Chapter 10

Community Natural Resource Management in the Highlands of Ethiopia

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Common property resources[1] are important sources of timber, fuelwood, and grazing land in developing countries. When community members have unrestricted access to the resource, or when use regulations are ineffective, these resources are exploited on a first-come, first-served basis. Each individual user of the resource will tend to continue to use the resource until her average revenue is equal to the marginal cost of using the resource (Gordon 1954). In the presence of externalities, social marginal cost exceeds private marginal cost, and common property resources can still be degraded if an individual equates her marginal cost with her marginal benefit of utilizing the resource. These conditions lead to over-exploitation of the resource and the dissipation of the scarcity rent.

Several alternative solutions have been proposed to solve this problem, including collective action,[2] privatization, and imposition and enforcement of use rules by external forces such as the government (Wade 1987). The transaction cost of enforcing use rules imposed on communities by an external force is likely to be prohibitively high because of the high incentives of individual users to shirk or of the community members to collude against the use rules. Privatization is not always superior to community resource management because poverty, dependence on the natural resources, and natural and environmental risks may make common property a more rational solution to problems of resource management (Runge 1992). McCarthy, Kamara, and Kirk (2001) argue that private property of communal rangelands will become optimal only when collective action is so poor that it becomes welfare-improving to appropriate land individually.

Collective action for natural resource management can also mitigate the negative influence of population pressure on natural resource management as predicted by the Malthusian perspective. In the presence of collective action, institutional and organizational development, and the development of infrastructure, population pressure is more likely to have a positive effect on natural resources than in the absence of these developments (Pender 2001). Moreover, 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 organizations to enforce them (Rasmussen and Meinzen-Dick 1995).

Hence, the solution to the problem of resource degradation in developing countries depends not only on appropriate technologies and efficient market prices but also on local-level institutions of resource management and the organizations to enforce them (Rasmussen and Meinzen-Dick 1995; Baland and Platteau 1996). Community resource management institutions and organizations are now receiving greater attention as a viable alternative to regulation by the state or privatization as a means of rectifying inefficiencies caused by attenuated property right systems, externalities, and other market failures.

However, devolving rights to local communities to help build institutions for common property management may not be a sufficient condition for sustainable use of such resources. Effectiveness in internal governance is needed for the effective application of community rules (Turner, Pearce, and Bateman 1994; Swallow and Bromley 1995). Hence, the need to identify factors that facilitate or hinder the development and effectiveness of local level institutions and organisations for natural resource management becomes important for developing policies to strengthen community resource management.

In Ethiopia, rural communities depend primarily on common property resources for irrigation water, construction material, fuelwood, and grazing land. Population pressure, market and government failures, and the absence or ineffectiveness of use regulations of common property resources have resulted in severe degradation of the resources (Stahl 1990; Gebremedhin 1998). Perhaps as a result, Ethiopia has been identified as the country with the most environmental problems in the Sahel belt (Hurni 1985).

After the 1974 revolution, increasing shortage of biomass for fuelwood and construction purposes resulted in emphasis given to rural afforestation and reforestation. Guided by Marxist ideology, the military government then favored state and social forestry, and individual tree planting efforts were undermined (Bruce, Hoben, and Rahmato 1994). Since 1991, the policies of the national and regional governments emphasized natural resource conservation as a key component of the agricultural development strategy. Unlike during the military government, decentralization of resource management has been encouraged. For example, in Tigray region, woodlot management has been devolved from community (*tabia,* which usually consists of four or five villages) level to village level to subvillage level and to individual farmers (Jagger, Pender, and Gebremedhin 2003). However, most of the woodlots in the region still remain under community management.

As part of the conservation-based agricultural development strategy pursued in the northern Ethiopian highlands of Tigray that is aimed at rehabilitating the degraded environment, several natural resource conservation and development efforts have been under way in the region, especially since 1991. These efforts include construction of soil and water conservation structures, area enclosures (areas closed from human and animal interference to allow natural regeneration with enrichment plantations), community woodlot development, community grazing land management, and the development of small-scale irrigation.

However, there is a scarcity of evidence regarding the factors that facilitate or hinder community resource management in the region. Empirical evidence on the determinants of collective action for natural resource management can provide useful guidance to policy makers in the region in their effort to enhance the effectiveness of community resource management efforts. The empirical results will also contribute to the growing literature and debate on collective action for natural resource management in developing countries.

This chapter provides evidence on the determinants of collective action for community woodlot and communal grazing land management in the highlands of Tigray. The chapter uses multivariate econometric methods to analyze the determinants of collective action and its effectiveness in managing woodlots and grazing lands.

