Community Management of Grazing Lands and Impact on Environmental degradation in the Ethiopian Highlands

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Paper to be presented at the
International Association for the Study of Common Property Conference
Victoria Falls, Zimbabwe
June 17-21, 2002

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We gratefully acknowledge the Norwegian Ministry of Foreign Affairs for funding this research and the collaborative support of the Amhara National Regional State Bureau of Agriculture in implementing the project on "policies for sustainable land management in the highlands of Amhara region, from which the data used here were collected. We are especially thankful to the many officials and farmers who took the time to respond to our numerous questions. All errors are the responsibility of the authors.

Abstract

Communal grazing lands are important sources of livestock feed in developing countries, although unrestricted access to such resources can result in overexploitation and degradation of the resource. Collective action, through restrictions and regulating use by the community, can play a significant role in sustainable grazing land management. Restricting access and use can reduce degradation of the resource by eliminating overexploitation and, therefore, improve availability and quality of forage in the long run. On the other hand, by restricting grazing in certain areas, there is tendency to shift pressure to other unrestricted grazing areas, which can rapidly increase degradation of those resources. Using data from 98 villages in the highlands of Amhara region, this paper first examines the determinants of collective action and its effectiveness in communal grazing lands management and the effect of restricting access and use in certain grazing areas on the condition of other communal grazing resources.

More than one-half of the communities had at least one such restricted grazing area, with the total area in each of those communities averaging twenty-two hectares. About 70 percent of the restricted grazing lands were managed at the village level, while the remaining was managed at a higher *kebele* level, usually consisting of three to five villages.

The results show collective action is more likely to be successful in communities that have large areas, are far from markets, and where wealth (oxen ownership) is more equally distributed. Where there are more alternative sources of feed, as in irrigated areas, collective action is not likely to succeed.

The results do not show much effect of restricting grazing access in certain areas on degradation of other unrestricted grazing areas. However, increasing the proportion of restricted grazing land had a robust negative impact on the quality of other unrestricted grazing resources, although managing the restricted grazing land at the lower village level had a robust positive impact. Population growth had the most negative effect across board: reducing availability and quality and increasing erosion of grazing lands. This is consistent with a neo-Malthusian notion regarding the negative impacts of population growth. We also found that severity of erosion of grazing lands was lower in areas with higher rainfall areas and better access to credit and extension programs offered by NGO’s.

Overall, these results suggest that community grazing land management can contribute to sustainable use of grazing lands and alleviation of feed shortage problems, as in the highlands of northern Ethiopia. However, collective action for grazing land management may be more beneficial and more effective in communities with large areas, that are far from markets, where wealth is more equally distributed, and where population pressure is low.

Key words: Collective action; Ethiopian highlands; restricted grazing lands

1. Introduction

Common grazing lands are important sources of livestock feed in developing countries, although unrestricted access to such resources can result in overexploitation and degradation of the resource. Alternative ways of managing common resources, including state, collective and private management, have been suggested to arrest resource degradation. However, there is debate on the effectiveness of the various methods in improving use benefits as well as reducing degradation (Wade, 1986; Pearce and Turner, 1990; McCarthy *et al*., 2001).

Increasingly, however, collective (community) action is recognized as a viable and promising method of managing natural resources (Gebremedhin *et al*., 2000, 2002; McCarthy *et al*., 2001). For successful community natural resource management, it is necessary that management and use rights be vested in the community. In addition, the community must establish use regulations and enforce those regulations. For the resource to be sustainable, however, the community also needs to observe the regulations (Turner *et al*., 1994; Swallow and Bromley, 1995). With respect to the use regulations, the common practice has been to impose some kind of restrictions in using the resource. Depending on the resource, these can include a combination of restricting use to certain products only, to certain times of the year only, to certain demographic groups only (or in the case of grazing land, to certain livestock species only), harvesting quotas, or simply closing off the entire resource for a long period of time or until the resource has regenerated to levels that can be sustainably harvested.

By restricting access to and use of grazing lands, availability of forage can be reduced in the short run. However, restricting access and use can reduce degradation of the resource by eliminating overexploitation and, therefore, improve availability and quality of forage in the long run. On the other hand, by restricting grazing in certain areas, there is tendency to shift pressure to other unrestricted grazing areas, which can rapidly increase degradation of those resources. This paper has two main objectives: first, to examine the determinants of collective action and its effectiveness in communal grazing lands management in the highlands of Amhara region; and, second, to examine the effect of restricting access and use in certain grazing areas on the condition of other communal grazing resources.

The next section of this paper examines livestock feed resources and feeding systems in the highlands of Amhara region. The conceptual framework for examining the determinants and impacts of collective action in grazing land management and hypotheses are presented in section 3. In section 4, we present the data, empirical approach, results and discussion. Conclusions and policy implications are presented in section 5.

2. Livestock feeding systems in the highlands of Amhara region

The Amhara region is located in the north-western part of Ethiopia. The region covers about one-eighth of the total area of the country and is home to about 27% of the total human population (Befekadu and Berhanu 2000) and 35% of the total livestock population[1] (BoA 1999). In the region, livestock and human populations are concentrated in the highland areas, which constitute about 66% of the total area (*ibid.*). Historically, human and livestock settlements have concentrated in the highland areas, especially in the 2300-3200 m.a.s.l. range (*dega* agro-ecological zone), because of the relatively good rainfall reliability, cool temperatures and the absence of diseases (e.g. malaria and trypanosomosis).

