in a bimodal pattern with two alternate wet and dry seasons (Hutchinson and Polishchouk 1988). The Gu season is the major rainy season (averaging 300 mm) lasting from April to June, followed by the minor Hagai dry season from July to September. The Der season follows the Hagai and is a minor rainy season (averaging 100 mm) lasting from October to December. Followed by the major Jilaal dry season from January through March (Hutchinson and Polishchouk 1988). Precipitation characteristics in the Lower Shabelle Region include scarcity, and poor distribution, together with variability in both the timing of the wet season and year to year precipitation. The more frequent droughts occur every four to five years (Handulle and Gay 1987; Unruh 1991). However FAO probability graphs estimate that partial or complete failure of rainfed crops due to inadequate precipitation is likely to occur as frequently as two years in five (Young 1985).

Range resources for livestock in the Somali interior have shown evidence of overgrazing for some time (Box 1968). The low successional stage of much of the herbaceous vegetation on the rangelands are most likely due to heavy stockings during successive droughts (Box 1968). The low rainfall and low natural carrying capacity of much of the interior means that vast areas must be used in order to maintain livestock.

Soil moisture deficits in the interior prevail for most of the year and vegetative growth is highly seasonal. The length of the growing season and the severity of the soil moisture deficit are the primary factors determining range productivity in southern Somalia (LRDC 1985).

Methods

Data Collection

Opportunities to utilize the agricultural practices familiar to refugees involved in restocking efforts requires that relevant information be obtained on such culturally-based knowledge and history of land-use. While land-use practices and patterns of functioning, in-place production systems can be observed and to some degree quantified with an agronomic approach, the practices and patterns familiar to a dislocated refugee population cannot. Barring previously obtained detailed information on the refugee groups, questionnaire surveys may be one of the only ways to obtain such information with the speed necessary in refugee efforts.

The data for this study were collected during 18 months of fieldwork from 1987 to 1989, and consist of information gathered from formal questionnaire surveys totaling 495 interviews, in addition to key informant interviews and farm area measurements.

Three formal questionnaire surveys were carried out targeting three different groups: small (or subsistence) farmers (less than 25 ha.), large farmers (25 ha and above), and agro-pastoralists. While these three target groups did include significant numbers of refugees, the questionnaires were not intended to focus on this group. Rather the focus was on 'getting at' the ingredients necessary for this analysis as they existed in functioning, in-place land uses representative of 'refugee agriculture', in order to allow study of carrying capacity relationships in the desired context. Refugee concentrations in the area, in the numbers needed for this investigation were primarily in relief camps, where they were not engaged in a production system. Thus this group did not present the necessary variables under study here. Thus because the design considered here was not in existence as a whole, and therefore could not be directly observed, the elements of the design (which were directly observed) were 'lifted out' of patterns of land use contained in relevant contexts (subsistence agriculture, agropastoralism).

The small farmer survey consisted of three rounds of questionnaires given to 114 randomly selected participants, and focused on a wide variety of subjects in order to reveal present land-use practices. The large farmer survey was made up of 30 non-randomly selected participants who were interviewed once and were asked for much of the same information. The agro-pastoralist survey was comprised of 123 non-randomly selected interviews with small farmers who also owned livestock and were familiar with seasonal influxes of livestock, fodder sources and fodder requirements for livestock. The agropastoralists themselves often engaged in nomadic pastoralism. This latter survey was carried out solely for the purpose of determining the relationship between the different states of land present in the study area and the length of time that livestock are able to live off this land.

Parcel measurements were obtained for all of the randomly selected small farmers in the study in order to accurately determine area. Because all of the area occupied by large farmers is registered and therefore had to be surveyed, stated farm sizes were quite accurate and easily verified from the local land registry (Unruh 1993).

Conversion of livestock quantities into standard stock units (SSU) was accomplished using Field's (1980) method, which takes into account Somali specific breeds, herd age structure, feeding habits, and liveweights; thus capturing more of the Somali variant of pastoralism than utilization of the TLU (tropical livestock unit) would have allowed. For Somali conditions the standard stock unit is a mature bovine with a liveweight of 450 kg that consumes 4,100 kg of dry matter per year. In this framework one SSU is equivalent to two camels or cattle, 20 sheep or goats, or 5 donkeys.

