

COMMUNITY RESOURCE MANAGEMENT: THE CASE OF GRAZING LANDS IN TIGRAY, NORTHERN ETHIOPIA

Berhanu Gebremedhin* John Pender Girmay Tesfay*****

Acknowledgement

We gratefully acknowledge the financial support of the Swiss Agency for Development and Cooperation. We are also grateful to Mekelle University for institutional support and collaboration during the field work and data analysis, the Tigray Regional Bureau Agriculture and Natural Resource Development and the Tigray Regional Bureau of Planning and Economic Development for logistical support and collaboration in the work. We are especially thankful to the many farmers and officials who patiently responded to our numerous questions. The usual disclaimer applies.

* Post Doctoral Scientist, International Livestock Research Institute (ILRI), Addis Ababa

** Research Fellow, International Food Policy Research Institute (IFPRI), Washington
D.C.

*** Professor of Agricultural Economics, Mekelle University, Mekelle

1. Introduction

Communal grazing lands are important sources of livestock feed in developing countries (ILRI, 1998). In the presence of sufficient demand for livestock or livestock products, unrestricted access to the grazing lands will result in overexploitation of the resource and the scarcity rent of the resource remains unappropriated. Each individual user of the resource enjoys the full benefit of her use of the resource but bears only a fractional part of the cost. As a result, the traditional uncontrolled and free grazing system in many developing countries has caused severe degradation of the grazing lands.

Alternative solutions have been proposed to solve this problem including privatisation, imposition and enforcement of use rules by external forces such as the government, or state ownership of the resource (Wade, 1986). It is unlikely that natural resource problems can be solved by private or state property alone. The market system backed by public interventions which themselves are based on market incentives are likely to succeed in solving resource degradation problems (Pearce and Turner, 1990). The transaction cost of enforcing use rules imposed on the community by an external force is likely to be prohibitively high due to the high incentives of individual users to shirk or the community members to collude against the use rules.

In the presence of collective action, institutional and organisational development, and the development of infrastructure, population pressure is more likely to have a positive impact on natural resources than in the absence of these developments (Pender, 1999). The success of public policies to improve natural resource management depends to a large extent on the presence and effectiveness of local level institutions and organisations (Rasmussen and Meinzen-dick, 1995).

Community natural resource management is increasingly recognised as a viable alternative to privatisation or state ownership of the resource. As a result, local level resource management institutions and organisations to enforce them are receiving greater attention (Baland and Platteau, 1996; Rasmussen and Meinzen-Dick, 1995).

However, devolving rights to local communities to manage resources, establish use rules and regulations, and the mechanisms to enforce the rules is only a necessary condition for successful community resource management. Sustainable resource management requires that community rules and regulations be effectively observed (Swallow and Bromely, 1995; Turner et al., 1994). Hence, identification of the factors that favour or retard from the development and effectiveness of local organisations becomes important.

Although livestock contribute to land degradation, allegations against them tend to be exaggerated or even unfounded (Ehui et al., 1998). The underlying causes of land degradation may be incomplete property right systems including tenure insecurity, and perverse financial incentives rather than increasing livestock numbers or grazing land. With appropriate livestock development policies and public interventions in technology transfer, livestock have the potential to contribute significantly to the development of sustainable and environment friendly mixed crop-livestock systems.

Ethiopia has the largest livestock population in Africa and stands 10th in the world. The livestock sub-sector is an important and integral component of the agricultural sector supplying draught power for cultivation, food and income to households, and insurance against risk. However, the contribution of the sub-sector to the country's

economy remains far below its potential due to feed, disease and management problems. Communal grazing lands have been important sources of livestock forage in the country. Recently, however, several communal grazing lands have been severely degraded due to the free and uncontrolled grazing system.

The degradation of grazing lands is especially severe in the northern Ethiopian region of Tigray. Cognisant of this problem, the improvement of animal feed production has become one major component in the regional livestock development strategy (Fitsum et al., 1998). In addition to efforts to increase the number of feed trial and seed multiplication sites, and the number of farmers who would benefit from forage seed distribution, communities have been empowered to develop and enforce use regulations of communal grazing lands. However, there is a paucity of evidence regarding the nature of local level institutions and organisations for grazing land management in Tigray, or their effectiveness. More generally, there is inadequate empirical evidence for developing countries regarding the effectiveness of community institutions to manage and regulate use of grazing land, in spite of the increasing attention in the literature to the potential contribution of community resource management in recent years.

