Does Gender Influence Forest Management?: Exploring Cases from East Africa and Latin America

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Abstract
The influence of gendered relationships on access to forests and on forest sustainability remains a concern for scholars and practitioners. This paper presents a comparative study of forest management across four countries in East Africa and Latin America: Kenya, Uganda, Bolivia and Mexico. It focuses on one question: Do varying proportions of women (low, mixed, high) in forest user groups influence their likelihood of adopting forest resource enhancing behavior? We found that higher proportions of females in user groups, and especially user groups dominated by females, perform less well than mixed groups or male dominated ones. We suggest that these differences may be related to three factors: gender biases in technology access and dissemination, a labor constraint faced by women and a possible limitation to women's sanctioning authority. Mixed female and male groups offer an avenue for exploiting the strengths of women and men, while tempering their individual shortcomings.

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1. Introduction

The influence of gendered relationships on access to forests and on forest sustainability remains a concern for scholars and practitioners. Approaches to forest management the world over have undergone profound changes: from central state control prior to the 70s through the community-based approaches of the 80s and the devolution of the recent 90s. Women's involvement in decision making has hardly kept pace with the earlier changes (See Bina Agrawal's in literature review) and they don't seem to fare any better under devolution programs (Jumbe and Angelsen, 2007). The need for understanding this continued lack of involvement is acute as women continue to be among the poorest in many developing countries, and their dependence on forest resources for subsistence, as safety nets and for incomes will assume even greater importance as they face new challenges due to increasing global interconnectedness and climate change.

This paper presents a comparative study that spans these different phases and approaches to forest management across four countries in East Africa and Latin America: Kenya, Uganda, Bolivia and Mexico. We focus on one question: Do varying proportions of women (low, mixed, high) in forest user groups influence their likelihood of adopting forest resource enhancing behavior? Forest enhancing behaviors include a range of activities, from the adoption of technologies that reduce forest dependence (eg bee-keeping) to the adoption of management techniques that seek to improve forest condition (eg planting tree seedlings), to regular monitoring and sanctioning that regulates harvesting levels, to conflict management that increases the possibility of individuals following rules.

These four countries represent a range of settings of the extent to which authority has been devolved and in the length of time that each has officially experimented with devolution programs. timing of such devolving reforms. Kenya is a newcomer to devolution and represents the most centralized forest management of the four countries. Mexico, an early decentralizer has had the longest experience in devolving to communities, while Uganda and Bolivia both of who devolved to intermediate levels between the community and the state, undertook their reforms in the 1990s. So the purpose of this paper, which is part of a broader study on decentralization and its gendered impacts in these four countries, is to explore the behavior of predominantly female vs mixed vs predominantly male user groups with regard to forest management. We find some evidence of a gendered effect. Holding other factors constant, predominantly female groups are less likely to adopt technologies and engage in practices that enhance forest condition, unlike predominantly male groups who are more likely. There appears to be no significant differences in the incidence of conflict in user groups.

Section 2 presents a literature review; Section 3 describes the methodology and data structure; Section 4 describes the user groups, their activities, their resource rights and presents the results of descriptive statistics on gendered differences in property rights and governance arrangements; section 5 discusses the empirical model and section 6 discusses the regression results. Section 7 concludes the paper.

1. Overview of relevant literature

Much has been written on the critical variables that influence sustainability. In a cross-examination of path-breaking research on resource sustainability, Agrawal (2001) argues that critical factors affecting sustainable resource use include: resource characteristics, nature of the group that manages resources (eg size, heterogeneity and poverty), institutional arrangements under which resources are managed (eg rules, norms, strategies) and the external environment. These four sets of variables have been demonstrated, across a broad range of resource types, to affect the incentives of individuals and groups, influencing their behavior to undertake (or not) actions that may (or not) enhance resource productivity and sustainability. He suggests the relationship between sustainability and the external environment, in the form of market influences, technology, demographic change and articulation with different levels of governance, has been underemphasized. Elements of resource characteristics such as riskiness, unpredictability and mobility have also not been adequately addressed, while the effects of group characteristics is yet to be resolved. Methodologically, the large numbers of case studies, which offer important insights into processes and interactions among resource users, have been inadequate in fleshing out the magnitude of the effects of multiple drivers, an important dimension in public policy making and priority setting of policy interventions. Comparative case studies and large N studies offer an avenue for exploring causality and for making generalizable conclusions. Still, even though case studies may have difficulties with attributing impact, they often yield nuances and insights that cannot be generated by quantitative techniques.

The following brief sweep of the literature follows the four dimensions of Agrawal's (2001) review of critical variables affecting resource sustainability, and maps out the relevant relationships and mechanisms through which those dimensions affect sustainability. The review is limited in two ways: it focuses on forest resources and it does not exhaustively explore all the relationships and variables that are thought to influence sustainability.

In a study across 12 countries in Africa, Asia and Latin America Gibson et al. (2005) hypothesized that where resource users regularly monitor and sanction resource use the condition of forest resources, or more specifically, the commercial and subsistence values of forests as perceived by both users and forest authorities, will likely be better than where rules are not enforced. Enforcement develops trust among individual users that other users are complying with agreed rules and that no individual is gaining advantage over others. Taking into account the levels of cooperation among users, their level of formal organization and their dependence on the forest resource, the study demonstrates that rule enforcement is positively and strongly associated with forest condition, and that it is in fact more important than other institutional variables in influencing forest condition. It is a necessary condition for successful resource management.

The importance of monitoring and enforcement is demonstrated by in-depth case studies of forests in Uganda's Mpigi District (Banana and Gombya-Ssembajjwe, 2000). Here, different indicators of forest condition (eg species richness, tree density and cover) and

disturbance (eg pit sawing, charcoal burning) varied across different property regimes. While government forests were generally more likely to be degraded than private forests, some government forests were in just as good condition as the relatively smaller private forests. Despite the clear and well-defined boundaries of the government forest reserves, the forests are large, with long boundaries and hence difficult to effectively monitor. Because a poorly resourced forest authority is incapable of equipping and motivating its officials, resource users can easily circumvent rules, and harvest indiscriminately. On the other hand, the private forest is small and well monitored by the owner, whose farm hands double up as guards. Though equally as large as the others, the government forest that is in relatively good condition is an exemplar of cooperation between management authorities and a relatively isolated minority pygmy community that lives within the forest (and is permitted use) and monitors harvesting levels and schedules. The inaccessibility of this forest, with only one road passing through is a subsidiary factor.