The small farmers and agropastoralists in the study area fall within the definition of subsistence producers following Massey

(1987). Present cropping patterns in the study area are dominated by maize (*Zea mays*) and sesame (*Sesamum indicum*) cultivated primarily as subsistence crops. Vegetables and other minor crops are grown only on a limited scale. Maize is cultivated primarily in the Gu season, while sesame is the dominant crop in the Der season. The little maize that is grown in the Der is dependent on available irrigation (Unruh 1993).

Carrying Capacity

Calculation of livestock carrying capacity for the different land-uses (in different states in different seasons of the year, and in good, average, and poor water years) was facilitated by putting available forage producing land--as it occured within the farming system--into five categories, two crop residue categories: maize, and sesame; and three grazing categories; previously cultivated, fallow, and riverine grassland. The difference between the fallow and previously cultivated categories is that a fallow field is intentionally left uncultivated during the growing season, whereas the previously cultivated category comprises the non-crop vegetative regrowth which is present on cultivated lands after the harvest, due to the inefficiency of hand weeding. Thus a field cultivated with maize or sesame provides two fodder categories, the stover (stalks and leaves) of the crop itself harvested and piled in one corner of the field, and the weedy vegetation still present in the field after harvest. Land in the grassland category is never cultivated, and comprises uncultivable areas approximately 50 m wide along the larger canals and portions of the old river channel which are swampy due to seepage from canals, or a locally high water table.

The term water year is used instead of precipitation because there are two sources of water for the study site; rainfall, and for some fields, irrigation. Precipitation in the area does not contribute appreciably to river flows because the riverbed is higher than the surrounding area, facilitating some gravity fed irrigation. Most of the water in the Shabelle river comes from a catchment in the Ethiopian highlands. Thus the term water year is meant to include both rainfall and irrigation, or a combination of the two however they may occur across the study site.

While the equations used to calculate carrying capacity based on these categories have been previously reported (Unruh 1993) their application to the problem of restocking refugee pastoralists has not. Equation 1 estimates carrying capacity for the crop residue categories under three different water availability states (good, average, and poor or drought).

Eq. #1.

$$C_{si} = SSU_i * [(X_i/R_{isw})/3]$$

Where C_{si} is the carrying capacity for SSU in season *s* on land category *i*; SSU_i is the number of SSU that can live off a single unit of crop remnant of category *i* for one month; $[(X_i/R_{sw})/3]$ is the monthly quantity of crop residue units available in season *s* in land category i (number of maize bals or sesame ambuls). In this last expression X_i is the total area (ha) under category i;

R_{isw} is the area in category i producing a single unit (bals or ambuls) of crop residue in season s, in water year w, where w is defined as good, average, or poor; 3 is the number of months per season, for all seasons. Carrying capacity was calculated on a seasonal basis because season determines availability. The units used for quantities of maize and sesame crop residue are known locally by the terms bal, and ambul respectively.

Equation 2 estimates carrying capacity for the grazing categories, under the same water availability states.

Eq. #2.

$$C_{si} = (X_i * SSU_{iw})/3$$

Where C_{si} and X_i are defined in equation 1; SSU_{iw} is the number of SSU sustainable on one hectare of land category i in water year w; and 3 is the number of months per season.

Utilization of Fodder Resources

Temporal availability of fodder resources

Fodder availabilities from the above measures varied throughout the year. In the Gu season only grassland and fallow land was available because all other land was under cultivation. In the Hagai season available forage was made up of fields fallowed in the Gu, plus maize and sesame crop residue from the Gu season harvest, and land just harvested in the category of previously cultivated, as well as grassland areas. Der season forage sources included any fodder left over from the Hagai, and Der season fallow and grassland areas. In the Jilaal, maize and sesame crop residue produced in the Der season was available, plus the categories of previously cultivated, Der fallow land, grassland, and any fodder left over from the Der season. Table 2 summarizes in a the temporal availabilities of the different fodder producing categories.

Initial restocking units

Several studies have discussed the advantages of beginning restocking and herd recovery efforts with small stock (goats and sheep) (Mace 1989; Coppock et al 1986; Tacher 1983; Scott and Gormley 1980; Hogg 1983b; McCabe 1987 1990a; Mace 1989). These advantages include low purchase cost, availability, fast reproductive rate, and for goats greater survival capacity, drought resistance, and more diverse forage preferences (Young 1985), including browse which exists on otherwise degraded lands (Box 1968). The ability of small stock to subsist on a wider range of forage than large stock is one reason why switching to small stock is seen as a famine coping mechanism in some areas (Hutchinson et al 1992). Small animals are frequently kept in the vicinity of the residence where they are cared for by women and children, facilitating livestock raising while engaged in crop agriculture (Young 1985). Young (1985) suggests that as women and children make up the majority of refugee camp populations in his study in Somalia, it is not surprising that in many exclusively agricultural refugee projects the number of small ruminants (mostly goats) is often large.