Data

This study is based on a survey of 50 *tabias* (the lowest administrative unit in Tigray, comprising usually four or five villages) and 100 villages in the highlands[3] of Tigray in the 1998–99 cropping season, as part of the IFPRI/ILRI/Mekelle University research project on Policies for Sustainable Land Management in the Highlands of Tigray. Sample *tabias* were selected based on random sampling stratified by proximity to a market town and presence of an irrigation project. Within each *tabia,* two villages were selected randomly. A semistructured questionnaire was administered with representative individuals at both levels. Each interview involved 10 respondents chosen to represent different age groups (below 30 years of age, and older), villages (representation of each sample village), primary occupations (farming or off farm), and gender. The survey collected information about changes in agricultural and natural resource conditions between 1991 and 1998 and their causes and effects.

Community woodlots and grazing lands with use regulations are common in the highlands of Tigray. Almost 9 out of 10 *tabias* in the highlands of Tigray have woodlots (Table 10.1), and 90 percent of villages have restricted grazing areas[4] (Table 10.2). There are nine woodlots per *tabia* on average, and these average about 8 hectares in size; the average area of restricted grazing land per village was 38 hectares. Most of the woodlots were established since the fall of the military government in 1991. However, more than 58 percent of the restricted grazing areas were established before 1966, and only 17 percent were established after 1991. The establishment of most woodlots (95.5 percent) has been promoted by external organizations, usually the Tigray Regional Bureau of Agriculture and Natural Resources (TBoANR), while only 32 percent of the restricted grazing areas were promoted by external organizations and programs.

Whereas all restricted grazing lands were managed at the village level, woodlots were managed at both the village and *tabia* levels. *Tabia*-managed woodlots

Table 10.1 Characteristics of community woodlots: Means

Item	Village-managed	*Tabia*-managed	All woodlots
Percentage of *tabias* with a woodlot	57.7	29.9	87.6
	(8.1)	(7.2)	(5.8)
Number of woodlots per *tabia*	7.2	0.9	9.0
	(1.3)	(0.2)	(1.3)
Area of woodlots (hectares)	5.1	18.5	7.9
	(0.9)	(3.8)	(1.4)
Percentage of woodlots established since 1991	75.6	91.3	78.0
	(8.8)	(5.2)	(7.6)
Percentage of woodlots			
Promoted by a program or organization	94.6	98.7	95.5
	(3.8)	(1.4)	(3.0)
Promoted by BoANRD	76.5	91.4	79.5
	(8.7)	(7.4)	(7.2)
Promoted by REST	4.6	0.0	3.7
	(3.7)	(0.0)	(3.0)
Promoted by BoANRD and REST	4.8	7.3	5.3
	(4.6)	(7.2)	(3.9)
Promoted by World Vision	4.8	0.0	3.8
	(4.6)	(0.0)	(3.7)
Percentage of woodlots where users are:			
All *tabia* members	0.0	94.8	19.6
	(0.0)	(5.3)	(6.4)
Only village members	100.0	0.0	79.1
	(0.0)	(0.0)	(6.4)
Only the guard	0.0	5.2	1.1
	(0.0)	(5.3)	(1.1)

Note: Standard errors in parentheses. Means and standard errors are corrected for sampling stratification and weights.

Table 10.2 Characteristics and allowed uses of restricted grazing areas

Item	Village level	Grazing area level
Percentage of villages with restricted grazing lands	89 (0.0096)	
Number of restricted grazing lands per village	3.98 (0.16)	
Average area of restricted grazing lands (hectares)	38.2 (3.61)	10.45 (1.11)
Average age of restricted grazing land		23 (0.8)
Percentage of grazing lands promoted by external organizations		32 (3.5)
Value of community contribution for grazing land management (birr)		
Value per grazing land		1,580 (615)
Value per hectare		300 (60)
Value per household		3.66 (0.85)
Allowed uses of restricted grazing lands (percent)		
Cutting grass		22 (3.0)
Fuelwood collection		53 (3.4)
Collecting dung		90 (2.1)
Collecting fruits		66 (3.3)
Beekeeping		60 (3.2)
Cutting trees		0 (0.0)

Note: Standard errors in parentheses. Means and standard errors are corrected for sampling stratification and weights.

tend to be larger than village-managed woodlots, averaging more than 18 hectares in size compared to about 5 hectares for village woodlots (Table 10.1). The most common use allowed on woodlots is to cut and collect grass for animal feed, roof materials, or other purposes. Collecting fruits and beekeeping in woodlots are also commonly allowed. These uses are more common on village-managed than *tabia*-managed woodlots. In restricted grazing areas, in addition to grazing animals, fuelwood and dung collection and beekeeping are commonly allowed uses. Cutting and collecting grass was also practiced in 22 percent of the restricted grazing areas. Cutting trees, shrubs, branches, or roots and collecting fuelwood, barks, leaves, or dung are not allowed in woodlots. In a few cases animals are allowed to graze in the woodlot, but only during a drought.