The above study flags one more governance variables that are critical to resource management: property rights and tenure security. At the time of the study, most government forests were under strict centralized regimes that did not recognize the resource rights of communities, and which relied on excessively punitive measures to enforce compliance with rules. Nonetheless, like Gibson et al (2005), Banana and Gombya-Ssembajjwe (2000 p 96) argue that the critical factor for sustainability is enforcement: "Regardless of the *de jure* property regime, all forests can be *de facto* open-access regimes if there are no effective institutions and mechanisms to enforce the rules." In a follow up quantitative study, seven years later (which captures the forest decentralization reforms), the authors affirm the primacy of enforcement, but also suggest that biophysical characteristics of the resource, market integration, and forest dependence of forest adjacent and forest-distant communities are of increasing importance in forest sustainability. They conjecture that over the longer term, forest condition is likely to be a function of how and whether local institutions and governance can adapt to a changing internal and external environment (Banana et al., 2007).

Agrawal and Chattre (2006) argue that an emphasis on institutions and governance in the evaluation of forest sustainability tends to overestimate their importance. Biophysical factors such as tree species composition, elevation, aspect and rainfall were observed to overwhelm the significance of economic pressures, institutions (enforcement, duration, co-management) demographic pressures and gender relations (equitability of power positions between men and women, incidence of gender-related conflict) in influencing forest condition in an analysis of cross sectional data from 95 sites in Himachal Pradesh, India. While all the factors in the estimation remain significant, the coefficients of the biophysical factors are on average higher than those of other factors. The authors argue that even though there is little scope to influence the character of the biophysical factors estimated in their model, a systematic evaluation of the magnitude of their relative effects provides a more realistic picture of the strength of other factors, which in turn can help decision makers more objectively understand the limits of their interventions. It is worth noting that this study also attempted to incorporate gender-related variables in the analysis. The involvement of women in decision making positions pays dividends in enhanced forest condition. Because women are most involved in the collection of forest

products, they have intimate knowledge and are better placed to craft appropriate regulatory mechanisms. However, the involvement of women in decision making is not without struggle; often they are included after resource condition deteriorates to such an extent of scarcity that they demand to be part of the governance structure.

It is generally recognized that forests are important for the poor, majority of who are women, and who often do not own land but do use forest resources for subsistence, as safety nets and even to generate modest incomes. It is also generally agreed that women are critical actors in the management of forest resources. Most gender related studies on forest sustainability, which would fall under the rubric of group characteristics in Agrawal's (2001) typology of factors, are dominated by studies from India and Nepal, that have focused on analyzing the impacts of community forestry. Relative participation of men and women in various capacities of decision making have been the key items under study. Agarwal (1997, 2001, 2003) observes that women are often excluded from participation for various reasons including: the rules governing the comunity forestry groups, social barriers stemming from cultural constructions of gender roles, responsibilities and expected behaviour, logistical barriers relating to the timings and length of organizational meetings, and male bias in the attitudes of those promoting community forestry initiatives. As an example, the rules of forest closure, designed to regenerate deteriorating forests often ban entry of both humans and animals. This places a disproportionate burden on women, who have a daily responsibility for cooking fuel and tending cattle (Agarwal, 2007). In an earlier study Sarin (1995 cited in Agarwal, 2007) found that women's firewood collection time and distances traveled increased from 1-2 hours to 4-5 hours, and from half a km to 8-9, often prompting some women to break the rules.

Despite these constraints, however, these community forestry groupings have performed well in regenerating degraded forest lands (Agarwal, 2000). In fact, a recent study showed a significant improvement in forest quality, especially where women are involved in the Executive Committee of the Community Forest User Groups (Agrawal, 2007). Their involvemet in the EC enhances women's overall sense of involvement in the CFGs and improves women's general knowledge and information about CFG rules and activties. Similar work by Agrawal et al (2004) finds that womens' participation has substantial positive effects on regulating illicit grazing and felling, even after controlling for the effects of a range of independent variables that included. Bina Agarwal's studies thus suggests that a gender analysis is necessary in the evaluation of human-forest interactions and argues that while rules and their enforcement are critical drivers of forest sustainability, the same rules, norms and perceptions (in addition to personal and household endowments) can depress the relative contribution of especially women in community forestry. In addition to this, the security of women's property rights and access to forest and tree resources serve as an important incentive for their adopting resource conserving measures (Meinzen-Dick et al, 1997). Thus an attention to gender differences in property rights can also improve the outcomes of natural resource management policies and projects in terms of efficiency, environmental sustainability, equity, and empowerment of resource users. Although it is impossible to generalize across cultures and resources, it is important to identify the nature of rights to land, trees,

and water held by women and men, and how they are acquired and transmitted from one user to another.

It is worth reiterating that institutional factors do not operate on their own. Womens' participation in forestry in the Black Sea region of Turkey is conditioned by forest dependence, quality of cooperatives, quality of forest organization and quality of forest, which in total explained 58% of the variation in participation. However, levels of participation varied according to age and wealth levels. In other cases in India, levels of participation among women are constrained by caste considerations (Davidson-Hunt, 1996).

But what is it about women that makes for improved outcomes in their presence? Part of this gender difference arises from the fact that women, as the main and most frequent collectors of forest products, are more familiar with the forest than men (Agarwal, 1997). In addition, because they are the ones responsible for feeding the family they are most likely to be burdened by deteriorating forest condition and thus have a tendency to want to conserve and/or to reduce pressure on forest resources in order to avoid/mitigate hardship. In addition men are largely involved in timber extraction and have less frequent involvement in forests, unlike women who use products e.g. firewood, NTFP and are more likely to be in the forest more often, which is an aid to monitoring (Pandolfelli et al, 2007). Thus women tend to be better at the day to day monitoring and even subtle sanctioning, and men at the bigger but less frequent enforcement. Women living around the Olokemiji forest reserve in Nigeria tend to adopt practices that lower pressures on forests such as the cultivation of less nutrient-demanding crops such as cassava and yam, and using environmentally-friendly farming systems such as terracing and taungya (Gbadegesin, 1996). Similarly, village women from Nigeria's Cross River State, successfully resisted men's alienation of large forest blocks from whose ranges they gather many non-timber forest products (NTFPs) that constitute the bulk of their families' means of subsistence and income generation (Johnson, 2003).

Westermann et al. (2005) analyzed 46 groups in 20 countries and concluded that collaboration, solidarity and the capacity to manage conflicts increases in groups where women are present. The authors suggest that this solidarity and cooperation is derived from norms of reciprocity that have developed due to work responsibilities that rely on frequent collaboration. Mackenzie (1995), however, warns against assuming a necessary and complementary relationship between women and sustainability as these may be limited/constrained by the existing strucure of incentives such as limited control over land, labor and technology.

The preceding account highlights the relevance of Agrawal's (2001) four factors critical for enhancing resource sustainability across settings. It emphasizes the importance of rules enforcement and monitoring but observes that biphysical factors are particularly critical in influencing forest condition. In addition, gender relations as a subset of group characteristics are of increasing importance and may interact with rules and norms to either enhance or depress sustainability. Our study explores the implications of gender composition in user groups on forest sustainability, and does so across forest sites in

countries in East Africa and Latin America. In particular, we focus on intermediate behaviors that are in turn theorized to influence sustainability outcomes. We hypothesize that predominantly female and mixed user groups are likely to have less conflict, more likely to adopt technologies and management practices, including monitoring, that reduce pressures on forests and enhance forest condition.