Once a household has accumulated enough small stock it can begin to exchange these for cattle and camels (McCabe 1990a; Mace 1989). Moris (1988) notes that in countries with irrigation sectors, animals can often be moved out of a pastoral drought zone through purchasing by households with other sources of income (ie., irrigated farming and associated activities). This then presents the possibility at least for a redistribution of animals back to pastoralists in a restocking effort (Moris 1988). Although many more animals would likely be needed than that available locally from an irrigation sector.

For pastoralist restocking Hogg (1983b) proposes the equivalent of 5 sheep/goats per person for the Isiolo Boran in northern Kenya. For a family of six (Hogg 1983a) this would be 30 small stock, or in the standard stock units of the present study 1.5 SSU per household. This is the same number of small stock in the restocking scheme studied by Mace (1989). Pratt and Gwynne (1977) recommend 4.5 SSU for the same family size. However this is apparently intended to provide for a largely pastoral diet (Hogg 1983b) and might be inappropriate for the initial stages of a restocking effort where participants are also engaged in crop agriculture.

Characteristics of fodder resources

Important in the utilization of crop residue for livestock, are the 'value' of the fodder resources (categories), and the 'vulnerability' of these to drought (Unruh 1993). Value and vulnerability are interrelated, and carrying capacity at any one point in time depends on both. The value of a fodder source is its nutritional ability to support livestock, and vulnerability is the reduction in value due to drought.

Individually each category, will manifest a value that extends the full range of its vulnerability. The summed positions of all values within the vulnerability range of each category results in a carrying capacity at any one point in time. Additionally, carrying capacity can vary by changing the areal extent of categories due to farmer-decision making in response to season, drought, needs for subsistence foods, income requirements, market influences, etc.

Relationship between value, vulnerability, fodder resource, and water availability

Figure 2 presents the combined aspects of availability, value and vulnerability in terms of the capacity of the land categories to support the 1.5 SSU per household recommended by Hogg (1983b). The left vertical axis designates the carrying capacity in SSU/ha/mo, and the horizontal axis designates the land area necessary to maintain 1.5 SSU. The upper left corner of each box is the value of the category in SSU/ha, and the position of that point over the horizontal axis is the amount of land (ha) needed to sustain 1.5

SSU in a good water year. The lower right corner of each box represents the value of that category in a poor water year, and the area needed in such a year to maintain 1.5 SSU for that category. The vertical lines of each box then represent the vulnerability of each category, between good and poor years, or, the reduction in carrying capacity for a given area. The horizontal lines of the boxes represent the amount of additional land required to offset the decrease in value in a poor year in order to continue to maintain 1.5 SSU. The right vertical axis of Figure 2 illustrates the relationship between dry season/drought and value.

In the context of temporal availability (Table 2), value and vulnerability operate to determine carrying capacity on a seasonal basis. This framework for looking at carrying capacity was used in a previous study (Unruh 1993) to explore options for multiple land use, it is used here to connect the recommended number of livestock given to households in a restocking scheme, with land needed to both support households from subsistence agriculture, and provide adequate forage for livestock, in the context of the frequent droughts which visit the area.

It can be observed in Figure 2 that vulnerability and area are inversely related. While a large drop in value due to drought (high vulnerability) for higher value categories (fallow, maize) will result in large livestock displacement, this also means a smaller increase in area is needed to sustain a given number of livestock than for lower value categories (sesame, previously cultivated). However a small change in land-use from a high value category to a lower one will result in a large livestock displacement. Whereas a similar change in land area for a low value category (to yet a lower value category) will result in a much lower livestock displacement.

Displacement here means that the livestock present would not be sustained off of the fodder resources available, and these animals would likely be sold, or suffer mortality if other means are not secured for their maintenance. Avoiding displacement is a priority in restocking efforts. This is why including drought recurrence into considerations of livestock carrying capacity is necessary. In addition, mandating that the scheme participants engage in continuous maize-fallow cropping would mean that unhindered customary land-uses and management would not operate, and could make this population more vulnerable to drought in an arrangement where maintenance of livestock is one objective along with agricultural production for subsistence purposes.