Almost all woodlots and most grazing areas are protected by a guard paid in cash or in kind. In some cases, the guard is compensated by being allowed to collect grass from the woodlot or grazing area. It is more common for the local community to hire the guard for village-managed than for *tabia*-managed woodlots. In 77 percent of the restricted grazing lands, village residents contributed cash or in kind for guard payment.

The most common violations of restrictions of woodlots and grazing lands reported in 1998 were cutting grass and grazing animals when not allowed. Cutting of trees or branches were also frequently reported violations on woodlots. Violations are more common on *tabia*-managed than village-managed woodlots.

Given the limited allowed uses of the woodlots, the benefits received are, not surprisingly, small. Of 164 village-managed woodlots in our sample, benefits were reported being received in 1998 from only 57 woodlots, mainly from cutting grass. Fewer than half of the households in the villages benefited from grass cutting on average, and the average estimated value of benefit was 2,783 EB per woodlot in 1998, only about 2 EB per capita in the villages where benefits were received. The benefits from *tabia*-managed woodlots are even lower, averaging only 352 EB per woodlot, less than 0.10 EB per capita. In the case of restricted grazing areas, 42 percent of households were reported to have benefited from grazing animals in 1998. Other benefits of grazing lands to rural households include cutting grass for feed and other purposes, collecting dung, and collecting fuelwood from dead trees.

Villages are pursuing a more intensive strategy of woodlot management than *tabias.* Labor for tree planting, constructing soil and water conservation structures, weeding, and harrowing are the main collective input, averaging 0.18 person-days per capita for village-managed woodlots and 0.13 person-days per capita for *tabia*-managed woodlots. Village woodlots are also planted much more densely than *tabia* woodlots. The average survival rate is somewhat higher for *tabia* woodlots, but in view of the differences in planting densities, the number of surviving trees per hectare is still much higher on village woodlots. Considering the average returns per capita reported above, the average return per person-day invested in 1998 was about 10 EB for village-managed woodlots (comparable to the daily wage rate in rural Tigray) but less than 1 EB for *tabia*-managed woodlots.

The main benefit of a woodlot is not likely the value of grass collected but rather the value of the trees in the woodlot, a nonliquidated capital gain. The most commonly planted trees in community woodlots are eucalyptus trees (especially globulus and camaldulensis). The average price of eucalyptus poles in the highlands of Tigray was about 28 EB per pole in 1998 (Jagger and Pender 2003). On the basis of the average planting density (about 4,500 trees per hectare) and survival rate (64 percent), a woodlot of average-sized eucalyptus trees would be worth more than 80,000 EB per hectare on average, and much more in places where wood is very scarce. With an average of more than 70 hectares of woodlots per *tabia* (nine woodlots averaging almost 8 hectares each), this represents a substantial contribution to the wealth of communities in Tigray (averaging more than 5 million EB per community). Thus, despite the limited amount of current benefits that people are receiving from community woodlots in Tigray, community members are generally satisfied that they will benefit from them eventually. Only a small fraction of communities report uncertainty about future benefits as a problem, although the problem is more commonly reported for *tabia*-managed than village-managed woodlots. In almost all cases, community members reported that the condition of the area where the woodlot or the restricted grazing lands were established had improved substantially as a result of the protection and investment in developing the resources. Only a few communities reported a problem of increasing pressure on other lands as a result of the protection of woodlots or grazing lands.

Empirical Approach

When community resource users are able to negotiate among themselves to set rules of access, when cost of monitoring compliance or violations is not very high, and when noncooperation would lead to nonprovision, rational individuals will tend to voluntarily comply with rules of restrained access, thus paving the way to the development of collection action. Analysis of individual incentives to contribute to collective action for common property resource management has been the most dominant economic approach to the study of the determinants and effectiveness of collective action (Baland and Platteau 1999; Agrawal 2001; Varughese and Ostrom 2001). Underlying these incentives is the perceived distribution of benefits and costs, which may in turn be influenced by factors related to the nature of the resource, the characteristics of the community, the interrelationships between the community and the resource, the external environment such as the role of external programs and organizations, and access to markets (Agrawal 2001).