2. Methodology

2.1. Data collection

This study is part of a global, multi-disciplinary team, the International Forest Resources and Institutions research program (www.indiana.edu/~ifri/network.htm). The IFRI research protocol was used to collect data from forest sites, from settlements around each forest and from among user groups and local organizations involved in forest management. Using a set of 10 standardized instruments, quantitative and qualitative data were collected about institutional arrangements, the incentives of different participants, and their activities. Focus group discussions and key informant interviews were used to obtain the information on forest user group characteristics, on their activities, on property rights and governance structures. Resource characteristics such as slope steepness were estimated.

3.2 Data Structure

Our data covers Kenya and Uganda in East Africa and Bolivia and Mexico in Latin America. We have 22 forest sites in Uganda, 12 in Kenya, 18 sites in Bolivia and 4 in Mexico (Table 1), for a total of56 sites.

Table 2 provides a more detailed listing of the sites and forests visited. Out of the 56 sites, some have only one forest reserve, but some sites have more than one forest reserve, for a total of 67 forests. An IFRI forest is an area of at least .5 ha containing woody vegetation exploited by at least three households and governed by the same legal structure. The first visits in each of these 67 forests were conducted between 1993 and 2003. Out of the 67 forests, 36 were in East Africa, 13 of which had been visited twice. Site revisits often occur in 3-5 year intervals. 31 of the 67 forest reserves are in Latin America, and were visited only once. So total in sample we have 13 forests (out of 67) which were re-visited, and all of these 13 forests are located in either Uganda or Kenya.
The unit of our analysis is user groups. A user group is group of people who harvest from, use, and maintain a forest and who share the same rights and duties to products from a forest; may or may not be formally organized

Our main interest is in whether and how gender composition of the group may influence behavior (i.e whether groups adopt resource conserving behavior, or rules etc) and how that in turn influences forest condition. There are one or more user groups in each forest. Each user group harvests one one or more forest products, such as timber, water, firewood, etc.

We classified user groups in the 13 forests in East African that were visited twice, into three groups. Group one comprises user groups that existed in two visits, which accounted for a very small proportion of the 13 forests (about 20%Group two. Group two comprises user groups that existed in our first visit, but were not present in follow-up visits. These groups were amajority, accounting 50% of user groups within the 13 forests. Group three comprises those user groups that did not exist in the first visit, but were present in the second. The two types of groups make up a big portion in our data (about 80%). In other words, forest revisits in East Africa did not reinterview those groups that were interviewed in the first visit. For the rest of 54 forests (out of 67 forests), we have one-time observations. In summary, only 4% of the user groups in our (20% out of 13 forests) forest reserves were visited twice.

We pooled together all user groups from the four countries for a total of 181 observations, and then deleted observations of the user groups that were visited twice and whose names appeared twice in the sample. at the 2nd visit whenever this user group's name appears twice in our sample[3]. We call this subsample "ONE" sample and we total have 171 observations for our user groups. We use this sub-sample for our main analysis[4].

3. Descriptive Statistics

4.1. Forest Resources

The size of the forests varied a lot, from the minimum 20.8 hectare in Kenya to 44,900 hectares in Bolivia (Table 3).[5] The smallest size of the forests Kenya, Uganda, and Bolivia is less than 100 hectares, but in Uganda, the largest forest is 220 times the size of the smallest forest; in Kenya, the largest forest is 700 times the smallest forest; in Bolivia, the multiplier is about 1000 times. The distribution of the size of forest in Mexico is smoother, with the largest forest less than 10 times the smallest ones.

Among our 155 valid observations for the forests, about 30% are small (less than 200 hectare), about 30% are middle size (between 200 hectare and 1500 hectares), the rest of 40% are either big (between 1,500 hectare and 10,000 hectares) or extra large size (larger than 10,000 hectares). For Uganda and Kenya, the small size and medium size (less than 1,500 hectare) forest account for 77% and 50% of sites, respectively; for Mexico, they account for 100%, but for Bolivia, only 25% of forests are less than 1500 hectares. The average forest size is the largest in Bolivia, which is the double the size of the forest in

[3] For some user groups (e.g., the user groups in the Bufuma forest and Kapkwai forest in Uganda), even though they were visited twice, we only have information of the 2nd visits, so we keep them in our subsample.

[4] Later in the regression analysis, we will use another subsample for comparing, in which we drop all the observations from the 2nd visit and remain with 143 observations.

[5] Most (about 90%) of the 13 forests which were visited twice remained the same size for two visits, but 10% have different sizes in two visits. For example, in site Namungo at Uganda, the size of first visit to Lwamunda Forest Reserve is 1,000 hectare, but the size shrunk to 40 hectare four years later in the 2nd visit.

Kenya, four times the size of forest in Uganda, and sixteen times of the size of the forest in Mexico.

The topography varied among four countries. In Uganda and Bolivia, most of the forest land (about two-thirds) were mostly flat or rolling terrain; while in Kenya and Mexico, most of the forest land (more than 90%) have either steep or primary steep slopes.

4.2. Forest Resource Rights

Examining rights over forest resources needs to consider multiple aspects of rights, especially in the context of devolution. One level is the statutory (*de jure*) "ownership" of the land or forests themselves. But this does not tell the full story. It is equally (if not more) important to consider who holds different types of use rights to the forest, which are often specific to different forest products. And because rights become meaningless without enforcement, we consider both external and internal enforcement mechanisms.

We classified the legal owners of the forest land into five types: national government, local government, villages, other multiple types of ownership and private ownership (Table 4). Uganda has two extremes: the majority (87%) of the forest land belonged to the national government, the rest to private individuals or families. In Kenya, all forest land belongs to national government. So in Africa, the forest land was more centralized. In Latin America, the forest land was more decentralized and we have more diverse ownership: more than half of the forest land was owned by different types of local communities in either Bolivia or Mexico.

Ownership of the underlying land does not necessarily imply that only the owner can use forest resources. Rights to use the resources range from open access to restricted use. We identified a forest as being under open access whenever one of the following conditions apply: anyone can use the forest; anyone who is a citizen of the country; or anyone who is a citizen of the state or district. Any restrictions or rules related to the forest entry besides the above three (e.g. if access is limited to those living in a nearby village or to members of a particular group) are classified as "no open access". In Africa, over 80% of the forests reported open, but the rate of open access to forests is only 57% for Bolivia and and 24% for Mexico.