Potential planning scenarios

In order to account for frequent drought in the relationship between forage production, availability, and livestock maintenance, land allocation per household needs to be considered in terms of the area under land categories likely to be in-place in poor water years; given the customary management practices of the participants and the degree of marginality of the land resource. Also important are the categories that have both an acceptable value and a low vulnerability, and the area (ha) required per SSU for these categories.

Sesame (box 4 in Figure 2) because of its comparatively low vulnerability, might be an option (to connect livestock numbers to) given the high drought recurrence of the study site; although larger land areas might be needed than for other categories. However maize forage (along with other categories) produced for the most part in the Gu, and to a lesser extent in the Der, would also play a role in livestock maintenance.

In a sesame scenario, for every 1.5 SSU, 0.94 ha of access would be needed for every month in a poor water year. For the whole year this would be 11.25 ha. This does not imply that 11.25 ha should be the land allocation per pastoralist family in a refugee agricultural/restocking scheme. Livestock carrying capacity is only one consideration in such a scheme. Human subsistence is another. What this might suggest however is that enough land be allocated to pastoralists so that under customary cropping practices sufficient land ends up in sesame (in this case) to sustain the recommended number of livestock in a poor water year. Alternatively incentives of some sort could be used to encourage cultivation of an optimal fodder source, so that less land per family is needed (for livestock carrying capacity) but that a recommended number of livestock is still sustained. In any case contributions made by livestock to human subsistence would need to be included in calculations of the area needed per family. This could have the effect of reducing the amount of land needed to sustain refugee households.

Combinations of categories are also possible, depending on drought frequency. If the study site experienced more infrequent drought, combining the sesame category with the grassland category (box 3 in Figure 2) might be an option, as the two overlap considerably. For such a combination the area required would be the average of the two categories in a poor year (0.87 ha/1.5 SSU for one month, or 10.38 ha for one year) which is less than the area for just sesame.

If the frequency of drought years were still lower, perhaps just the grassland category might be chosen (0.79 ha/1.5 SSU/month, or 9.48 ha/1.5 SSU/year); or a combination of grassland and maize (box no. 2) categories (0.59 ha/1.5 SSU/month, or 7.08 ha/1.5 SSU/year) for yet a lower frequency. The lower the drought frequency the higher up the left vertical axis of Figure 2 a base fodder resource might be selected from; because such crops will be more reliably cultivated. In the above scenario with the grassland category, the case is more to illustrate the position the category occupies in Figure 2 with respect to sesame, rather than to imply that farmers will allocate more of their land to grassland. It does mean however, that using grassland vegetation as forage is a more reliable option with a lower drought recurrence. The idea is to match an appropriate position along the curve in Figure 2 with an observed recurrence interval.

The categories used in this study are specific to the Somalia study site, and are meant to serve as examples. They are not the only fodder sources, land areas, and livestock numbers available for such an agriculturally based restocking scheme. Other categories and land-uses would have different values and vulnerabilities, but they may lend themselves to a similar analysis.

The above scenarios refer only to an initial number of livestock per household (1.5). As more and larger livestock are accumulated, eventually the carrying capacity of the allocated land will be exceeded, and either proportionally more land will be needed or the excess animals will be grazed in an increasingly transhumant fashion. The latter may ultimately be the goal of a restocking scheme. While this could be seen as displacement, there is a difference between livestock displacement due to a drop in carrying capacity, and the carrying capacity being exceeded by increasing herd size.

Labor allocation to grazing even a few animals in a transhumant fashion however is perhaps more easily accomplished by sending animals out with kin or others who frequently contract to herd animals not their own. If this became the case for a significant percentage of a household's livestock, crop residue might then become a primarily dry season fodder source, while continuing to provide human sustenance. However as herd size increases other sources of income and subsistence become less important, and diminish (Mace 1989). Trading increasing numbers of goats and sheep for cattle and camels, which have a larger travel radius and provide much more subsistence requirements (Mace 1989), would encourage a trend toward increasing transhumance.

If one of the goals of a restocking scheme is to enable pastoralists to disperse from the more heavily populated areas, then the rate at which a household is able to increase numbers of small stock so as to trade for larger stock becomes important. In the restocking scheme studied by Mace (1989) this rate is affected by drought which increases livestock mortality resulting in wide variation in household success in restocking. The design presented in here could have the effect of buffering this mortality by taking into account the frequency of drought years and its impact on forage in the agricultural component of the scheme.