Since 1991, ownership of livestock has generally declined, mainly due to loss to drought and diseases (Benin *et al.*, 2002). Recurrent drought is a common phenomenon in Ethiopia, leading to severe food and feed shortage and loss of livestock, especially in the central and north-eastern highlands, stretching from northern Shewa through Wello into Tigray, and low-lying areas in the southern and south-western parts (Webb et al. 1992). For example, during the 1971-75 drought period, resulting from a sequence of rain failures, it was estimated that 50% of livestock in the Wello and Tigray areas alone was lost (*ibid.*).

[1] Compared with other regions, Amhara is ranked first in number of goats, second in cattle, sheep, asses, horses and poultry, and fifth in camels (CSA 1998).

The major sources of feed, their relative importance, and critical periods in the region can be classified according to the particular farming system (ANRS, 2001). As Table 1 indicates, the farming systems in the region can be classified into three: sorghum-teff mixed farming system in the *kolla* agro-ecological zone at altitudes less than 1700 m.a.s.l.; teff-millet-maize system in the mid-to-high altitude range; and the barley-wheat system at altitudes greater than 2700 m.a.s.l.. While, cattle ownership is more important in the first two farming systems, ownership per household is higher in the teff-millet-maize system, where animal traction is more important. The importance of sheep increases with altitude, while that of goats declines. The main sources of feed are communal free grazing areas, crop residues, stubble grazing on cropland during the dry season and after harvest, and hay (cut-and-carry system). As Table 1 also indicates, free grazing in communal grazing areas is the most important source in the first two systems, followed by stubble grazing and cut-and-carry hay. In the barley-wheat system, all three sources are equally important. Generally, availability of feed is critical during the growing seasons of March to May (*belg*) and July to August (main rains) when croplands are cultivated. During these periods, movement of livestock is restricted and free grazing is limited to designated communal grazing areas and uncultivated hillsides. In addition, crop residues and hay that were stocked from the previous season are also depleted.

It seems that there has been significant changes in the use of various feed sources since 1991 (Benin *et al*., 2002). With the exception of purchased feed[2] and crop residues, use of other sources of fodder (communal grazing lands, woodlots, forests, homestead (e.g. prickly pear) and private pastures) has declined between 1991 and 1999, and the decline was larger in higher rainfall areas. Table 2 shows that the increase in use of crop residues was greater in higher rainfall areas, while increase in use of purchased feed was greater in drought-prone areas, with the proportion of households buying feed being about three-times larger in drought-prone areas.

[2] Purchased feed includes oil-seed cakes, grain mill by-product, straw and *atella* (residue obtained from brewing local beer).

The free grazing system has contributed significantly to the land degradation problem in the Ethiopian highlands, where grazing on hillsides and other fragile areas is widespread during the rainy season when other sources of feed (e.g., stubble grazing and crop residues) are in short supply. Following harvest during the dry season, all cropland become open to free grazing (stubble) until the next growing season. During this free grazing period, the little vegetative cover is completely grazed, the soils become bare and compacted, and farmers have to till the land several times to loosen up the soil to allow infiltration of the rains and avoid sheet erosion. However, repeated tillage also exposes the topsoil for other forms of erosion. The free grazing system also has a negative effect on the conservation efforts, as trampling animals often damage physical conservation structures such as stone terraces and soil bunds. Thus, the free grazing system results in significant negative externalities, especially for farmers who do not own livestock, as they are forced to bear the additional cost of maintaining their plots. However, these same farmers may benefit from increased soil fertility arising from the manure left by the grazing animals. Whether or not the costs outweigh the benefits is an empirical issue that is outside the scope of this study.

3. Conceptual framework and hypotheses

Theories to explain collective action (or lack of it) in management of common pool resources have utilized game theory to show how cooperation may fail to arise as a result of externalities that individuals fail to take into account, especially in a one-shot game (Sandler, 1992). Others have argued that cooperation may arise from decentralized action if resource users expect a sufficient number of other resource users to also cooperate, as in an assurance game (Runge, 1981); or if the game is repeated with sufficiently high probability and players do not discount the future too heavily, allowing sufficient future expected punishment to enforce cooperation (Ostrom, 1990; Baland and Platteau, 1996). The relevance of assurance games to appropriation of benefits from a common pool resource has been questioned, as has the ability of community members to enforce individual specific punishment strategies in a repeated game context if the number of community members is large (McCarthy *et al*., 2001). Even if such decentralized enforcement mechanisms are used, the assurance-game theories do not explain why communities often choose collectively to pay explicit costs (such as hiring a guard) to monitor and enforce restrictions on use of common pool resources, or why there are often violations of such restrictions. In addition, informing the effect of restrictions in one area on other unrestricted areas is also important.