Most (two-thirds) of the forests' users have the rights to harvest all of the forest products from their forests.[6] The rate is highest in Uganda (90%) and lowest in Kenya (30%), with Bolivia and Mexico in the middle (70% to 80%). The low user rights in Kenya is perhaps not surprising because all forest land is owned by the government but Uganda also has 87% of the sample forests under government ownership, This implies even if the forest

[6] In the 13 forests which were visited twice, about 80% of their rights remained same through the two visits, but a few of them did change during the period of the two visits. For example, in Uganda, the owner of Kajjonde forest reserve in site Mityana had right to harvest forest products in 1999, but not in 2002; on the opposite side, the owner of Mukasa cultural forest in site Katebo did not have right to harvest in 1994, this right was reported in the second visit of 2000.

land belonged to the same type of national government, the specific content of the rights differ.

We also looked at the external enforcement for each forest, classified into four types: (1) forest-specific governmental organization, (2) other government organization, (3) community-based organization, and (4) private organization external to the forest. The first category includes forestry agencies of the national, state, district, or local government. Other government organizations includes an aid agency of a foreign government and a nonforestry agency of a national, state, district, or local government. Community-based organizations are local forest-specific formal or informal organization or firm (including nonprofit private organization). Private organization external to the forest is for-profit national/multinational firm or nonprofit private national/multinational organization. Since the forest sizes varied, we standardized the external enforcement entities into number of organizations per 1,000 hectares. Table 5 shows the number of organizations of each type is around five on average for all four countries. For Uganda, the country had many community-based entities, but fewer forest-specific government organizations and private organization in their forests. Kenya is the opposite: very few community-based organizations, but many forest-specific government organizations and private organization. Bolivia had a relatively balanced number of organizations for each category. Mexico had a large number of community-based organizations but very a small number of forest-specific government organizations.

4.3 User Groups Activities

4.3.1 General condition of user groups

A user group is defined here as a group of people who harvest from, use, and maintain a forest and who share the same rights and duties to products from a forest; they may or may not be formally organized.

There is diversity in the occupations of user group members. The groups might be composed of family members, housewives, pit sawyers, illegal harvesters, fishermen, (selling fish as well as trading), subsistence or commercial farmers. Some of user groups were full-time cultivators who own agricultural lands (growing food crops or cash crops, some with cattle), while others did not own land, house, or grow crops.

There is also variety in the gender composition of user groups. Some groups were female only, for example, a group of housewives, or a group of housewives, daughter, and female relatives. Some groups were male only, while others were mixed gender, e.g. a group of men, women and children, or men and children (with both gender), or women and children (with both gender). Table 6 shows that Uganda and Kenya had more gender-segregated groups, with about one third composed of only men, and 6 to 16% of groups all-female. Bolivia and Mexico had more mixed groups and no women's only groups, and no more than 10% all-men's groups. On average, all-female user groups accounts for very small proportion of our total sample.

The products the user groups collected from the forests included animals, food, fuelwood, craft materials (for example, palm leaves), water, bamboo, charcoal, etc. Some groups collected forest products for domestic use. For example, women collected dead wood in the form of branch mainly as firewood for own domestic use, male groups extract bamboo for constructing own homes, hunters hunting wild animals for food and clothing. Some groups collect forest product for commercial use, such as to sell timber or bamboo, or charcoal .

The user groups were formed at different time periods. The earliest was formed around 1400, while others were formed as recently as 2000. Some of user groups have lived in the forests for generations and think the forest belonged to them from the very beginning, long before the colonists came, and they are true residents of the forest. This view was prevalent in Mexico and Kenya. We divided the forest formed year into four periods: very old (formed before 1900), old (formed between 1900 and 1950), not old (formed between 1950 and 1980), and recent (after 1980). For four countries together we found that each of the first two category accounts for 22%, and each of the last two category accounts for 28%.

A lot of the user groups are either forest habitants or permanent settlers, that either lived in or next to the forest permanently. About 35% of our user-groups lived within 1 kilometer from the forest (e.g. on the slope of the forest, or settled from middle-hill to the ridge of the undulating hill). About half of the user groups (about 55%) between one to five kilometers from the forest (e.g. in the villages bordering the forest reserve). Only 5% of the user groups lived between five and ten kilometers from the forest and another 5% lived more than 10 kilometers from the forest. The latter were probably newcomers living in urban centers near the forest, or a few fishermen coming in and going.

The size of the user groups varied from less than ten individuals (in Uganda, Kenya or Bolivia) to more than 20,000 individuals (in both Kenya and Mexico).

4.3.2. The relation between the user groups and the forest

On average about 70% of households in the user groups depended significantly on the forests for their own subsistence, but the extent of dependence varies according to the forest product (Table 7). The major products that user groups harvest from forests are fodder, fuel wood, timber, biomass and food. Fuel wood and timber are the two most frequently harvested products from the forests . Sixty user groups (about 39%) and forty user groups (about 26%) gather all their needs for fuel wood and timber from forests, respectively. On average, user groups got 60% of their fuel wood and 44% of timber from the forest, respectively.

Not a lot of user groups got their fodder or food from forest: 66 user groups (about one half) and 49 user groups (about one third) did not get any fodder and food from forests, respectively. These dragged the mean level of fodder and food collection from forest down to 29% and 18%, respectively. The use of biomass from the forest is the lowest

among these five products, with less than 20% of user-groups reporting any collection of biomass.

About 90% of user groups had to share harvests from the forest with other user groups. Most (73%) do not limit other communal people from harvesting forest products.

The user right for the forest product is product specific (Table 8). For the trees, bushes, grasses, about half of user groups reported they had rights to harvest these products, even though they sometimes just collected them without direct harvesting. About one third of user groups did not have the right to harvest them, even though they sometimes harvested these products.

For leaves (either on ground or climbing leaves), about 30% of the user groups had the right to collect them when harvested, and about 40% of the user groups had the right to collect even when not harvested.

Almost all (about 96%) of user groups had right to use water in the forest. By contrast, use rights for wildlife are the lowest of all forest products. When the wild animals were not harvested, only 6% of user groups had the right to obtain them; even when wild animals were harvested, only 30% of user groups had right to obtain them.

4.3.3 Exploring gendered differences in property rights, governance and conflict

Table 5 shows that Latin America has no female only groups, while East Africa has some. We thus decided to run our analyses of gender differences separately in order to take into account this apparent difference between the two continents. Based on the distribution of male/female proportions we also categorized the user groups into three groups: predominantly female groups where the proportion of females was greater than 66% of the members in a user group, mixed groups where proportion of females was between 33-66% and predominantly male groups where the proportion of females was less than 33% in a user group.

In East Africa, predominantly female groups and mixed groups are more likely to have rights to harvest trees, than predominantly male and mixed groups, while mixed groups are more likely to harvest bushes than either predominantly female and predominantly male groups (Table 9). Predominantly female groups are more likely to harvest leaves than the other two groups. All groups appear equally likely to have rights to harvest grass, climbing leaves, water and wildlife. In Latin America on the other hand, there was no apparent differentiation in rights to all the products: both mixed and predominantly male groups were equally likely to have rights (Table 10). However, all predominantly male groups reported that they had rights to harvest bushes, grass, ground leaves, climbing leaves and water. While slightly more mixed groups indicated they had rights to harvest trees and wildlife. These differences were not significant.