Hence, in this study, factors related to the number and characteristics of community members (by facilitating or hindering trust and cooperation), the external environment (through the effect of the involvement of external organizations and programs or access to markets on costs and benefits of collective action), importance of the resource for livelihood, and community experience in establishing and managing local organizations are considered important determinants of collective action and its effectiveness for woodlot and grazing land management.[5]

The indicators of collective action and effectiveness in managing woodlots used in the econometric analysis include the amount of uncompensated collective labor per hectare invested, whether the community pays for a guard to protect the woodlot, whether there were any violations of the restrictions on use of the woodlot, the number of trees planted per hectare on the woodlot since its establishment, and the survival rate of the trees planted. In the case of grazing lands, we used area of restricted[6] grazing land per household in the village, whether communities pay for a guard to protect the grazing land, the monetary value of contribution per household for grazing land management, whether communities established penalty systems for violations of use restrictions, and whether violations of use rules and regulations occurred in 1998, as indicators of collective action.

Community members may respond to noncooperation by cooperating to increase each other's incentive to cooperate or through exhortation and penalties. Thus, establishment of a penalty system is used as an indicator of collective action.

Violations of use restrictions and regulations are used as an indicator of failure of collective action.

The type of regression model used depends on the nature of the dependent variable. We use a Tobit model to explain collective labor investment and survival rate in the case of woodlots, and area of restricted grazing land per household and monetary household contribution per hectare in the case of grazing lands, because these variables are censored. We use binary probit models to explain whether the community pays for a guard, whether there were violations of restrictions in woodlots or grazing lands, and whether the community established a penalty system in the case of grazing lands, because these are binary variables. We use least-squares regressions for tree planting density because this variable is continuous.

The factors used to explain variations in collective action and its effectiveness in managing woodlots include population density, access to market, involvement of external organizations or programs in the establishment of woodlot, whether the woodlot is managed at the village or *tabia* level, and the area of the woodlot. The factors used to explain differences in collective action in managing grazing lands include the number of total households in a village,[7] heterogeneity in ox ownership by the community, community experience in running local organizations, distance to market, involvement of external organizations or programs in establishing the restricted grazing land, whether cattle production is the second most important source of livelihood in a community, and the total area of the community.

At low levels of population, the demand for collective action to manage community resources may be low, and the organizational costs of attaining it high, because of fixed costs. As population grows, increasing resource scarcity will increase the benefits of improved resource management, whether through collective action or development of private property. This may induce increased collective action, particularly if economies of scale or high exclusion costs favor collective over private management. However, as population grows to very high levels, the gains from collective action may be outweighed by the incentive problems associated with it, as rising scarcity increases the benefits from attempting to "free-ride" on the efforts of others or lowers the per capita benefits of cooperating. Thus, there may be an "inverse-U relation" between collective action and population, with higher levels and effectiveness of collective action at intermediate population than at very low or very high population (Pender and Scherr 2002).

The effect of market access on collective action for community resource management is ambiguous. On one hand, having better access to markets increases the value of resources and thus the value of managing resources well, which may favor collective action. On the other hand, better market access may tend to undermine individuals' incentives to cooperate by increasing the opportunity cost of labor or by offering more "exit" options, making it more difficult to punish those who fail to cooperate (Bardham 1993; Baland and Platteau 1996; Pender and Scherr 2002). The presence of external organizations or programs may favor collective action for community resource management when those organizations are seeking to provide complementary inputs to local collective inputs but may undermine collective action if external organizations are providing substitutes for collective action or otherwise undermining collective action (Pender and Scherr 2002).

We expect that collective action will be more prevalent and more effective for village-managed woodlots than for *tabia*-managed woodlots because villages are smaller, more cohesive, and a more stable unit than *tabias* (e.g., the *tabias* were reorganized in 1995 to include more villages). We were not able to test for the effect of level of management on collective action for grazing land management because all restricted grazing lands were managed at the village level. To the extent that economies of scale are important in favoring collective action (for example, in protecting the woodlot), we expect that collective action should be greater and more effective on larger woodlots.

The effect of heterogeneity on collective action is unresolved because communities may be heterogeneous in several aspects including sociocultural background, interests, and endowments, and each of these aspects may affect collective action differently (Baland and Platteau 1996; Baland and Platteau 1999). The conditions under which certain aspects of heterogeneity enhance or undermine collective action also remains unknown (Varughese and Ostrom 2001). In this study, we considered heterogeneity in terms of ox ownership in the community. We hypothesize that heterogeneity in ox ownership may undermine collective action for grazing land management because of possible divergence of interests in and perceived benefits from use of the grazing lands. We measured heterogeneity by the coefficient of variation of the distribution of the proportion of households with no oxen, one ox, two oxen, and more than two oxen.