Pender (2002) has developed a theory for analyzing communal grazing lands management that accounts for cooperation in establishing use restrictions and monitoring and enforcing restrictions, as well as allowing for imperfect cooperation, where it may be optimal for violations to occur. Building on the work of McCarthy *et al*. (2001), Pender shows that it may be optimal for a community to establish restrictions without actually spending anything on monitoring, corresponding to the "social fencing" case where the community establishes restrictions but does not hire a guard. Rather, the community enforces the restrictions by mutual trust.

The conceptual framework for examining the determinants and impacts of collective action in grazing land management is given in equations (1) and (2).

(1)

$$RESOURCE\ \ MANAGEMENT_V = f(PROFITABILITY, POPULATION, PENELATY, \\ PROBABILITY\ OF\ \ DETECTION, TRANSACTION\ COST, OTHER\ VILAGE\ FACTORS)$$

(2)

$$\Delta RESOURCE\ CONDITION_{Vi,t} = F(INITIAL\ CONDITION, RESOURCE\ MANAGEMENT \\ PRACTICES_{Vj,t}, RAINFALL, ELEVATION, OTHER\ FACTORS)$$

Equation (1) assumes that collective action in grazing land management (e.g., whether grazing restrictions are established, area of grazing land with restrictions, or whether there are violations of restrictions) depend on factors including profitability, the penalty, average probability of detecting violators, heterogeneity of that probability, population size, fixed transaction costs, and other factors (Pender, 2002). In equation (2), changes in resources conditions (e.g., quality or erosion) are assumed to depend on the initial condition of the resource, other resource management practices (e.g., whether there are restrictions, type of restrictions, and area restricted), natural factors (e.g., rainfall and elevation) that influence erosion, etc., and other factors.

Higher profitability promotes establishment of restrictions, while higher population or transaction costs inhibits it. Changes in the maximum penalty or probability of detecting violators may have no effect on monitoring if the optimum solution is one with no monitoring. However, if positive monitoring is used (ignoring transaction costs), then increasing the maximum penalty or probability of detection will reduce the number of violators for a given level of monitoring, thus increasing profits if the transaction costs are paid and, thus, the likelihood of establishing the restriction. Increasing heterogeneity has the opposite effect.

If a grazing restriction is established, it may or may not be enforced with positive monitoring costs, and profitability has no impact on this decision. Increases in the maximum penalty or average probability of detecting violators will increase the likelihood of the community deciding to pay positive monitoring costs, while increased heterogeneity reduces it. Increased population size increases the likelihood of monitoring (assuming a restriction is established), though at a diminishing rate.

The number of violators in equilibrium is not affected by profitability, but is decreased by higher penalties or higher average probability of detection, and increased by greater heterogeneity or higher population size. The amount spent on monitoring is an increasing function of profitability and a decreasing function of population size. The effects of maximum penalty, average probability of detection and heterogeneity on monitoring costs are ambiguous in general, though we may expect that increases in penalties or probability of detection will tend to increase monitoring while increased heterogeneity will tend to reduce it. With regard to the effects of heterogeneity, the impacts of heterogeneity in maximum penalties should be qualitatively similar to the impacts of heterogeneity in probability of detecting violators.

By restricting grazing in certain lands, availability of forage in those areas can be reduced in the short run. However, restricting access and use can reduce degradation of the resource by eliminating overexploitation and, therefore, improve the availability and quality of forage in the long run. On the other hand, by restricting grazing in certain areas, there is tendency to shift pressure to other unrestricted grazing areas, which can rapidly deteriorate the conditions of those resources.

4. Data, econometric approach and results

Survey

The study is based on analysis of a community-level survey conducted in 98 villages (*gots*) in the highland areas (above 1500 m.a.s.l.) of the Amhara region in 2000. A stratified random sample of 49 Peasant Associations (PA's or *Kebeles*, usually consisting of 3 to 5 villages) and two villages randomly selected from each PA were selected from highland areas of the region. Using district (*wereda*) level secondary data, the stratification was based upon indicators of agricultural potential (whether the *wereda* is drought-prone or non drought-prone/higher rainfall, as classified by the Ethiopian Disaster Prevention and Preparedness Committee), market access (access or no access to an all-weather road), and population density (1994 rural population density greater than or less than 100 persons per sq. km.). Two additional strata were defined for *kebeles* where an irrigation project is present (in drought-prone vs. higher rainfall areas), resulting in a total of 10 strata. Five *kebeles* were then randomly selected from each stratum (except the irrigated drought-prone stratum, in which there were only four *kebeles*), for a total of 49 *kebeles* and 98 villages. *Weredas* predominantly (more than 50% of total area) below 1500 m.a.s.l. were excluded from the sample frame. Information were collected at both *kebele* and village level using group interviews with about ten respondents from each *kebele* and village, selected to represent different genders, ages, occupations, and in the *kebele*-level survey, different villages.

Information collected includes whether there are common grazing areas subject to grazing restrictions, how restrictions are enforced, whether there are penalties and violations of penalties, size of the area, etc.. The data were supplemented by secondary information on population from the 1994 population census, geo-referenced maps of the boundaries of each sample *kebele*, and geographic attributes, including altitude and climate.