With regard to governance arrangements, mixed groups in East Africa were more likely to monitor and sanction than were predominantly male and predominantly female groups (Table 11). Predominantly female groups did not regularly monitor their members' forest

activities. Mixed groups and predominantly male groups are more likely to undertake regular monitoring than predominantly female. Though not significant across the three categories, predominantly female groups were least likely to engage in forest improvement activities or in the adoption of technologies that would improve forest productivity. Mixed groups were least likely to undertake regeneration, though this is not significant. Predominantly female groups reported about half the level of conflicts as predominantly male groups ad mixed groups; this was however not significant.
In Latin America on the other hand, predominantly male groups are more likely to engage in rule making and management than mixed groups (Table 12). They are also more likely to have conflicts.

Thus a look at descriptive analysis suggests that even though user groups with higher proportions of women may tend to have less conflict, they are less likely to engage in regular monitoring of the forest resource and also unlikely to engage in various activities and technologies that enhance the forest's overall productivity or condition. We explore this further in the next section, where we include other factors that the literature identified as important in affecting resource sustainability.

4. Empirical Model

5.1 The Dependent Variables

We use four dependent variables to approximate user group behavior. These include the implementation of monitoring and sanctioning activities, the undertaking of management activities, the adoption of forest improvement technologies, and the incidence of conflicts. All these four variables are described below :

- Monitoring and sanctioning: 1= regular monitoring and sanctioning (year round or seasonally), 0=otherwise.
- Regeneration activities: 1=Whether user groups undertake any of the following regeneration actitivities regularly i.e. at least once a year: plant seedlings, trees, bushes, built fences and clear undergrowth.
- Technology: 1=Whether individuals in the user group undertook any of the following technologies to improve the productivity of the forest: adopting improved bee-keeping techniques, planting seedlings that alter species mix or other technologies.
- Conflict: 1= Whether individuals faced any issues that have engendered conflict within the user group.

5.2 The Model

Ordered Probit model is used for our regressions. Let's take monitoring and sanctioning as an example. Let y_i * stands for the true value of monitoring and sanctioning engaged by user group i resided, and our latent regression is as following (Greene, 2000):

$$y_i^* = \beta' x_i + \varepsilon_i \tag{1}$$

β is a vector of coefficients we are going to estimate, x_i is the vector of our explanatory variables for the user group i and ε_i is the vector of normally distributed residual terms with $E(\varepsilon_i) = 0$.

Since y_i^* is unobserved, and what we observed is the regularity with which user groups monitor the forest, which we use symbol y_i :

$y_i = 0$ if the true monitoring value is substantially below normal ($y_i^* \leq 0$),
$y_i = 1$ if the true monitoring value is below normal ($0 < y_i^* \leq \mu_1$),
$y_i = 2$ if the true monitoring value is normal ($\mu_1 < y_i^* \leq \mu_2$),
$y_i = 3$ if the true monitoring value is above normal ($\mu_2 < y_i^* \leq \mu_3$)
$y_i = 4$ if the true monitoring value is substantially above normal ($\mu_3 \leq y_i^*$)

The $\mu_1, \mu_2,\ \mu_3$ are the unknown parameters to be estimated together with coefficient vector β (we have $0 < \mu_1 < \mu_2 < \mu_3$). We have the following probabilities:

$$\Pr ob(y=0) = \int_{-\infty}^{-\beta' x} \frac{1}{\sqrt{2\pi}} e^{\frac{t^2}{2}} dt$$

$$\Pr ob(y=1) = \int_{-\infty}^{(\mu_1 - \beta' x)} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt - \int_{-\infty}^{-\beta' x} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt$$

$$\Pr ob(y=2) = \int_{-\infty}^{(\mu_2 - \beta' x)} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt - \int_{-\infty}^{(\mu_1 - \beta' x)} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt$$

$$\Pr ob(y=3) = \int_{-\infty}^{(\mu_3 - \beta' x)} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt - \int_{-\infty}^{(\mu_2 - \beta' x)} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt$$

$$\Pr ob(y=4) = 1 - \int_{-\infty}^{(\mu_3 - \beta' x)} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt \tag{2}$$

5.3 The Explanatory Variables

We include three types of explanatory variables: resource characteristics, user group characteristics, and governance arrangements. Definitions of the variables are given in Table 13.

The resource characteristics include the (log of) size of the forest area (in hectares) and a categorical variable for topography, which ranges from flat to steep topography. As indicated on Table 1, the size of the forest varied a lot in all of the four countries. Both

the largest size and smallest size forests were owned by the national government (both in Bolivia).
The characteristics of the user groups include the distance that users live from the forest, the log of user group membership size, a dummy variable for wealth heterogeneity, proportion of female members, proportion of literate members, and duration of the user group's existence (log of years since formation). The majority of the user groups lived either in the forests or close to the forests. The size of the user groups varied enormously, from a couple of members to thousands of members, with an average of 766 members. About 41% of the user groups thought there was large wealth difference among them. On average, 37% of the members of the user groups are female. The average literacy rate of group members is 61%. The mean of the user group duration is 75 years, but this average is skewed by one very old user group, as discussed above.

The relationship of the group with the forest owner is indicated by a dummy variable with a value of 1 if the forest owner is a member of the user group; 0 otherwise. Very few (14%) of the user groups included the owner of the forest. Finally, two property rights variables are included among the group characteristics. Property rights of the user groups are indicated by a dummy variable that equals 1 if the group has the right to harvest trees from the forest. Property rights of others are indicated by another dummy variable with a value of 1 if there are other groups sharing the forest. About 58% of the user groups had the right to harvest trees from the forest, either directly or by collecting but obtained from the forest. About 90% of the user groups reported that other user groups also had the right to harvest forest product from their own forest.

Governance arrangements include formal ownership of the forest land, external enforcement institutions, exclusion rules, and property rights of the forest owners. Forest ownership is designated by a series of dummy variables for ownership by the national government, local government, village, other multiple ownership, and private ownership. About 68% of the forests belong to the national government, about 8% belong to the local government and another 8% belong to the villages and settlements, 5% belong to the private individuals and families, and 1% belong to other types of multiple ownerships.

External enforcement includes four categories of external organizations that may be involved in enforcing forest rules: government forestry-related organizations, other government organizations, community-based, and private organizations. We standardized external enforcements into total number of organizations per 1,000 hectares of the forest land, and the average value is about five organizations of each type per 1,000 hectare of the forest land.

The presence of exclusion rules or open access is designated by a dummy variable with a value of 1 if the forest has open access to local residents. About 70% of the forests reported open access to the local residents on average. Finally, property rights of the owner is designated by a dummy variable with a value of 1 if the owner has the right to harvest produce. Two-thirds of the forest owners had the rights to harvest all of the forest products.