This paper attempts to contribute to this gap of knowledge for developing countries. The paper has two interrelated objectives. First, it evaluates the nature of community grazing land management in Tigray and its impact on the sustainable use of grazing lands. Second, it analyses, using multivariate econometric methods, the factors influencing collective action and its effectiveness in managing grazing lands.

2. The Setting

The study area, Tigray, is the northern most region of Ethiopia located on the Sudano-Sahelian dry lands zone (Warren and Khogali, 1992). It covers an approximate area of 80, 000 sq. km with an average population density of about 40 per sq. km, and population growth rate of about 3%. Most of the area is arid or semiarid with annual precipitation of 450 to 980 mm. Most of the rain falls within the months of June, July and August exhibiting high intensity, and high temporal and spatial variability (Berhanu Gebremedhin, 1998). More than 85% of the regional population lives in the rural areas and depends on mixed crop-livestock subsistence agriculture.

Since 1991 the Ethiopian government has been following an economic development strategy known as Agricultural Development-Led Industrialisation (ADLI) which places greater emphasis on agricultural development. Regional administrations have been able to draw economic development strategies specific to their conditions within the framework of the ADLI. The Tigray region has embarked on resource conservation-based ADLI, focusing on conservation and development of soil and water resources, environmental rehabilitation through area enclosures and tree plantation and the development of small scale irrigation systems. An integral part of the resource conservation and development effort has been popular participation of local communities (Berhanu Gebremedhin, et al., 2000).

According to the 1998 livestock census, the region has about 3.04 million cattle, 0.94 million sheep, 1.47 million goats, 0.41 million equines, and 0.013 million camels (BoANRD, 1999). Livestock play an important role in the rural economy of Tigray. They are sources of draught power for traction and transportation, cash income from sale of livestock and livestock products, food such as milk for household consumption and

manure to maintain soil fertility. The primary purpose of livestock production in the crop-livestock mixed farming systems of the region is draught power production.

The contribution of the livestock sub-sector to the regional economy has been constrained primarily by lack of adequate and quality feed, and livestock diseases. For instance, the annual financial loss due to inadequate feed and management problems is estimated to reach as high as 46.9 million Birr¹ for beef production and 230.9 million Birr for milk production (Desta Hagos, 1997).

The major livestock feed sources in the region include crop residues (45%), natural grass (35%), browse (10 %) and crop aftermath (8%) derived from 3.2 million ha of grazing land, and 3.6 ha of cultivated land (BOANRD, 1997; UNECA, 1997). Crop residues consist of straw, stalk, stovers, sheath and chaffers. About 68% of the crop residue is fed to oxen, 20% to milking cows and newly castrated bulls while the remaining balance is fed to other livestock during critical periods (UNECA, 1997). Prickly pear is also increasingly being used as animal feed, mainly in the southern and eastern zones of the region. The spineless cactus is chopped and given to animals while the spiny cactus is treated for spine removal with fire and knives. Considering the total number of livestock and the contributions of different sources of feed, the grazing lands in Tigray are supporting livestock far beyond their carrying capacity (BOANRD, 1997; UNECA, 1997; Gebrekidan Teklu, 1994).

The livestock feeding system in the region shows slight difference by altitude (Tsigeweyni Tekleab, 1997). In the highlands, livestock feed mostly on weeds, and green grass from farm strips and bunds from July to September. From October to December, the dominant feed sources are crop aftermath and range lands. From January to June, crop residues, hay, and cactus in some places especially in the eastern and southern zones, are the primary source of feed. In this altitude zone, the critical feed shortage is observed in the period from July to September, while limited feed shortage is observed during April to June. The period from October to March is the period of relatively adequate feed.

In the lowlands, fallow land and crop aftermath are the major source of feed from July to January for farmers with small herd size (livestock reared around homesteads), while crop residues and hay constitute the major source from February to April. While adequate feed appears to be available during July - April, May to June is the critical feed shortage period for these farmers. For farmers with large herd size (livestock reared on range lands), natural grazing land is the major source of feed from July to March. While adequate feed appears to exist for the period July to January for these farmers, February to March is characterised by limited feed availability, and April to June is the critical feed shortage period.