Data

Tables 3 and 4 show some of the characteristics of restricted grazing lands in the highlands of Amhara region.[3] More than one-half of the communities had at least one such restricted grazing area, with the total area in each of those communities averaging twenty-two hectares. About 70 percent of the restricted grazing lands were managed at the village level, while the remaining was managed at a higher *kebele* level, usually consisting of three to five villages.

The establishment of most of the restricted grazing lands were promoted by the *kebele* administration (mostly during the derg regime). On average, only 12 percent of the restricted grazing lands were protected by employing a paid guard, although all of those managed at the higher *kebele* level attracted no monitoring cost. Here, the restrictions are enforced by mutual trust. Even in the cases where a paid guard was hired, the community rarely incurred the cost, which was mainly paid by the organization involvement in the establishment of the restricted grazing area. Not surprisingly, however, almost all the restricted grazing lands had established penalties for violators. There were violations in about 19 percent of the cases, with the number of violations being slightly higher at the village level. It appears that almost all of the violations were penalized, mostly through cash fines.

Although primarily designated for grazing, there were other benefits or uses of the restricted areas, including cut-and-carry grass for hay without obtaining any permission from the relevant authorities (occurring in about 60% of all restricted grazing lands), collection of dung (83%), collection of fuelwood (83%), and beekeeping (93%). The very low percentage of collection of fuelwood and beekeeping and at the *kebele* level may be due to the lack trees in those restricted grazing areas. There were also problems associated with the restrictions.

[3] Grazing restrictions include grazing certain animals only (especially oxen) during the cropping season or grazing all animals at certain times of the year only.

In about 17 percent of the restricted areas, communities felt that the restrictions had contributed to less grazing (forage). Conflict over use (19%) and uncertainty about the benefits obtained (12%) were some of the other problems, although uncertainty about the benefits were mostly expressed at the village level. Asked how the restrictions had affected the condition of the grass (especially in terms of regeneration), community members felt that the situation had not changed in 41 percent of the cases. In 43 percent of the cases, there was a feeling that the condition had deteriorated, while in 16 percent of the cases, it had improved slightly. Thus, it seems that, degradation had generally increased or, at best, remained unchanged.

With respect to other grazing resources in general, community members felt that their availability and quality had slightly declined since 1991 (Table 5). In addition, they felt that the proportion of grazing lands suffering from severe and moderate erosion had increased between 1991 and 1999, especially in the drought-prone areas.

Econometric approach

Econometric analysis was used to estimate equation (1) to examine the determinants of the following aspects of collective action in grazing land management: (1) whether a village has a restricted grazing land or not; (2) total area of restricted grazing land per village; and (3) whether there were any violations of the restrictions with respect to a particular restricted grazing land. While the first two dimensions are considered as indicators of collective action, violations of restrictions is used an indicator of failure of collective action. Econometric analysis was also used to estimate equation (2) to examine the effect of collective action (whether a restricted grazing land exists, total size of restricted area, and the level of management)[4] on community's perception of: (1) change in availability of grazing lands since 1991 (2) change in quality of grazing lands since 1991; (3) change between 1991 and

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[4] With respect to whether there are restrictions and total area of restricted grazing lands, we used both the predicted values (from estimation of the collective action models) as well as the actual vales and then tested for endogeneity bias using a Hausman test (Hausman, 1978; Greene, 1993). Although we failed to reject exogeneity, we, nevertheless, report the robustness of the coefficients to using predicted values.

1999 in proportion of grazing lands suffering from severe erosion; and (4) proportion of grazing lands suffering from sever erosion in 1999.

Depending of the type of dependent variable, different econometric techniques were utilized. Probit models were used to estimate the probability that a community had a restricted grazing land and that there were any violations. For size of restricted grazing land, we used a tobit model since the values were censored, i.e., there were both zero values for villages without any restricted grazing land and continuous values for those having at least one such area. Note that the tobit model explains jointly the likelihood of a restriction occurring and total area restricted (Greene, 1993). With respect to the perceptions of community members in the changes in availability and quality of grazing lands, the perception were measured using ordinal indicators of change since 1991 with five possible levels: significant reduction, slight reduction, no change, slight improvement, and significant improvement. We, therefore, used ordered probit models (Madala, 1983) to estimate the effect of grazing land restrictions on these changes. Ordinary least squares was used to estimate the differences between 1991 and 1999 in the proportion of grazing lands suffering from severe erosion, since there was no censoring of the dependent variable (i.e., the proportions were never zero or one in any village).

Factors affecting collective action

The factors used to explain differences in collective action try to capture transaction costs, profitability, dependency on the resource, and the incentive mechanism. These include the total number households in a village, wealth homogeneity of the community, experience with local organizations, distance to market, and whether cattle production is the second most important source of livelihood in a community (Gebremedhin *et al*., 2000 and 2002; Pender, 2002). Although Pender (2000) does not predict any impact of a very large number of households, it is probable that when the number of households is very high collective action may be low due to increasing transaction costs or higher competition for the resource. Thus, we hypothesize an inverted U-shape relationship between number of households and collective action for grazing land management, where collective action is low at low and very high levels of population.