5. Results and Discussions

The following sections provide an interpretation of the regression results presented in Table 14.

6.1. Technology

Female dominated user groups are less likely to adopt forest improving technologies relative to the male dominated ones. In fact the probability of investing in new technology is reduced by 25% for female dominated user groups than for male dominated ones. In forests characterized by steeper topography, or where government organizations are more and community and private forest interests are fewer, user groups tend to adopt technologies that tend to improve forest productivity such as adopting improved bee-keeping techniques, planting seedlings that alter species mixes. In addition, user groups using forests owned by national government (as opposed to local governments) tend to adopt such technologies. User groups in Latin America are more likely to invest in new technology as compared with user groups in Africa.

6.2 Regeneration

This variable sought to examine the regularity with which user groups undertook activities aimed at regenerating the forest such as planting tree seedlings and bushes, clearing undergrowth or constructing fences. Regression results indicate that gender does not seem to affect the regularity with which user groups undertook regeneration activities in the forest, even though mixed and male dominated groups had higher reporting of regular monitoring and sanctioning. However, there are significant differences across East Africa and Latin America, with user groups in the latter being more likely to undertake regeneration activities in their forests.

6.3 Monitoring and sanctioning

With regard to gender, mixed groups tend to do more monitoring than male-dominated ones and female-dominated ones. The female-dominated ones are unlikely to conduct any monitoring at all. Where forest topographies are steeper, user groups are more likely to monitor forest resources, as when there are more government organizations concerned with forestry. Private organizations however, tend to diminish user group monitoring. Older user groups that have been formed for longer are more likely to monitor forest resources regularly, while the further away user groups are from the forest, the less likely they are to undertake forest monitoring. Property rights also influences the likelihood of monitoring: user groups in forests owned by local government are less likely to monitor than those in government forests, while private ownership increases the likelihood of monitoring. Differences in wealth also tend to improve the likelihood of forest monitoring, while user groups in Latin America are more likely to monitor than those in East Africa.

6.4 Conflicts

Gender factor does not seem to affect the incidence of conflicts in user groups. An increasing number of community organizations reduces the probability of conflicts

among user groups, while the presence of forest based organizations and government organizations tend to increase it. Paradoxically, conflicts have a higher probability where forest owners have the right to harvest forest products. In addition, wealth heterogeneity, forest size, and steep topography tend to increase the likelihood of conflicts among user groups. However, there is no regional difference in the incidence of conflict among user groups.

The above results, especially with regard to gender, consistently depart from our earlier theoretically-driven expectations. We had anticipated that higher proportions of women in user groups would increase the likelihood of such user groups adopting governance arrangements and technologies that are in turn expected to improve resource sustainability. There are several possible ways to start to understand this puzzle.

First, a broad literature on natural resources management in developing countries suggests that extension work; the main means through which new technologies are disseminated to rural populations is gender biased (Knox et al, 2002; Doss and Morris, 2001). In recent work in Ethiopia for example, German et al (2008) found that female-headed households had never been visited by agricultural extension officers, unlike male farmers who do get regular visitations. Traditionally forest management has been associated with timber, a product of commercial value that is often traded in markets largely by males. It would this not be surprising if forest extension officials were biased towards males. In addition, many technologies that remove pressure from forests such as bee keeping and seedling planting require the purchasing of equipment, including the seedlings themselves. Without support, women, whose incomes are generally low are disadvantaged in the uptake of such technologies. It is thus unsurprising that predominantly women's user groups are less likely to adopt such technologies.

Second, even though statistically insignificant, predominantly women's groups reported less incidences of undertaking regeneration activities such as tree planting or clearing undergrowth, than predominantly male and mixed groups. While a similar explanation as above can be extended to this problem (i.e. tree planting is a technology for which information and inputs are necessary), it can also be hypothesized that some of these activities are labor intensive and require time to implement. Increasing the survival rates of seedlings requires regular monitoring, including frequent watering, the application of manure and protection from birds and other animals. It is unlikely that women, who are already engaged in productive and reproductive activities, will have the necessary time and labor to spare for this additional activity.

Third, the same labor constraint hypothesis may well apply in any account that seeks to explain why predominantly female user groups perform poorly in monitoring and sanctioning than do mixed and predominantly male groups. Alternatively, it may reflect a gendered disparity in whose authority counts in sanctioning infractions or even that women prefer not to jeopardize their social networks through sanctioning since they may be more dependent on these networks than men (Pandolfelli, pers comm, 8th July, 2008).

Fourth, while conflict appears insignificant across our three categories, the descriptive analysis does suggest that a higher proportion of women in user groups does depress the incidence of conflict in user groups. This result is consistent with Westermann et al (2005) who demonstrate that women are more likely to have stronger norms of solidarity given their tendency to cooperate in other spheres of their lives.

Finally, it is unclear why there exists a differential in women's participation between the two Latin American countries and the East African ones. Bolivia and Mexico had no women's only groups, while East Africa had a few. In both regions however, the older forest user groups had a higher proportion of females than the newer ones, which may suggest some as yet unknown barriers to entry that may relax as the user group matures.

6. Conclusion

We began this exploration by asking one question: whether varying proportions of women (low, mixed, high) in forest user groups may influence their likelihood of adopting forest resource enhancing behavior across four countries in Africa and Latin America. A review of the literature answers this question in the affirmative and suggests that because women are more dependent on forest resources, spend more time in the forest, and have built strong norms of cooperation, they are more likely to display behaviors (eg governance arrangements and technology adoption) that in the ultimate positively affect forest sustainability. The literature also suggests other critical factors that may influence resource sustainability and decision making such as resource characteristics, human capital, external organizations, and property rights. We accounted for these factors in our analysis in order to assist us in fleshing out the magnitude and direction of our gender variable. We found that higher proportions of females in user groups, and especially user groups dominated by females, perform less well than mixed groups or male dominated ones. We have suggested that these differences may have to do with gender biases in technology access and dissemination, with a labor constraint faced by women who are at once a source of labor in family farms and the providers/care givers of families and with a possible limit in their sanctioning authority. The descriptive analyses suggest a high dependence on forest for subsistence and incomes by a population of users who largely live in close proximity to the forests.

What kinds of lessons can we draw from this initial exploration? While we have raised several questions that require further analyses and verification, we can also suggest that mixed groups appear to offer an avenue for exploiting the strengths of women and men, while tempering their individual shortcomings. Mixed groups (which already exist) for example can take advantage of men's capacity to adopt new technologies and resource management and monitoring practices, while benefiting from women's capacities to manage conflict and enhance cooperation. Sultana and Thompson (2006) found that mixed-sex groups were more effective at monitoring than women's groups because men were able to patrol the fishponds at night when it was physically less safe for women to do so. This however does not detract from the obvious need to ensure that men and women in mixed groups engage in functional and effective partnerships that do not undermine the authority of either and that technologies be targeted at women in ways that

will facilitate their adoption. Importantly, in depth studies to better understand the transactions costs of such mixed groups are necessary (Pandolfelli et al, 2007).