An additional possibility, as herd size increases and livestock make a larger contribution to household maintenance, is to plant stands of crops in higher density. This would increase the biomass production of fodder, at the expense of grain production. This process has been observed to occur on its own in refugee camps near the study area (Young 1985). At the point at which this occurs and beyond, livestock may become so numerous as to favor the cultivation of some crops used exclusively for fodder. While Young (1985) argues that this would reduce the trophic level of refugee agriculture by 85% in terms of calories produced from a unit area of land, that estimate is in the context of a refugee scheme where only crop production for human consumption is maximized, and does not consider the potential market aspect of forage cultivation.

Conclusions

The underlying premise here is that risk avoidance, and subsequently enabling refugees to become re-engaged in their pre-famine production systems, is the priority, as opposed to maximizing agricultural production.

The amount of land allocated to each household in a agricultural restocking scheme such as the one examined here, would depend on the crops used, the area under those crops required to maintain a household, and the area under the same crops needed to sustain at least an initial number of livestock. Crop choice ideally would be something familiar to the participants in the scheme, and might also fit in some fashion into a local and/or regional economy.

Hjort (1989) points out that there is no unique natural limit for the carrying capacity of an area. An important illustrative aspect of this study, previously discussed by Hjort (1989), is that the interplay between fodder access and pastoralist herds precludes simple and straight forward conclusions about carrying capacity. Decision-making and management play major roles. Actual carrying capacity depends on the range of possible and impossible connections involved in different combinations of the various components which make up the local ecology and resident production systems.

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Table 1. Estimated time for cattle herd reconstitution after varying levels of drought loss.

Percent herd loss	**Number of years taken for herd reconstitution**
20	3
30	10
40	12
50	21
60	30
70	43
80	61
90	85

Tacher (1975)

Table 2. Temporal availabilities of fodder categories.

	Season			
Category	**Gu**	**Hagai**	**Der**	**Jilaal**
Fallow[1]	______	=====	=====	=====
Maize[2]		=====	=====	=====
Grassland	=====	=====	=====	=====
Sesame[2]		=====	=====	=====
Prev. Cult.		=====		=====

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[1] Fallow land available in the Gu and Hagai, is not necessarily the same fallow land available in the Der and Jilaal.

[2] Some crop residue left over from _Gu_ production may be available in the _Der_ (dashed lines).

Figure Captions:

Figure 1. Location of the study site.

Figure 2. Value and vulnerability for fodder resource carrying capacities.

========================MISC========================

Table 2. Comparison of Forage Values and Vulnerability for Fodder Sources in Good, Average, and Poor Years. (Values are in quantity of SSUs sustained from one hectare of fodder resource for 30 days.)

	Fallow/ Idle	Maize	Riverine Grassland	Sesame	Previously Cultivated
Good yr.	10.15	7.5	4.6	3.16	1.87
Ave. yr.	7.35	5.04	3.2	2.3	1.14
Poor yr.	4.6	3.79	1.9	1.6	0.41
Fodder reduction from good to poor years (%):	55	50	59	49	78
SSUs/ha displaced from good to poor years:					

5.55	**3.71**	**2.7**	**1.56**	**1.46**

MISC===

Using Pratt and Guynne's (1977) number of 4.5 SSU per household in the land area calculations, while intended for a primarily pastoral diet, would allow for herd growth from an initial 1.5 SSU per household. However this would mean a significant increase in area needed per household (an additional 1.9 ha per household for the sesame scenario). And eventually herd growth would exceed even the carrying capacity of this larger area.

Vegetation

Acacia-Commiphora deciduous bushland and thicket is the dominant (and "climax") vegetation over the majority of the Somali-Masai Region (White 1983). Usually this vegetation is dense bushland, 3-5 m tall with dispersed emergent trees of a maximum height of 9 m. Locally this bushland is often impenetrable and forms thickets, with the dominant Acacias and some Commiphoras having spines or thorns (White 1983). Succulents are scattered throughout the region but are rarely abundant (White 1983).

In areas where the precipitation is less (100-200 mm/yr) semi-desert grassland occurs on deep sand, and shrubland occurs on stony soils. These grasslands are dominated by *Eragrostis hararensis, Panicum turgidum* and, *Asthenatherum glaucum* (White 1983). The shrubby species include *Aerva javanica, Jatropha pelargoniifolia* (glandulosa) and *Farsetia longisiliqua* (White 1983). Shrubby species are most abundant in eroded and overgrazed areas.