The more heterogeneous the community is the less likely will be collective action because of the reduced chance to arrive at a cooperative agreement due to divergence of interests. We measured heterogeneity of community members by the coefficient of variation (CoV) of the distribution of the proportion of households with no oxen, one ox, two oxen, and more than two oxen. Similarly, experience with local organizations, measured by the number of local organizations operating in the community, should favour collective action due to possible learning effect. Generally, dependency on a resource should favour collective action. Although, the primary source of livelihood for rural communities in the study area is cereal crops production, communities showed difference in their second most important source of livelihood. We, thus, included a dummy variable for cases where cattle rearing was the second most important livelihood source. We expect that where cattle rearing is an important livelihood strategy, collective action for grazing land management will be high.

The effect of market access on collective action is mixed. Better market access may increase the value of the resource and the return (profitability) from managing the resource effectively, thus favouring collective action. On the other hand, better market access may decrease the incentive of members to adhere to restrictions and use rules by increasing the opportunity cost of labour or by providing more "exit" options, making enforcement of rules more difficult (Pender and Scherr, 1999; Baland and Platteau, 1996). We measured market access by the walking time from the village to the nearest market town and distance to *wereda* town.

The level of management of the resource is also very likely to have an impact on the success of collective action. We test for this effect (village vs. *kebele*) using a dummy variable. At the village level, it may be easier to reach a cooperative agreement and so village members will be less likely to cheat, especially where restrictions are enforced by mutual trust. On the other hand, there may be fewer resources (e.g., militia and jails) available to enforce penalties and so village members may be more prone to violate restrictions, knowing that the consequences of being caught are not drastic. Thus, the effect of level of management is ambiguous.

In addition to the above factors, we include other factors that may affect differences in decision making across villages: total area of the village, agricultural potential (measured by average annual rainfall, altitude, and proportion of area irrigated) and land tenure policy (whether there has been land redistribution in the village).

Factors affecting changes in condition of grazing lands

In addition to the collective action variables (whether a restricted grazing land exists, total size of restricted area, and the level of management), we include several factors (both static and dynamic) that may affect changes in the condition of grazing lands (Pender *et al*. 1999; Benin *et al*., 2002). These include agricultural potential (measured by average annual rainfall, altitude, and change in proportion of area irrigated), access to markets (walking time to the nearest market town and distance to the *wereda* town), population growth (change in household density), land tenure policy (whether there has been land redistribution in the village), access to credit and technology (changes in proportion of households participating in credit and extension programs), and education (change in adult literacy).

Increase in proportion of area irrigated can alleviate the feed-shortage problem through increased production of crop residues and the development of private pastures and, thus, reduce the pressure on grazing resources. However, increased availability of such alternative sources of feed can reduce the incentive of community members in conserving grazing lands (e.g., terracing hillsides), leading to deterioration of grazing lands. Increase in population pressure can confound the production of forage thereby reducing the availability and quality of grazing resources. Better market access can create "exit" options for farmers out of agriculture and, thereby, ease the pressure on grazing resources. However, by increasing the value of labour in other non-farm activities, better market access can also reduce the incentive of community members in conserving communal grazing lands. Extension can contribute to improvement in grazing lands by transferring effective conservation technologies to community members. On the other hand, extension, in addition to credit, by increasing alternative sources of feed (crop residues, through increased use of fertilizer, and adoption of stall feeding practices), can also reduce the incentive of community members in conserving communal grazing lands. By reducing the amount of farmland of the household for supporting livestock and/or allocating part of communal grazing lands land for cropping activities, land redistribution can increase the pressure on already degraded grazing resources.

Results and discussion

Descriptive statistics

Table 6 shows a description of the explanatory variables used in the econometric analyses (for both collective action in grazing land management and change in condition of grazing lands), their means and standard errors. Average annual rainfall (has a mean of 1,217 mm), altitude (2,182 m.a.s.l.), proportion of area irrigated (2%), and change in proportion of area irrigated (0.04%); Distance to the *wereda* town (38 km) and walking time to the nearest market (119 minutes); number of households (1,279) and change in number of households per sq. km. (9); number of local organizations (9); whether cattle rearing is second most important livelihood activity (61%); total area of community (60 sq. km.); heterogeneity in oxen ownership (CoV of the proportion of households owning zero, one, two, or more than two oxen, 12); change in proportions of households obtaining credit and associated extension from ACSI (7%)[5], BoA (18%), and other formal sources (e.g., NGO's, 18%); change in adult literacy (13%); whether there has been land redistribution since 1991 (68%); and whether restricted grazing land is managed at the village level (34%). Note that the above changes, unless otherwise stated, refer to the difference between1991 and 1999 values.

Table 7 shows the econometric results for the determinants of collective action in grazing land management, while Table 8 shows the impact of collective action (restrictions, area of

[5] ACSI started operating in the region in 1995 and so we used the proportion of households participating in 1999, which is equivalent to the change since 1991.

restriction, and level of management of restrictions) on changes in the condition of grazing lands.