Experience with local organizations should favor collective action because of possible learning effects, and the effect of social capital on the costs or community ability to enforce collective action (Rasmussen and Meinzen-Dick 1995; Baland and Platteau 1996; Pender and Scherr 2002). Up to ten different local organizations operate in the study area. Not all communities have all the local organizations. We measured differences in community experience with local organizations by the number of local organizations operating in a given community and expect that higher experience with local organizations will favor collective action for grazing land management.

Communities that depend on a common property resource for livelihood and are likely to use the resource over a long time horizon may be more likely to self-organize to manage the resource collectively (Varughese and Ostrom 2001). The primary source of livelihood for rural communities in the study area is cereal crops production. Communities showed differences in their second most important source of livelihood. We include a dummy variable representing whether the second most important livelihood source in a given community is cattle rearing. We expect that where cattle rearing is an important livelihood strategy, collective action for grazing land management will be more likely.

We include dummy variables for the different zones of Tigray to proxy for differences in agroclimatic potential, as well as other differences between these zones (e.g., differences in enforcement of restrictions on woodlots by zonal and *woreda* authorities), for both woodlots and grazing lands. The Southern and Western zones generally have higher potential as a result of better soils, higher rainfall, and irrigation. We include population density and population density squared for woodlots, and population and population squared for grazing lands to test for an inverted-U-shaped relationship between population density and collective action. Market access is represented by distance to the *woreda* (district) town, which is usually where farmers market their produce and purchase inputs. The effect of external organizational presence is investigated by including a dummy variable indicating whether the woodlot or restricted grazing land was promoted by an external organization. Another dummy variable reflects whether the woodlot is village-managed or *tabia*-managed. Finally, the size of the woodlot is included to investigate whether there are economies (or diseconomies) of scale in woodlot protection and management. In the case of grazing lands, we include area of village to test if collective action in grazing land management is higher in villages that have wider total area.

Results

Woodlots

The econometric results for the determinants of collective action for woodlot management are presented in Table 10.3. We find that the intensity of management of woodlots (labor input, community contribution to protection, and planting density) is lowest in the Central zone of Tigray, but survival rate is the highest in this zone (controlling for other differences between zones). This suggests that a less intensive approach to woodlots is being pursued in the Central zone but that this can be consistent with higher survival rates (though lower density of surviving trees), probably because of less competition among trees in the less densely planted woodlots for water, sunlight, and nutrients. Community labor input is also lower in the Eastern zone than in the Southern zone, but community contributions to protecting woodlots are greater, leading to fewer violations of restrictions and higher survival rates. Thus, the approach to community woodlots in the Eastern

Table 10.3 Determinants of collective action and its effectiveness on community woodlots, 1998

Explanatory variable	Collective labor input (person-days/hectare)	Whether community pays for guard	Whether any violations of restrictions occurred	Number of trees planted per hectare	Survival rate of planted trees (%)
Central zone (cf. Southern zone)	–1,541.292**	–1.258*	–0.437	–11,374**	18.03*
Eastern zone (cf. Southern zone)	–928.882**	1.060*	–1.509***	2,288	17.50*
Western zone (cf. Southern zone)	–1,442.685	0.363	–1.029	6,853	5.24
1994 population density (persons/km^2)	36.545**	0.0110	–0.0122	–249.3**	0.0085
1994 population density squared	–0.1023**	–0.0000601	0.0000387	0.693**	–0.000255
Distance to *woreda* town (kilometers)	16.0929**	–0.00462	–0.00623	241.5**	0.350***
Woodlot promoted by external organization	1,148.053	–1.286***	0.0870	5,505	–5.573***
Woodlot managed by village (cf. managed by *tabia*)	–615.094	0.668	–0.158	5,114	7.712
Area of woodlot (hectares)	–28.1209	–0.0122	0.00500	–278.3	0.426
Intercept	–3,639.085**	0.842	0.900	12,067	38.95**
Type of regression	Tobit	Probit	Probit	Least-squares	Tobit
R^2/pseudo-R^2	0.231[a]	0.273[b]	0.136[b]	0.525	0.436[a]
Number of positive observations/total observations	66/223	110/219	53/219	76/76	73/76[c]

Note: All regression results are corrected for sampling stratification and sampling weights, and standard errors are robust to heteroskedasticity and nonindependence within the primary sampling units (*tabias*).

*****, **, * indicate significance levels at 1 percent, 5 percent, and 10 percent, respectively.**

[a] R^2 for least-squares regression on the same data.

[b] Pseudo-R^2 values.

[c] Planting density and survival data were not collected for all woodlots in the sample.

zone appears to be oriented toward less labor intensity of management but greater effort to protect the trees, with a favorable effect on tree survival. We find no statistically significant differences in tree management, protection, or survival between the Western and Southern zones.