In the highlands of Tigray, grazing systems show slight difference based on season. During the rainy season, when most arable lands are under crops, livestock are confined to graze on valley bottoms, farm strips and steep hill sides (Tsigeweyni Tekleab, 1997). The grazing animals cause significant soil disturbance by trampling on the hillsides during the wet season thus contributing to soil erosion. During the dry season, arable lands become grazing areas.

¹ In 1998, USD 1 = 7 Birr.

Free and uncontrolled grazing is the dominant grazing system in the region. In most parts of the region, grazing lands are common property resources². Most of the grazing lands are grazed and trampled the whole year round without any resting period, resulting in depletion of the palatable species and invasion by less palatable or unpalatable ones. Moreover, grazing on crop land contributes to soil compaction and the need for frequent tillage to prepare fields for crops, making practices such as reduced tillage less feasible.

In addition to its contribution to the degradation of grazing lands, the grazing system has a negative effect on the conservation efforts underway in the region. Physical conservation structures such as stone terraces and soil bunds are destroyed by the freely roaming livestock. Biological conservation practices such as grass strips and tree plantations are also being destroyed or trampled reducing the chance for establishment and regeneration.

Although the consequences of environmental degradation that results due to the free grazing system are faced by both owners and non owners of livestock, the free grazing system causes externality costs to those who do not own livestock. Fallow lands and cultivated lands after harvest are considered as grazing lands without access restrictions. Free grazing leaves the lands without vegetation cover thus contributing to soil erosion and the decline of soil fertility, decrease in soil organic matter and the deterioration of the soil structure. The farmers who own the lands but who own no livestock will then be forced to bear the cost of maintaining the fertility of the land by applying commercial fertiliser or manure, or face the consequence of lower yields.

Some rural communities in Tigray also practice reserving grazing areas for dry season feed. In the southern zone, reserved grazing areas are mostly grazed by oxen from February until the onset of the next rainy season, while in the central zone reserved grazing areas are used for hay making or are grazed by the whole livestock herd starting from October. However, the reserved grazing areas appear to be mainly the valley bottoms thus contributing to the continuous degradation of the hillsides during the rainy season.

In the eastern zone, private ownership of grazing lands is practised. In some *woredas* (districts) of the zone such as Eurob and Hauzen, the privately held grazing areas are converted to communal grazing lands after about two months of private grazing, while in Saesi Tsaeda Emba, private grazing is practised all year round (Tsigeweyni Tekleab, 1997). In some *tabias* of Saesi Tsaeda Emba, farmers separate reserved grazing lands intended for cows and oxen. While valley bottoms are reserved for oxen, marginal grazing lands are reserved for cows.

Stall feeding of livestock is not practised in rural Tigray. The shift towards stall feeding needs to be seen within the overall context of agricultural production in the region (Berhanu Gebremedhin, 1998). Stall feeding can increase availability of manure and reduce the energy loss of livestock due to walking in search of feed where there is usually little. On the other hand, stall feeding requires more labor for watering, housing, and breeding. Oxen and pack animals also need the physical exercise required for plowing and transporting. Stall feeding may, however, be more feasible in a more intensive dairy production close to cities.

² Common property resources are defined as those resources which are collectively owned and managed by a given community. They are to be contrasted with open access resources that have no defined owner.

3. Research Methods and Hypotheses

3.1 Methods

The results are based on data collected from a survey of 50 *tabias* (the lowest administrative unit in Tigray consisting usually of four to five villages) in the highlands³ of Tigray in the 1998-99 cropping year. Sample *tabias* were selected using a stratified random sampling. *Tabias* were stratified based on distance from the nearest market town and presence of an irrigation project. Two villages were selected randomly from each *tabia*. A semi-structured questionnaire was administered in a group interview with community representatives at both the *tabia* and village levels. Each interview involved ten respondents chosen to represent different age groups, villages, primary occupations and gender. The survey collected information about changes in agricultural and natural resource conditions between 1991 and 1998, and their causes and effects.

Descriptive analysis of survey data was used to identify the nature and impact of community management on grazing lands, the role of local and external organisations in managing them, the institutions that evolved and their enforcement mechanisms. Econometric analysis was used to examine the determinants of collective action and its effectiveness in managing grazing lands.