Determinants of collective action

Increasing proportion of area irrigated was associated with declining likelihood of a community having a restricted grazing land, probably due to an increase in alternative feed sources associated with irrigation. Irrigation allows higher cropping intensity to achieve higher crop yields and, thus, higher crop residues. With higher yields from irrigated plots, part of cropland can also be released for private pasture development. As expected, more local organizations and homogeneous (in oxen ownership) communities were associated with greater likelihood of having a restricted grazing land. Larger communities (total area) were also associated with greater likelihood of establishing restrictions, with lager grazing areas being restricted.

With respect to violation of grazing restrictions, we find that lower likelihood of violating restrictions were associated with higher rainfall areas, increasing homogeneity in oxen ownership, poor access to market. Higher rainfall areas may have more alternative sources of feed, thus reducing the dependency on communal grazing resources and tendency to violate restrictions. More homogeneous communities have a greater chance of arriving at a cooperative agreement due to similarity of interests, thus reducing the tendency to violate restrictions. Communities that are far from markets have limited non-farm opportunities, making enforcement of rules less difficult. In contradiction, however, we find that communities that were farm from the *wereda* town were more likely to violate grazing restrictions.

We find contradictory evidence of an inverted U-shape relationship between population and collective action. The likelihood of violating restrictions is low at low and very high population levels. The reason for this is not apparent. Also unexpectedly, we find that increasing number of local organizations and if cattle rearing is secondary activity were associated with greater likelihood of violating restrictions. Managing restricted grazing lands at the lower village level was also associated with greater likelihood of violating restrictions. It may be that the resources (e.g., militia and jails) available to enforce penalties are fewer at that level, and so village members may be more prone to violate restrictions, knowing that the consequences of being caught are not drastic. Greater probability of violating restrictions was also associated with increasing proportion of area irrigated and there has been land redistribution since 1991.

Impacts of collective action

We find that increasing the proportion of restricted grazing land had a robust negative impact on the quality of other unrestricted grazing resources, although managing the restricted grazing land at the lower village level had a robust positive impact. We do not find any impact between collective action (whether a restriction was established, total size of restricted area, and the level of management) and change in availability of grazing lands, change in proportion of grazing lands suffering from severe erosion, or proportion of grazing lands suffering from severe erosion in 1999.

Of the other factors, population growth has had a negative effect across board. The negative effect of population growth on availability, quality and erosion level of grazing lands is consistent with a neo-Malthusian notion regarding the negative impacts of population growth. Thus, population growth is not inducing sufficient investment in improvement of communal resources to overcome the negative effects of increased pressure on degrading resources.

Declining quality of grazing lands was associated with areas where land redistribution had taken place, as there seem to be further increasing pressure on the already degraded grazing resources, where parts of traditional grazing areas (hillsides and waste lands) were distributed for cropping and tree-planting activities. Benin *et al*. (2002) also found increased ownership of livestock where land redistribution had taken place. Severity of erosion of grazing lands was lower in areas with higher rainfall areas, poor access to markets, and higher participation of households in credit and extension programs offered by NGO's.

5. Conclusions and implications

Communal grazing lands are important sources of livestock feed in developing countries, although unrestricted access to such resources can result in overexploitation and degradation of the resource. Collective action, through restrictions and regulating use by the community, can play a significant role in sustainable grazing land management. Restricting access and use can reduce degradation of the resource by eliminating overexploitation and, therefore, improve availability and quality of forage in the long run. On the other hand, by restricting grazing in certain areas, there is tendency to shift pressure to other unrestricted grazing areas, which can rapidly increase degradation of those resources. Using data from 98 villages in the highlands of Amhara region, this paper first examines the determinants of collective action and its effectiveness in communal grazing lands management and the effect of restricting access and use in certain grazing areas on the condition of other communal grazing resources.

More than one-half of the communities had at least one such restricted grazing area, with the total area in each of those communities averaging twenty-two hectares. About 70 percent of the restricted grazing lands were managed at the village level, while the remaining was managed at a higher *kebele* level, usually consisting of three to five villages. We found that collective action is more likely to be successful in communities that have large areas, are far from markets, and where wealth (oxen ownership) is more equally distributed. Where there are more alternative sources of feed, as in irrigated areas, collective action is not likely to succeed.

We did not find much effect of restricting grazing access in certain areas on degradation of other unrestricted grazing areas. We found that increasing the proportion of restricted grazing land had a robust negative impact on the quality of other unrestricted grazing resources, although managing the restricted grazing land at the lower village level had a robust positive impact. Population growth has had the most negative effect across board: availability, quality and erosion level of grazing lands. This is consistent with a neo-Malthusian notion regarding the negative impacts of population growth. We also found that severity of erosion of grazing lands was lower in areas with higher rainfall areas and better access to credit and extension programs offered by NGO's.

Overall, these results suggest that community grazing land management can contribute to sustainable use of grazing lands and alleviation of feed shortage problems, as in the highlands of northern Ethiopia. However, collective action for grazing land management may be more beneficial and more effective in communities with large areas, that are far from markets, where wealth is more equally distributed, and where population pressure is low.