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Table 1: Summary of sites, forests and visits per country

Country	Sites	Forests	Years	revisits
Uganda	22	24	1993-2002	10
Kenya	12	12	1997-2003	3
Bolivia	18	24	1994-2001	
Mexico	4	7	1997-2000	
	56	67		

Table 2: Sites and Forests visited

Country	Site Name	Forest name (NAME)	Visit Date	Visit time(s)
Uganda	Namungo	Lwamunda Forest Reserve	1993 and 1997	2
		Namungo's Forest	1993 and 1997	2
	Mbale	Mbale Forest Reserve	1993 (1st visit)	1
	Echuya	Echuya Forest Reserve	1993 and 1998	2
	Bukaleba	Bukaleba	1993 (1st visit)	1
	Butto-buvuma	Butto-buvuma	1994 and 2000	2
	Mpanga	Mpanga Natural Reserve	1994 (1st visit)	1
	Ssisa	Mugomba.	1995 and 2000	2
	Kagezi	Lwamunda (B)	2001 (2nd visit)	1
	Mugalu	Mugalu Forest	1995 (1st visit)	1
	Gombe	Kizzikibi Forest Reserve	1994 (1st visit)	1
	Lukambagire	Lukambagire forest	1994 and 2002	2
	Kizikiio	Najjakulya forest	1995 (1st visit)	1
	Kwezi	Kyambogo Forest Reserve	1994 (1st visit)	1
	Mbarara	Rwoho	1999 and 2002	2
	Mityana	Kajjonde Forest Reserve	1999 and 2002	2
	Kitoba	Kyamugongo Forest Reserve	1995 (1st visit)	1
	Sango Bay	Malabigambo	1995 (1st visit)	1
	Masaka	Jubiya Central Forest reserve.	1999 and 2002	2
	Kalangala	Busowe Forest Reserve.	2000 (1st visit)	1
		Kabunja Private Forest.	2000 (1st visit)	1
	Masaba	Bufuma Forest Reserve	2001 (2nd visit)	1
	Kapchorwa	Kapkwai	2001 (2nd visit)	1
	Kisamula-lugyo	Wangeregeze Forest Reserve	1997 and 2002	2
Subtotal	*22 sites*	*24 forests*		
Kenya	Chorlem	Mt. Elgon (Chorlem Block)	1997 and 2001	2
	Kimothon	Mt. Elgon (Kimothon Block)	1997 and 2002	2
	Kilimanjaro (Loitokitok)	Loitokitok (Kikelelwa Forest)	1998 and 2002	2
	Vanga	Vanga Mangrove Forest	2000	1
	West Mau (Londiani)	West Mau (Kedowa block)	2000	1
	Upper Imenti Forest	Upper imenti forest	2001	1
	Gathiuru Forest Block	Gathiuru forest	2001	1
	Ramogi Hill Forest	Got Ramogi	2001	1
	THIM LICH OHINGA	Thimlich Ohinga Forest	2002	1

	EBURRU	Eburu Forest	2002	1
	ABERDARE(Mikeu)	Aberdare (Wanjohi Block)	2002	1
	TUGEN HILLS FOREST	Katimok Block 3 - Tugen Hills Forest	2003	1
Subtotal	*12 sites*	*12 forests*		
Bolivia	El Huayco	El Huayco	1994	1
	Comunidad de Juntas	Belén Cruz	1994	1
	La Merced	La Merced	1994	1
	Corregimiento de Trinidadcito	Trinidadcito	1995	1
	Sitio de Chapis	Bosque de Chapis	1995	1
	Chiquiaca	Chiquiaca	1995	1
	Motovi	El Camotal	1995	1
		San Marcos	1995	1
	Comunidad Puerto San Lorenzo	Puerto San Lorenzo	1995	1
	Santa Rosa	Chipiriri	1995	1
		Santa Rosa	1995	1
	Copacabana del Chimita	Copacabana de Chimimita	1995	1
	San Miguelito	Monte Comunal 1 SB	1995	1
		San Miguelito del Isiboro	1995	1
	Misiones	Bosque Comunal	1996	1
		Bosque Familiar	1996	1
	Santa Anita	Bosque Comunal Santa Anita	1996	1
		Bosque Familiar Santa Anita	1996	1
		SANTA ANITA - GANADERO	1996	1
	La Emboscada, San Boroa, Beni	Bosque de la Embocada	2001	1
	Villa Aquiles	Bosque de Villa Aquiles	2001	1
	Lagunillas, SC	El Bosque de Lagunillas	2001	1
	San Juancito	Bosque de San Juancito	2001	1
	San Lorenzoma	San Lorenzoma Forest	2001	1
Subtotal	*18 sites*	*24 forests*		
Mexico	Capulalpam	Bosque de Silvicultura	1999	1
		Bosque Para El Uso Domestico	1999	1
		Refugio para Animales Silvestres	1999	1
	Ejido Cerro Prieto	Zona Amortiguamiento	1999	1
		Zona Nucleo	1999	1

	San Francisco Donaciano Ojeda	Donaciano Ojeda Forest	2000	1
	San Andres Huayapam	Huayapam Forest	2000	1
Subtotal	*4 sites*	*7 forests*		
Total	*56 sites*	*67 forests*		

Table 3: Size of the Forest (Unit is Hectare)

Country	Observations	Min.	Max	Mean	Std. Dev.
Uganda	59	40	9073	1950	2632
Kenya	50	20.8	14895	4209	5011
Bolivia	30	46	44900	8756	11600
Mexico	16	155.8	1500	515	516
Average of Four Countries	155	20.8	44900	3848	6576

Table 4: Legal Owner of the Land on Which the Forest is Located

Country	National Govt.	Local Govt.	Settlement(s) or Village(s)	Other Multiple Types of Ownership	Private Individual(s) or Family
Uganda	87%	0%	0%	0%	13%
Kenya	100%	0%	0%	0%	0%
Bolivia	30%	12%	31%	27%	0%
Mexico	0%	43%	14%	43%	0%
Average of Four Countries	69%	8%	7%	11%	5%

Table 5: External Enforcement (Mean of the # of Org. Per 1000 Hectare)

Country	Govt. Org.	Comm.Based Org.	Forest-specific Govt. Org.	Pri. Org. Ext. to Forest
Uganda	4.28	9.7	4.61	1.63
Kenya	1.93	0.41	10.6	4.76
Bolivia	10.89	4.63	6.44	9.49
Mexico	9.2	11.83	0.08	9.21
Average	4.71	5.72	6.62	4.71

Table 6: Gender Composition of User Group (unit is % of # of User Groups)