Effective collective action for resource management requires that the beneficiaries prepare and agree on a set of rules of restrained access to the resource; make arrangements for financial, labor or other contributions required for the management of the resource; and lay out a system of punishment for violations of the use restrictions. Thus, the indicators of collective action and effectiveness used in the econometric analysis include whether there are restricted grazing areas in a village, whether communities established penalties for violations of use restrictions, whether there were any violations of the restrictions on use of the restricted grazing areas in 1998, and whether the violations were penalised when they occurred. These indicators may be considered as indicators of collective action for protecting the grazing lands.

The type of regression model to use depends on the nature of the dependent variable. We use binary probit models to examine the determinants of whether a village has restricted grazing areas, whether penalties were established, whether any violations occurred and whether violations were penalised since these are binary variables.

3.2 Hypotheses

The likelihood of a successful community institutions and organisations for resource management depends on a number of factors related to the nature of the resource being managed, the location attributes of the resource, the characteristics of the community, and the nature and role of external organisations operating in the community in relation to the resource (Rasmussen and Meinzen-Dick, 1995; Wade, 1996). Thus the factors used to explain differences in collective action and its effectiveness include population density, access to market represented by distance to nearest *woreda* (district) town, agricultural potential represented by zonal dummies, area and age of the restricted grazing land, and whether the grazing land was promoted by an external organisation.

We base our hypotheses regarding the effect of these factors on community resource management on the literature on induced innovation theory and collective action

Highlands are defined as those areas which are above 1500 m.a.s.l.

in managing common property resources (Hayami and Ruttan, 1985; North, 1990; Olson, 1965; Berhanu Gebremedhin et al., 2000; Rasmussen and Meizen-Dick, 1995; Baland and Platteau, 1996; Wade, 1985; Pender and Schere, 1999; Pender, 1999; Otsuka and Place, 1999; Boserup, 1965). Community resource management is more likely to be effective when the resource is of moderate size and more clearly demarcated, due to possible economies of scale, ease of detection of rule-breaking "free riders" and higher benefits. Thus we expect that collective action will be higher for medium-sized grazing lands than for small or very large ones.

Low population density may retard from collective action due to the high organisational cost of achieving effectiveness. As population density increases, the need for improved resource management increases thus raising the benefits from collective action, especially if economies of scale or high exclusion costs favor collective over private management. At very high levels of population density, however, the transaction cost of enforcing community rules and the incentive for community members to "free ride" on the effort of others may be high. Diseconomies of scale may replace the economies of scale of collective action. In such circumstances, the benefits from private management may outweigh the benefits from collective action. This suggests an inverse U-shaped relationship between population density and collective action with intermediate levels of population density favoring collective action, while low and very high population densities retarding from collective action.

The location attributes of the resource can be represented by market access and agricultural potential. The effect of market access on collective action is mixed. While better market access may increase the value of the resource and the return from managing the resource effectively, thus favoring collective action, better market access may also decrease the incentive of members to abide by community rules by increasing the opportunity cost of labor or by providing more "exit" options, making enforcement of rules more difficult (Pender and Schere, 1999; Baland and Platteau, 1996). The effect of agricultural potential is also ambiguous for similar reasons.

External organisations can favor collective action by providing technical support, and complementary inputs provided that this interventions are demand driven. On the other hand, external organisations may retard from collective action if their role substitutes for collective action (such as by replacing local effort or dictating management decisions) or otherwise undermining collective action (such as by increasing "exit options" of local community members) (Pender and Schere, 1999). Communities with longer experience of collective resource management may be more likely to enforce use regulations effectively than communities with limited experience in collective resource management due to possible "learning effect". Thus age of the grazing area is expected to favor effective community resource management. Since almost all restricted grazing areas are managed at the village level, we are not able to test the effect of the level of management on collective action.

4. Results

4.1 Descriptive Analysis

Grazing areas with some regulations of use (“restricted grazing areas”) are common in rural communities in the highlands of Tigray. Almost 90% of villages in the highland has one or more restricted grazing areas. The average restricted grazing land area per village is 38 ha and the average grazing land area is 10.5 ha (Table 1). On average, each village in the highlands has about four restricted grazing areas. However, there is a wide variation in the number and area of restricted grazing lands per village. Almost all restricted grazing areas are used exclusively by the village which manages them. In addition to grazing livestock other allowed uses of the restricted grazing areas include cutting grass for feed or construction, fuel wood collection from dead trees and dung collection, and bee keeping. However, cutting trees or shrubs is not allowed.