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Table 1. Livestock composition, feed sources and feed-shortage months in the Amhara region, by farming system

	Farming System		
	1	2	3
Cropping system	Sorghum-teff	Teff-millet-maize	Barley-wheat
Altitude (m.a.s.l.)	<1700	1700-2700	>2700
Local agro-ecology classification	Kolla	Weyna Dega	Dega-lower wurch
Ownership of livestock			
Percent in total herd			
Cattle	57	57	39
Sheep	9	20	40
Goats	26	11	6
Equines	8	11	14
Number per household			
Oxen	1.24	1.57	1.09
Cows	0.90	1.14	0.86
Sheep	0.56	1.58	3.23
Goats	1.57	0.86	0.52
Donkeys	0.47	0.72	0.61
Importance of feed sources (rank)			
Communal grazing lands	1	1	1
Stubble grazing	2	2	1
Cut-and-carry (hay)	3	3	1
Feed shortage (months)	March-June	March-August	February-August

Source: Compiled from ANRS (2001).

Table 2. Perceived changes since 1991 in use of feed resources in the highlands of Amhara region, by agricultural potential

	Sample Mean		
Feed source	All communities	Drought-prone areas	Higher rainfall areas
Communal grazing lands	-0.41	-0.31	-0.49
Area enclosures	-0.02	-0.04	0.00
Woodlots and forests	-0.11	-0.02	-0.17
Private pastures	-0.28	-0.28	-0.29
Crop residues	0.60	0.29	0.83
Homestead (e.g., prickly pear)	-0.05	0.15	-0.19
Purchased feed	0.30	0.52	0.15

Notes: Change is an ordinal indicator of perception where: -2=decreased significantly, -1=decreased slightly, 0=no change, +1=increased slightly, +2=increased significantly. Sample means are adjusted for stratification, weighting and clustering of sample.

Source: Adapted from Benin *et al*. (2002).

Table 3. Characteristics of restricted grazing lands since 1991 in the highlands of Amhara region: community level

Item	All	PA-managed	Village-managed
Percent of communities with restricted grazing lands	0.53 (0.095)		
Number of restricted grazing lands	0.81 (0.18)	1.59 (0.18)	2.24 (0.26)
Average area of restricted grazing lands	21.5 (8.39)	30.2 (16.62)	46.0 (18.04)
Number of villages	95	19	27

Notes: Standard errors are in parentheses. Means and standard errors are adjusted for stratification, weighting and clustering of sample.

Table 4. Characteristics of restricted grazing lands since 1991 in the highlands of Amhara region: grazing land level

Item	All	PA-managed	Village-managed
Average area of restricted grazing lands (ha)	24.2 (9.07)	32.0 (23.36)	21.8 (9.58)
Average age of restricted grazing land (years)	16.8 (2.26)	6.3 (1.41)	18.1 (1.74)
Organization involved with establishment (percent)			
Wereda Administration	9	18	5
Kebele Administration	32	44	27
Village Administration	3	0	4
Bureau of Agriculture	4	0	5
Other external	52	38	59
Method of protection (percent)			
Paid guard	12	0	17
Mutual trust	86	100	80
Other	2	0	3
Percent of guards paid for by communities	1	0	0
Percent with established penalties	98	100	97
Percent with violations occurring	19	14	20
Percent with violations penalized	16	14	17
Percent with other benefits without obtaining permission			
Cut and collect grass	60	79	52
Collect dung	97	91	100
Collect fuelwood	83	6	78
Beekeeping	93	6	93
Percent facing problems			
Less grazing area	17	19	16
Conflict over use	19	15	20
Uncertainty about benefits	12	1	15
Regeneration of grass since restrictions (percent)			
Increased significantly	33	45	29
Increased slightly	10	14	9
No change	41	31	44
Decreased slightly	16	9	18
Decreased significantly	0	1	0
Number of restricted grazing lands	115	34	81

Notes: Standard errors are in parentheses. Means and standard errors are adjusted for stratification, weighting and clustering of sample.

Table 5. Perceived changes in condition of grazing lands since 1991 in the highlands of Amhara region, by agricultural potential

Condition of grazing land	Sample mean: All villages	Drought-prone areas	Higher rainfall areas
Change in availability since 1991	-0.75	-0.78	-0.72
Change in quality since 1991	-1.18	-1.15	-1.20
Proportion suffering from severe erosion			
1991	0.14	0.16	0.12
1999	0.19	0.26	0.14
Proportion suffering from moderate erosion			
1991	0.12	0.15	0.10
1999	0.15	0.20	0.11

Notes: Change is an ordinal indicator of perception where: -2=decreased significantly, -1=decreased slightly, 0=no change, +1=increased slightly, +2=increased significantly. Sample means are adjusted for stratification, weighting and clustering of sample