Climatology

Because evapotranspiration is greater than precipitation everywhere in the country, all of Somalia experiences a dry (B) climate according to the Koppen classification (Figure 2.)

(Hutchinson and Polishchouk 1988). Desert climates (BW Figure 2) exist in areas with less than 250 mm/yr. All other areas are classified as steppe (BS). All of these steppe areas are hot (BSh), except higher parts of the northwest region where they are cold (BSk). The final descriptor, summer (s) or winter (w) rain is not readily applicable to the southern areas of the country, due to its proximity to the equator (Hutchinson and Polishchouk 1988). In the northern areas summer rainfall predominates (BSks, BShs) (Hutchinson and Polishchouk 1988).

The soils of the project area are primarily vertisols. Textures are very heavy with up to 85% clay, a high proportion of which are expanding clays (TAMS, 1986). The fineness of the soil pores causes soil moisture to be held in high tensions, with relatively little available to plants without irrigation. The project site is very gently to gently undulating, with an overall slope to the north (TAMS, 1986).

The Shabelle river receives 90% of its discharge from a catchment of approximately 300,000 km^2 in the eastern highlands of Ethiopia at elevations exceeding 2,000 m (TAMS, 1986). The flow pattern is seasonal and torrential with high flows of short duration occurring in April, and longer duration flows occurring from August to December. The year to year flow variation is considerable, with an increasing tendency for the river to dry up in the lower reaches in the Jilaal (LRDC, 1985).

River water quality varies throughout the year with salinity crests occurring at the onset of the Gu wet season. With continuing irrigation development along the Shabelle, serious seasonal water shortages are being experienced (LRDC 1985).

Insert this section (which is located at the very end of the doc.) just after the section on: Relationship between value, vulnerability, fodder resource, and water availability")

Variance associated with forage resource data

The amount of dispersion in the data varied with the resource. Considerable variability was associated with the fallow category, although the standard deviation decreased from good (418.2 SSU) to poor (243.3 SSU) water years. This variation most likely reveals a pronounced difference in fallow field quality. Those occupying more fertile sites and nearer to large canals produce more fallow vegetation than more marginal sites. Sorting the data from this category according to carrying capacity (from low to high) would allow division of the category into seperate sub-categories (each with a much reduced standard deviation), producing a number of value and vulnerability 'boxes' which could be inserted in place of box number 1 in Figure 2. While this could be done for all the categories in the study, allowing greater precision in site specific carrying capacity estimates, the purpose of this analysis is to consider how livestock carrying capacity opportunities within crop agriculture might be assessed for purposes of restocking, thus being relevent to wider application, as opposed to a rigourous site specific assesment of study area in Somalia.

The previously cultivated category had the second highest standard deviation, also decreasing from good (64.5) to poor (32.4) water years. This high varability is as well most likey due to field quality, as well as the relative efficiency of hand weeding. The smallest standard deviations were associated with the production of fodder from the crop categories: 0.4 SSU for maize in good water years, and 0.9 SSU in poor years; and 7.0 for sesame in good water years, and 3.8 for poor years. However agropastoralists' notions as to how long a unit of maize fodder could sustain livestock varied greatly (standard deviation 456.7). This most likely incorpoates the pastoralists' thinking concerning definitions of livestock maintainenance as well as site quality. For some, maintenance implies the continuation of optimal body weight,

however for most, maintenance means little more than survival. Thus a great deal of weight might be lost and the animal would still survive. The relative condition of the maize stalk, as well as that of cattle might also explain some of this variance. The data for maintenance of SSU from a unit of sesame varied much less (standard deviation 7.6).

Variation in carrying capacity from grassland along the river and large canals perhaps revealed less difference in site quality for this resource, although the standard deviation did change from good (24.3) to poor (9.4) water years.

Clearly there exists a significant amount of variability in a study of this nature, more in some aspects, less in others. In a more detailed site specific analysis it might be worth the effort to concentrate on those aspects with less variability, or disaggregate certain categories so that less variance is contained within what is defined as a fodder resource. On the other hand high variability is quite likely going to be the norm when surveying dislocated subsistence populations. While this may differ with specific populations, accomodating high variances is likely to be an unavoidable necessity given the nature of the problem.

*****Note that data not normally distributed, no reason to think site quality would be*******