Table 1. Characteristics and Allowed Uses of Restricted Grazing Areas (standard errors in parentheses)*

Item	Village level	Grazing area level
Percentage of villages with restricted grazing lands	89 (0.021)	
Number of restricted grazing lands per village	3.98 (0.165)	
Area of restricted grazing lands (ha)	38.2 (3.615)	10.45 (1.112)
Percentage of grazing lands promoted by external organisations		32 (0.0349)
Allowed uses of restricted grazing lands (percent)		
cutting grass		22 (0.03)
fuelwood collection		53 (0.034)
collecting dung		90 (0.021)
collecting fruits		66 (0.033)
beekeeping		60 (0.032)
cutting trees		0 (0.0)

* Means and standard errors are corrected for sampling stratification and weights.

There is a long tradition of developing and enforcing use regulations of grazing areas in Tigray. More than 58% of the grazing areas in the surveyed villages were established prior to 1966, while only about 17% percent have been established since 1990. Village administration is the local organisation principally mandated for the management of the grazing areas. In a few cases, a group of elders has the management responsibility. In addition to the village organisations, *tabia* administrations and the

Bureau of Agriculture are also involved in management of the grazing areas. The role of the local and external organisations in the management of the grazing areas include organising and informing potential participants, preparing rules and regulations of use and enforcement of their implementation, and provision of material and technical assistance. The village administrations are principally involved in organising and informing beneficiaries, the preparation of rules and regulations and enforcement of implementation, and guard financing. The Bureau of Agriculture is involved mainly in the provision of material and technical assistance.

The most frequent contribution of village members in management of the grazing lands is cash or in kind contribution for guard payment. Other contributions of village residents include uncompensated labor contribution for the construction of soil and water conservation practices, guarding the area on rotation basis, and fencing and weeding.

Most grazing areas in the highlands (68%) are not promoted by any organisation or program indicating the prevalence of local initiatives for collective action in managing grazing lands. In cases where the grazing areas were promoted by an organisation or a program, the Bureau of Agriculture took the lead. More than half of the restricted grazing areas are used for grazing only by oxen while the remaining are grazed by all animals. There is a variation in the period during which the grazing lands are used for grazing. In 42% of the cases the grazing lands are used from September to December, 29% from January to May, and 13% from June to August. Only oxen are allowed to graze from June to August. In a few cases, grazing is allowed after the grass is cut.

The most common way of protecting the grazing lands is by hiring guards (77%) paid by contributions from households in cash or in kind, or in return for benefits from using the grazing areas. The most dominant way of compensating guards is payment in cash or in kind. When cash payment is used, a guard is paid 40 birr/month on average. In some villages only those who own oxen contribute for guard payment. When a guard is not hired, village households rotate in guarding the grazing lands or fence the grazing land. Mutual trust among villagers is used in a few cases as a way of protecting the areas.

Penalties for violations of use restrictions of grazing lands are widely used in the highlands of Tigray. In 1998, violations of use restrictions were reported in 26% of the grazing lands, of which about 81% were penalized. Farmers do not perceive any problems as a result of the use restrictions of the grazing areas in terms of shortage of grass, harbouring pests, fire hazard, shortage of fuel wood, or uncertainty about receiving benefit from them. Moreover, farmers believe that the use restrictions facilitate a significant regeneration of the grazing areas. All restricted areas remained restricted once they were established.

The most frequent violations of use restrictions of the grazing lands reported in 1998 were letting animals graze while grazing was not allowed, and cutting grass for feed and construction without permission. Other violations include cutting roots, branches, leaves or trees, and collecting fuel wood. Communities mostly use penalty in cash for violations of letting animals graze and cutting grass and trees when not allowed. Sixty one percent of cash penalties during establishment and 72% of cash penalties in 1998 were applied to violations of grazing animals and cutting grass and trees. In some cases (21% of penalties during establishment and 18% in 1998) the village courts were mandated to decide on penalties for violations. Confiscation of the cut grass and trees, and the cutting implements were used in few cases.