We find that the labor intensity of woodlot management is positively associated with population density but negatively associated with population density squared, consistent with the hypothesis of an inverse U-shaped relationship between population density and collective action. The turning point in this relationship (where maximum predicted collective labor input occurs) is at 179 persons per square kilometer, well within the range of population density observed in Tigray (the range in our sample is from 39 to 302 persons per square kilometer).[8] The magnitude of the effect is also substantial: an increase of population density from 40 to 50 persons per square kilometer would increase predicted labor input per hectare by 273 labor days (much more than the average labor input per hectare on woodlots, which is 164 labor days per hectare).

Other indicators of collective action and its effectiveness, including whether the community pays for a guard, violations of restrictions, and survival rate of trees, also show a relationship consistent with the inverted-U hypothesis (with the signs of the coefficients reversed for violations of restrictions), though these relationships are statistically insignificant. Unexpectedly, there is a statistically significant U-shaped relationship between planting density and population density, with planting density first falling and later rising as population density increases (the turning point is at 180 persons per square kilometer). It may be that lower planting density at moderate population density is a result of collective action; that is, a decision by communities to not overexploit the woodlot area by restricting the planting density. If this is the case, then this relationship also supports the hypothesis of an inverse-U relationship between collective action and population density. However, this is only an ex post hypothesis to explain a result that we did not expect, and further research would be needed to confirm or reject this hypothesis.

With regard to market access, we find that communities that are more remote provide greater collective labor input, plant trees more densely, and obtain higher survival rates. These results are both statistically and quantitatively significant: being 10 kilometers further from the *woreda* town increases predicted labor input by 16 labor days per hectare (10 percent of average labor input), predicted planting density by 2,400 trees per hectare, and tree survival by 3.5 percentage points. These findings are consistent with the argument that improved market access undermines collective action by increasing labor opportunity costs and/or giving people more "exit" options from the community.

The presence of external organizations, as indicated by whether the woodlot was promoted by an external organization (usually the TBoANRD), has a negative association with whether the community pays for a guard and with tree survival. The negative association with community payment for a guard is probably because external organizations often pay for the guard, reducing the need for this aspect of collective action. This is similar to results found by Pender and Scherr (2002) in Honduras, where external government organizations were found to displace local collective action. The negative association of external promotion with tree survival suggests that external programs may not be achieving full participation of local communities in promoting woodlots. Part of the problem may be that local communities often prefer to plant eucalyptus, which survive well and grow rapidly under the uncertain rainfall of Tigray, whereas external organizations sometimes promote other species that may be less hearty or less preferred by local households (Jagger and Pender 2003).

Contrary to our expectations, we did not find that collective action was significantly greater or more effective on village-managed woodlots than on *tabia*-managed woodlots, after controlling for other factors. This may be because the differences in benefits, community stability, or cohesiveness between the *tabia* level and the village level are relatively small, and other factors such as population density, market access, or external organizations may be more responsible for the differences in collective action found on different woodlots. The area of the woodlot also had a statistically insignificant effect on our measures of collective management of woodlots and its effectiveness. This suggests that economies or diseconomies of scale in woodlot management are weak.

Grazing Lands

The results of econometric analysis are presented in Table 10.4. We find that the Western zone has the least area of restricted grazing lands per household, 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 also have less area of restricted grazing lands per household compared with the Southern zone. However, communities in the Central zone are more likely to pay for guards and establish penalty systems for violations of use restrictions, and communities in the Eastern zone are less likely to violate use restrictions and are more likely to establish penalty systems than those in the Southern zone, suggesting that in areas where collective action for grazing land management is not easily established, it can nevertheless succeed once the hurdle of establishment is overcome.

Table 10.4 Determinants of collective action for grazing land management, 1998

Explanatory variable	Area of restricted grazing land per household	Whether community pays for guard	Average value of household contribution for grazing land management	If community established penalty system	If violations of use restrictions and regulations occurred in 1998
Central zone (cf. Southern zone)	–0.169***	1.017***	2.126	1.002*	–0.254
Eastern zone (cf. Southern zone)	–0.115**	0.073	–2.757	0.978*	–1.214***
Western zone (cf. Southern zone)	–0.259***	0.0173	2.000	0.053	0.153
Total number of households in village (average of 1991 and 1998)	–0.00038	0.033***	0.009	–0.0046	–0.00495*
Total number of households in village squared	0.000000065	–0.0000372***	–0.00001	0.000006*	0.0000067**
If restricted grazing area was promoted by external organization	–1.888***	3.380	0.249	0.076	
Distance to nearest market town (walking time in minutes)	–0.000034	0.0078***	0.006	0.005**	0.0016
If cattle rearing is second most important livelihood source	0.0237	–0.255	0.585	0.031	–0.231
Total number of local organizations operating in village	–0.0037	–5.375**	1.906**	1.591*	–1.502*
Heterogeneity of ox ownership in community	–0.029	–0.481	–25.708	2.816	3.713*
Total area of community	0.0015***	–0.0067	0.0639	0.0068	–0.0036
Intercept	0.218	–3.873*	–9.845	–0.3812	0.248
Type of regression	Tobit	Probit	Tobit	Probit	Probit
Number of positive observations/total observations	74/100	119/154	161/225	210/231	62/237