Table 6. Summary Statistics of explanatory variables

Type of Analysis/Explanatory Variable	N	Mean	Standard Error
Collective Action and Change in Resource Conditions			
Average annual rainfall (1000 mm)	93	1.169	0.035
Elevation (1000 m.a.s.l.)	93	2.175	0.082
Distance to wereda town (10 km)	93	3.836	0.623
Walking time to nearest market (100 minutes)	95	1.193	0.138
If restricted grazing land is managed at village level	95	0.339	0.078
If there has been land redistribution since 1991	95	0.675	0.082
Collective Action Only			
Proportion of area irrigated in 1999	93	0.002	0.001
Number of local organizations in 1991	95	8.865	0.389
If cattle-raising is secondary activity in 1991	94	0.609	0.064
Total area (km^2)	93	60.04	17.61
Number of households (100; mean of 1991 and 1999)	87	12.79	0.775
Number of households squared	87	181.3	20.87
Heterogeneity in oxen ownership in 1991	95	11.74	1.264
Change in Resource Conditions Only			
Change in proportion of area irrigated	93	0.000	0.000
Change in household density ($10/km^2$)	85	0.887	0.143
Change in proportion of households receiving credit and extension			
Bureau of Agriculture	95	0.181	0.062
Amhara Credit and Savings Institution	95	0.074	0.024
Other formal	95	0.181	0.077
Change in proportion of adult literates	95	0.134	0.012
If there has been restricted grazing land since 1991	95	0.532	0.094
Proportion of restricted grazing land in total area	93	0.003	0.002

Notes: Change refers to the difference between 1991 and 1999 values. Means and standard errors are adjusted for stratification, weighting and clustering of sample. Change with respect to the explanatory variables refers to difference in the 1991 and 1999 values.

Table 7. Determinants of collective action in grazing lands management in the highlands of Amhara region

Explanatory variable	Whether restricted grazing area established in village since 1991	Total area of grazing land per village	Whether violations of use restrictions occurred on grazing land in 1999
Average annual rainfall (1000 mm)	2.034	55.323	-5.957***
Proportion of area irrigated in 1999	-164.672*	-3314.217	121.350*
Total area (km^2)	0.006*	0.451***	-0.001
Elevation (1000 m.a.s.l.)	-0.075	-17.751	1.593
Distance to wereda town (10 km)	-0.121	-2.227	2.174**
Walking time to nearest market (100 minutes)	0.320	12.298	-1.762*
Number of households (100; mean of 1991 and 1999)	0.048	6.190	1.754***
Number of households squared	0.001	-0.168	-0.071***
Number of local organizations in 1991	0.189*	4.313	0.507**
If cattle-raising was secondary activity in 1991	0.593	9.603	2.557***
Heterogeneity in oxen ownership in 1991	0.592*	1.298***	-0.051**
If restricted grazing land managed at village level			5.319**
If there has been land redistribution since 1991	0.199	9.112	3.640***
Intercept	-5.397*	-174.608	-24.178***
Type of regression	Probit	Tobit	Probit
N	82	82	100
F	1.99*	9.80***	7.95***

Notes: Coefficients and standard errors are adjusted for stratification, weighting and clustering of sample. * Statistically significant at the 10% level; ** Statistically significant at the 5% level; *** Statistically significant at the 1% level..

Table 8. Impact of restricted grazing land management on perception of resource conditions since 1991 in the highlands of Amhara region

Explanatory variable	Change in availability of grazing lands	Change in quality of grazing lands	Change in proportion of grazing lands with severe erosion	Proportion of grazing lands with severe erosion in 1999
Average annual rainfall (1000 mm)	0.579	0.228	-0.034	-0.290***R
Change in proportion of area irrigated	50.130	-109.653	7.398	-2.694
Elevation (1000 m.a.s.l.)	-0.175	-0.410R	0.049	0.035
Distance to wereda town (10 km)	-0.088	-0.098	0.001	-0.018*** R
Walking time to nearest market (100 minutes)	0.110	0.054	0.061**	0.044
Change in household density (10/km^2)	-0.752***R	-0.384*R	0.026	0.096*** R
Change in proportion of households receiving credit				
Bureau of Agriculture	-0.858*	-0.111	0.041	-0.075
Amhara Credit and Savings Institution	-0.592	-0.402	-0.011	0.172 R
Other formal	0.619	-0.865R	0.004	-0.206** R
Change in proportion of adult literates	0.618	-0.436	0.234	-0.210
If land redistribution since 1991	-0.466	-0.732**R	-0.040	0.008
If there has been restricted grazing land since 1991	0.397	-0.330	0.035	0.026
Proportion of restricted grazing land in total area	14.782	-32.160**R	-1.237	-1.839
If restricted grazing land managed at village level	0.041	1.002*R	0.045	0.041
Intercept			-0.151	0.423**
Type of regression	Ordered Probit	Ordered Probit	OLS	OLS
N	83	83	83	83
F	1.15	3.43***	4.42***	6.46*** R
R^2			0.20	0.26

Notes: Change with respect to the explanatory variables refers to difference in the 1991 and 1999 values. For the ordered probit models, the dependent variables are ordinal indicators of perceived changes since 1991 where: -2=decreased significantly, -1=decreased slightly, 0=no change, +1=increased slightly, +2=increased significantly. For the first OLS model, the dependent variable is the change between 1991 and 1999 values. Coefficients and standard errors are adjusted for stratification, weighting and clustering of sample. * Statistically significant at the 10% level; ** Statistically significant at the 5% level; *** Statistically significant at the 1% level. R means coefficient of same sign and significant at the 10% level when predicted values of restricted grazing land variables (if there is restricted grazing land and proportion of restricted grazing land) are used instead of the actual values.