The survey asked about penalties used by communities for violations of use restrictions when area was established and in 1998. The nominal value of cash penalties has increased in 1998 compared to the time when the restricted grazing areas were established. The average cash penalty for grazing animals was 5 Birr/head of livestock or 35 Birr/violation during establishment, while the corresponding figures in 1998 were 10 Birr/head of livestock or about 100 Birr/violation. Moreover, the frequency of use of cash penalties, and imprisonment increased in 1998, while mandating the village court to decide on penalties, penalty in kind and confiscation decreased (Table 2). In a few cases penalties were not initially developed when the use restrictions were established while penalties were developed for almost all grazing areas in 1998.

The most frequently cited benefit received from the grazing lands in 1998 is grazing animals while feed is in short supply. On average, 42% of households in each village received benefit from grazing animals in 1998. Other benefits to rural households in 1998 include cutting grass for feed and other purposes, collecting dung, and collecting fuel wood from dead trees.

Table 2: Penalties Established for Violations of Use Restrictions of Restricted Grazing Lands (percent of grazing areas)

Type of penalty	when restricted grazing land was established	1998
cash penalty	63.3	69.9
Decided by village court	21.4	18.4
Penalty in kind	3.4	1.4
confiscate the cut grass and trees, and implements	2.7	1.4
no penalty	6.8	0.5
imprisonment	0.0	1.4
other*	2.4	7.0

* includes cash penalty combined with in kind payment, warning and imprisonment

4.2 Econometric Analysis

The results of econometric analysis are presented in Table 3. We include population density and population density squared to test for an inverted U-shaped relationship between population density and collective action. Zonal⁴ dummies were included to account for the differences in agricultural potential (the Southern and Western zones have generally higher agricultural potential) and other differences between these

⁴ The Tigray region is divided into four zones (Southern, Central, Eastern and western)

zones. Market access is represented by walking time from village to woreda town, which is the place farmers mostly use to market their produce and purchase inputs. The effect of the presence of an external organisation is examined by including a dummy variable

Table 3. Determinants of Collective Action and its Effectiveness on Grazing Lands^a

Explanatory variable	Whether a village has restricted grazing area	Whether penalties were established	Whether any violations of restrictions occurred in 1998	Whether violations in 1998 were penalized ^b
Central zone (cf. Southern zone)	-2.016***	0.1543	-1.5463***	-0.3215
Eastern zone (cf. Southern zone)	-1.473***	0.3513	-1.3662***	
Western zone (cf. Southern zone)	-2.586***	-0.6317	0.85232	
1994 population density (per sq. km.)	-0.0235215**	-0.0188463*	-0.01967***	-0.027345***
1994 population density squared	0.0000744**	0.0000518	0.0000926***	0.0000858**
Distance to Woreda town (walking time in minutes)	-0.0001353	0.00405***	0.003379***	0.0001157
Area of restricted grazing area (ha)		-0.02859***	0.000983	-0.0278*
Grazing area promoted by external organisation		0.38774	0.41069	-0.3504
Age of restricted grazing area		0.006648	0.00538	0.00094
Intercept	3.884***	2.8658***	-0.368	2.8179***
Type of regression	Probit	Probit	Probit	Probit

^a All regression results were corrected for sampling stratification and weights, and standard errors are robust to heteroskedasticity and non-independence within the primary sampling units (*tabias*).

^b Eastern and Western zones were dropped from these regression as they predicted outcomes perfectly.

* significant at 10% level, ** significant at 5% level, *** significant at 1% level.

for whether the grazing area was promoted by an external organisation. Age of a grazing area was measured as the number of years since the use regulations were established. The

size of the grazing area was included to examine the presence of economies (or diseconomies) of scale.

We find that the Western zone is least likely to have restricted grazing areas, consistent with the existence of a relatively more abundant grazing land in the zone compared to other zones of the region, thus perhaps reducing the need for restricted grazing areas. The Central and Eastern zones are also less likely to have restricted grazing areas than the Southern zone. That these zones are less likely to have restricted grazing lands may indicate that farmers in the zones resort more to other livestock feed sources than grazing lands, given the higher severity of land degradation in the zones (compared to the Southern zone). However, violations of use restrictions are less likely to occur in the Central and Eastern zones suggesting that once restricted grazing areas are established, community benefits are higher. The lower likelihood of violations of use restrictions in the Eastern zone is also consistent with the tradition of private ownership of grazing lands and reserving grazing lands for dry season grazing in the zone. There is no statistically significant difference in the likelihood of violations of use restrictions between the Southern and Western zones.