Note: All regression results were corrected for sampling stratification and weights, and standard errors are robust to heteroskedasticity and nonindependence within the primary sampling units (*tabias*).

*****, **, * indicate significance levels at 1 percent, 5 percent, and 10 percent, respectively.**

Communities are more likely to pay for guards at intermediate population than at low or very high total population. The turning point in this relationship (where maximum probability of communities paying for guards occurs) is 450 households per village, well within the range of total number of households per village and very close to the average number of households per village.[9] We also find that violations of use restrictions are least likely to occur at intermediate population (368 households per village). These results of the effect of population on collective action for grazing land management are consistent with the hypothesis of an inverse-U-shape relationship between population and collective action.

The involvement of external organizations in promoting restricted grazing areas reduced the likelihood of communities paying for guards, suggesting that the need for communities to pay for guards is eliminated by the payment made by the external organizations. Involvement of external organizations has a positive (but statistically insignificant) effect on household contributions for grazing land management.

Communities with greater presence of local organizations make higher contributions per household for grazing land management, are more likely to establish a penalty system, and are less likely to have violations of use restrictions and regulations. These results are consistent with the hypothesis that collective action for natural resource management may be higher and more effective in communities that have higher social capital. However, we also find a negative effect of experience with local organizations on the likelihood of communities paying for a guard. Perhaps a guard is less necessary in communities with greater investment in such local social capital.

Communities that are more distant from markets are more likely to pay for guards and establish a penalty system for grazing land management, suggesting that more distant communities have a higher need for restricted grazing lands and that collective action may be more likely because of lower opportunity cost of labor or limited exit options in such areas. These results suggest that in areas closer to markets, alternative management options such as private management of grazing lands may be a better option.

Whether or not cattle rearing is a second most important source of livelihood in a community failed to affect any of the indicators of collective action significantly. This may be because cereal crops production is the first most important source of livelihood in all communities, and cattle rearing is considered only as supplementary to crop production.

Heterogeneity in ox ownership tends to detract from collective action for grazing land management, perhaps because of divergence in interest or benefits received from restricted grazing lands. Heterogeneity increases the likelihood of violations of use restrictions and regulations (an indicator of failure of collective action). Heterogeneity was also associated with less household contribution for grazing land management, but that correlation was statistically insignificant. Communities with larger total area have higher area of restricted grazing land, as expected.

A possible explanation for the weak influence of some of the explanatory variables is that there may be multicollinearity among the explanatory variables. We tested for problems of multicollinearity in the regressions of woodlots and grazing lands and found potential problems only between population density and population density squared, and between the total number of households in village and its squared value. We have retained these variables because they were necessary to test the hypothesized inverted-U-shaped relationship. Moreover, omitting one of these variables could result in omitted variable bias, given their significance in several of the regressions.

Conclusions and Implications

Collective action in managing woodlots and grazing lands generally functions well in the highlands of Tigray. Despite the fact that community benefits from woodlots in 1998 were limited as a result of various restrictions on use, the woodlots contribute substantially to community wealth. Community members remain generally satisfied with the woodlots as a reserve of natural capital. Farmers perceive that developing and enforcing use rules and regulations for grazing land management results in significant regeneration of the grazing lands, and the conditions of the area under community woodlot management have improved significantly.

Benefits from woodlots were greater, and reported problems of management lower, on woodlots managed at the village level compared to the higher municipality level. Communities that manage woodlots at the village level applied greater labor inputs, planted much more densely, hired guards more often, and reported violations of restrictions less often. All restricted grazing lands are managed at the village level and remain enforced once established. Community members contribute to woodlot and grazing land management through cash, in kind, or through uncompensated labor contributions.

We found support for the hypothesis of an inverted-U-shape relationship between population density and collective action for woodlot management. We also found evidence for an inverse-U-shape relationship between population level and collective action for grazing land management. Collective action is higher and more effective at intermediate population density or level.