We find a U-shaped relationship between population density and violations of use restrictions of grazing lands, consistent with our hypothesised inverted U-shaped relationship between population density and collective action. Violations of use restrictions are higher at low and very high population densities. This suggests that, once restricted grazing lands are established, communities are more likely to observe use rules at medium population density than at low and very high densities due to higher collective benefits and possible economies of scale in managing the grazing lands. Consistent with this result, we also find a U-shaped relationship between population density and the development of penalty system and its enforcement when violations occur. This suggests that the need for a penalty system and its enforcement becomes less when violations are fewer, indicating that penalty system and its enforcement are not indicators of collective action but indicators of failure of collective action.

Contrary to our expectations, we find that restricted grazing areas are less likely to be established at intermediate population densities than at low and very high densities. This result is hard to interpret and suggests for a further investigation on the process that communities pass through in establishing restriction rules of grazing lands.

We find that more remote areas have higher violations of use restrictions and are more likely to develop penalty systems suggesting that lower resource values and benefits result in reduced (failure of) collective action. The presence of external organisations failed to have significant effect on any of the indicators of collective action, suggesting that since most restricted grazing lands were established through the initiatives of local communities, the role of external organizations was not important.

Community experience in managing restricted grazing lands did not have significant effect on collective action suggesting that there is no “learning effect” in community grazing land management in the region. Penalties are less likely to be developed and enforced for wider grazing areas. It may be that the difficulty of detection of violators undermines the need for penalty system. Area of grazing land explained occurrence of violations of use restrictions positively but was insignificant. In the regression for whether violations were penalised when they occur, Eastern and Western zones were dropped as they predicted outcomes perfectly.

5. Conclusions and Implications

Rural communities in Tigray have long tradition of developing and enforcing use regulations of grazing areas. Village organisations play an active role in managing restricted grazing areas by organising and informing beneficiaries, and establishing and enforcing use regulations, with technical and material assistance from the Regional Bureau of Agriculture. Beneficiaries contribute to grazing land management through cash and in kind contribution for protection and uncompensated labor contribution for the development of the grazing lands.

Upon realisation of the benefits from restricted grazing areas, communities maintain the use regulations once they are established. Given the crucial role of traction for crop production, oxen appear to be the main users of the restricted grazing lands. Communities tend to be more likely to develop and enforce penalties when violations of use restrictions are more frequent. Restricted grazing areas are least likely to be established in areas of relative abundance of livestock feed. We found no evidence of “learning effect” in community grazing land management.

We found some support for the hypothesis of an inverted U-shaped relationship between population density and collective action, especially through reduced violations of use restrictions and reduced need to develop and enforce penalty systems. However we also found that population pressure reduces the likelihood of establishment of restricted grazing areas. Market access appears to encourage grazing land management perhaps by increasing resource values or returns from use of the resource, especially by encouraging community members to observe use restrictions and reducing the need for penalties.

The findings imply that community grazing land management can contribute to a more sustainable use of grazing lands and the alleviation of feed shortage problems. Upon realisation of benefits, farmers can contribute to the management of grazing lands and be more likely to observe community rules. Community grazing land management may be more effective in areas closer to markets facing severe feed shortage.

Annex: Summary Statistics of Variables Used in Regressions

Variable	No. of Observations	Mean	Standard deviation	Minimum	Maximum
Eastern zone	263	0.349	0.477	0	1
Southern zone	263				
Western zone	263	0.061	0.239	0	1
Central zone	263	0.236	0.427	0	1
Livestock density (TLU per sq. km.)	259	120.84	32.3	57.01	196.12
1994 population density (per sq. km.)	261	132.38	63.43	35.78	302.56
Whether village has restricted grazing area	262	0.9	0.299	0	11
Whether village established penalties	237	0.958	0.201	0	1
Whether violations occurred	235	0.264	0.442	0	1
Whether violations were penalised	63	0.809	0.396	0	1
Walking distance from village to nearest woreda town (minutes)	263	164.9	113.62	10	720
grazing land promoted by external organisation	237	0.287	0.453	0	1
Area of grazing land	237	10.45	20.85	.25	200
Age of grazing land	236	23.56	11.07	0	32

References

- Baland, J-M. and J-P. Platteau. 1996. *Halting degradation of natural resources. Is there a role for rural communities?* Oxford:Clarendon Press.
- Boserup, E. 1965. *The conditions of agricultural growth.* New York: Aldine Publishing Co.
- Bureau of Agriculture and Natural Resource Development (BoANRD). 1999. "Livestock census analysis results." Mekelle.
- Bureau of Agriculture and Natural Resource Development (BoANRD). 1997. "Tigray Livestock Development Action Program: Executive Summary, Volume II." Mekelle.
- Ehui, S, Li Pun, H., V. Mares and B. Shapiro. 1998. "The role of livestock in food security and environmental protection." *Outlook on Agriculture* 27(2):81-87.
- Hagos, D. 1997 "Tigray Livestock Development Action Program." Tigray Bureau of Agriculture and Natural Resource Development: Mekelle. mimeo
- Hagos, F., J. Pender and G. Nega. 1999. "Land degradation in the highlands of Tigray and strategies for sustainable land management." International Livestock Research Institute Socio-economics and Policy Research Working Paper 25. Livestock Policy Analysis Project: Addis Ababa.
- Gebremedhin, B. 1998. "The economics of soil conservation investments in the Tigray region of Ethiopia." Ph D Dissertation. Department of Agricultural Economics: Michigan State University.
- Gebremedhin, B., J. Pender, and G. Tesfay. 2000. "Community natural resource management: The case of woodlots in northern Ethiopia." Environment and Production Technology Division Discussion Paper 60. Washington D.C.: International Food Policy Research Institute.
- Hayami, Y. and V.Ruttan. 1985. *Agricultural Development: An international perspective*, 2nd ed.. Baltimore: John Hopkins University Press.
- ILRI (International Livestock Research Institute). 1999. *ILRI 19998: Linking livestock and natural resource management.* IIRI, Nairobi, Kenya.
- North, D.. 1990. *Institutions, Institutional Change and economic performance.* Cambridge: Cambridge University Press.
- Olson, M.. 1965. *The logic of collective action. Public goods and the theory of groups.* Cambridge: Harvard University Press.

- Otuska, K. and F. Place, eds.. 1999. "Land Tenure and natural resource management: Forest, agroforest, and cropland management in Asia and Africa." Book Manuscript. Washington D.C.: International Food Policy Research Institute.
- Pearce, D.W. and R.K. Turner. 1990. *Economics of Natural Resources and the Environment*. Hertfordshire: Harvester wheatsheaf
- Pender, J.. 1999. "Rural population growth, agricultural change and natural resource management in developing countries: a review of hypotheses and some evidence from Honduras." Environment and Production Technology Division Discussion Paper 48. Washington D.C.: International Food Policy Research Institute.
- Pender, J. and S. Schere. 1999. "Organisational development and natural resource management: Evidence from central Honduras." Environment and Production Technology Division Discussion Paper 49. Washington D.C.: International Food Policy Research Institute.
- Rasmusen, L.N. and R. Meinzen-Dick. 1995. "Local Organisations for natural resource management: Lessons from theoretical and empirical literature." Environment and Production Technology Division Discussion Paper 11. Washington D.C.: International Food Policy Research Institute.
- Swallow, B.W. and D.W. Bromely. 1995. "Institutions, governance and incentives in common property regimes for African rangelands." *Environment and Resource Economics* 6:99-118.
- Tekleab, T. 1997. "Tigray Soil and water conservation action program: Livestock management and forage production." Mekelle. Mimeo.
- Teklu, G.. 1994. "A need for change in policy in the traditional grazing system and ownership right on communal lands." Natural Resource and Environmental Protection (NRDEP): Mekelle. mimeo.
- Turner, R.K., D. Pearce and I. Bateman. 1994. *Environmental economics: An introduction*. Hertfordshire: Harvester Wheatsheaf.
- United Nations Economic Commission for Africa (UNECA). 1997. "Livestock development in Tigray: Forage development strategy as a major entry point towards a sustainable minimum grazing system, Part I." Sustainable Development and Environmental Rehabilitation Program (SAERP): Addis Ababa.
- Wade, R.. 1986. "The management of common property resources: collective action as an alternative to privatisation and state regulation." Discussion paper No. 54. Agricultural and Rural Development Department. Washington DC: The World Bank.

Warren, A. and M. Khogali. 1992. Assessment of Desertification and drought in the Sudano-Sahelian Region, 1985-1991. New York: UNSO.