Market access detracted from collective action for woodlot and grazing land management, probably by increasing opportunity cost of labor and/or providing more exit options to rural communities. Involvement of external organization was associated with lower tree survival rate in woodlots and reduced the need for community contributions for protecting woodlots and grazing lands.

Experience in organizing and running local organizations encourages collective action for grazing land management, perhaps because learning effects of managing cooperative effort or social capital helps to reduce the cost of attaining and enforcing collective action. Heterogeneity in ox ownership appears to decrease collective action for grazing land management, perhaps because of divergence in interest or in benefits received from restricted grazing lands.

Our findings support the role of community resource management in redressing resource degradation. The results suggest that community resource management can be an effective means of redressing resource degradation and increasing community wealth. The results also imply that community resource management may be more effective and beneficial if conducted at the most local level and if involvement of external organizations is demand driven and complementary to local initiatives. Collective action for community resource management is likely to be more effective in areas with intermediate population that are far from market places and have higher social capital. In areas of greater market access and high population density, privately oriented approaches to resource management may be more effective.

Appendix 1: Summary Statistics of Variables Used in Regressions for Woodlot Management

Variable	Number of observations	Mean	Standard error	Minimum	Maximum
Labor days per hectare	223	164.76	65.90	0	10,800
Whether community hires a guard	223	0.490	0.092	0	1
Whether violations of restrictions occurred	223	0.228	0.054	0	1
Number of trees planted per hectare	80	4,453	1,837	333	51,750
Tree survival rate (percent)	80	63.7	5.1	0	97.5
Southern zone	233	0.141	0.049	0	1
Central zone	233	0.423	0.100	0	1
Eastern zone	233	0.397	0.100	0	1
Western zone	233	0.039	0.019	0	1
1994 population density (per square kilometer)	225	154.9	14.7	39.5	301.7
Distance to *woreda* town (kilometers)	229	27.6	5.0	0	87
Woodlot promoted by external organization	227	0.949	0.233	0	1
Woodlot managed by village (versus managed by *tabia*)	227	0.799	0.063	0	1
Area of woodlot (hectares)	227	7.76	1.34	0.13	100

Note: Means and standard errors are corrected for sampling stratification and weights.

Appendix 2: Summary Statistics of Variables Used in Regressions for Grazing Land Management

Variable	Number of observations	Mean	Standard error	Minimum	Maximum
Whether village has restricted grazing area	100	0.89	0.050	0	1
Area of restricted grazing area per household (hectares)	100	0.067	0.015	0	1.916
Whether community pays for guard	154	0.72	0.042	0	1
Average household contribution for grazing land management (Birr)	226	3.661	0.852	0	63.157
Whether village established penalties	231	0.97	0.008	0	1
Whether violations occurred	229	0.35	0.036	0	1
Eastern zone	231	0.23	0.047	0	1
Southern zone	231	0.30	0.050	0	1
Western zone	231	0.13	0.038	0	1
Central zone	231	0.32	0.053	0	1
Households per village	100	410	20.62	85	1,050
Walking distance from village to nearest *woreda* town (minutes)	231	200	8.04	10	720
If grazing land promoted by external organization	231	0.31	0.035	0	1
If cattle rearing is second most important livelihood source	231	0.68	0.053	0	1
Number of local organizations operating in village	231	4.1	0.124	1	6
Heterogeneity of ox ownership (coefficient of variation)	231	0.25	0.007	0.10	0.45
Area of community (square kilometers)	231	62.08	4.78	12.3	179

Note: Means and standard errors are corrected for sampling weights and stratification.

Notes

1. Common property resources are defined as those resources that are owned and possibly managed by a given community. They are contrasted with open access resources, which have no defined owner.

2. Collective action is defined as action taken by a group (either directly or on its behalf through an organization) to achieve a common objective, when the outcome depends on interdependence of members.

3. Highlands are defined as those areas above 1,500 meters above sea level.

4. All villages in the highlands have some type of communal grazing lands, including restricted and unrestricted.

5. The history of land tenure and redistributions is similar throughout the region. Hence, no variables of local histories of land allocation and tenure were included in the regressions.

6. Every village has communal grazing lands. Some communities organize rules and regulations to use and manage part of the community grazing lands. We used the area of the community grazing land used according to community rules and regulations as indicator of collection action.

7. Total number of households was used instead of population density because all restricted grazing lands were managed at the village level, for which we did not have area data.

8. Summary statistics of the variables used in the regressions are presented in Appendix 1.

9. Total number of households per village in the study area ranged from 85 to 1,050 with an average value of 410. Summary statistics of variables used in the regressions are presented in Appendix 2.