Country	All Male Group	Male Dominated	Female Dominated	All Female Group
Uganda	35%	15%	34%	16%
Kenya	35%	37%	22%	6%
Bolivia	9%	47%	44%	0%
Mexico	10%	37%	53%	0%
Average	27%	30%	35%	8%

Table 7: The quantity of supply from the forest (percentage of user group's needs)

Product	Total observation	Mean	Minimum	Frequency of Min.	Maximum	Frequency of Max.
Need for fodder	150	29%	0%	66	100%	11
Need for fuelwood	156	60%	0%	28	100%	60
Need for housing timber	156	44%	0%	49	100%	40
Need for biomass	150	6%	0%	120	100%	4
Need for food	140	18%	0%	45	100%	9

Table 8: User Rights of User-groups for the Forest Products (% of user-groups)

	If Harvested or Obtained		If Not Harvested or Obtained	
Product	**Has right to harvest this product**	**Does not have right to harvest this product**	**Has right to harvest this product**	**Does not have right to harvest this product**
Trees	59%	33%	0%	8%
Bushes	45%	28%	18%	9%
Grasses	53%	27%	9%	11%
On ground leaves	27%	18%	41%	14%
Climbing leaves	28%	20%	38%	14%
Water	86%	1%	10%	3%
Wildlife	30%	34%	6%	30%

Table 9. Property rights—East Africa
(percentage of groups in each category reporting they have a right to harvest)

Right to harvest	Predominantly Male	Mixed	Predominantly Female	Total
Trees	37.50	50.00*	64.29*	47.06
Bushes	39.58	70.59*	64.00*	52.22
Grass	47.92	61.11	52.17	51.69
Ground leaves	48.84	75.00*	76.19*	61.25
Climbing leaves	52.17	62.50	69.57	58.82
Water	98.08	100.00	95.65	97.73
Wildlife	23.08	33.33	0.00	19.54

*=significantly higher than other group(s)

Table 10. Property rights—Latin America
((percentage of groups in each category reporting they have a right to harvest)

Right to harvest	Predominantly Male	Mixed	Total
Trees	85.71	92.59	91.18
Bushes	100.00	95.45	96.30
Grass	100.00	88.00	90.32
Ground leaves	100.00	94.12	96.45
Climbing leaves	100	94.44	95.65
Water	100.00	91.67	93.33
Wildlife	83.33	87.50	86.67

*=significantly higher than other group(s)

Table 11. Governance--Africa
(percentage of groups in each category reporting they have certain practices)

Activity	Predominantly Male	Mixed	Predominantly Female	Total
Management	13.33	9.52	13.33	12.61
Other activities	25.00	28.58	10.00	21.62
Technologies	23.33	23.81	6.67	18.92
Rule enforcement	12.07	19.05	6.67	11.93
Monitoring	15.52*	28.57*	0.00	13.89
Leadership	16.95	9.52	17.86	15.74
Conflicts	37.93	30.00	17.24	30.84

*=significantly higher than other group(s)

Table 12. Governance—Latin America
(percentage of groups in each category reporting they have certain practices)

Activity	Predominantly Male	Mixed	Total
Management	84.62*	52.63	60.78
Other activities	23.08	28.95	27.45
Technologies	38.46	31.58	33.33
Rule enforcement	100.00*	60.00	70.83
Monitoring	53.85	34.29	39.58
Leadership	38.46	25.00	28.57
Conflicts	70.00*	37.84	44.68

*=significantly higher than other group(s)

Table 13: Definition of the Explanatory variables

Variable Name	Variable Definition
Resource characteristics	
Forest size	log form of forest size (unit of forest size in hectare)
Topography	topography of forest land-- 1=primary flat;2=mostly flat with some rolling terrain; 3=primarily rolling terrain; 4=mostly rolling terrain with some steep portions; 5=primarily steep
User group characteristics	
Distance	how far away do user groups live from forest. 1=within 1 km; 2=bt. 1km and 5km; 3=bt. 5km and 10km; 4=more than 10 km
Member size	log of user groups' size (group size is the total number of individuals in a user group)
Wealth heterogeneity	dummy, 1=there is large wealth difference among households in the user groups; 0=otherwise
Gender	proportion of female members in the user group
Human capital	proportion of the literate individuals in the user group
Duration of user group	log form of user groups' formed years
Governance Arrangements	
Ownership of the forest land	
Own_nat	dummy, 1=national govt.; 0=not national govt.
Own_loc	dummy, 1=local govt.; 0=not local govt.
Own_vil	dummy, 1=villages; 0=not villages
Own_mul	dummy, 1=other multiple ownerships; 0=not other ownerships
Own_pri	dummy, 1=private ownership; 0=not private ownership
External Enforcement	
Org_for	total number of forest-specific government organizations in the forest/1000 ha
Org_gov	total number of other government organizations in the forest/1000 ha
Org_com	total number of community based organizations in the forest/1000 ha
Org_pri	total number of private organizations external to the forest/1000 ha
Property rights	
Ownforest	dummy, 1=the user group includes the owner of the forest, if privately owned; 0=otherwise
Access rights	dummy: if the forest is open access to local resident-- 1=yes, open access; 0=no, no open access
Ownright	dummy, 1=legal owner of the forest has the right to

	harvest forest prod. ; 0=otherwise
Use rights	dummy, 1=the user group has the right to harvest trees from the forest; 0=otherwise
Use rights of other user groups	dummy, 1=other groups harvesting this forest; 0=otherwise

Table 14: Descriptive Statistics of Explanatory Variables

Variable Name	Definition	Observation	Mean	Minimum	Maximum
Resource characteristics					
Size	forest size (unit is hectares)	155	3848	20.8	44,900
Topography	forest topography	156	3.32	1	5
User group characteristics					
Distance	distance of user groups from forest	156	1.82	1	4
Msize	user group size	164	766	6	27,000
Wealthfid	wealth difference	160	0.41	0	1
Femalep	proportion of female members	162	0.37	0	1
Litper	proportion of the literate individuals	148	0.61	0	1
Duration	number of formed years of groups	135	75	0	599
Ownforest	user groups including forest owner	161	0.14	0	1
Uright	user group's right to harvest	142	0.58	0	1
Othug	other group's right to harvest	156	0.9	0	1
Governance Arrangements					
Own_nat	land owner is national govt.	164	0.68	0	1
Own_loc	land owner is local govt.	164	0.08	0	1
Own_vil	land owner is villages	164	0.08	0	1
Own_mul	land owner is other multiple owners	164	0.1	0	1
Own_pri	land owner is private	164	0.05	0	1
Org_for	forest-specific govt. organizations	126	6.62	0	73
Org_gov	other govt. organizations	137	4.71	0	87
Org_com	community-based organizations	126	5.72	0	100
Org_pri	private organizations	126	4.71	0	87
Access	open access	162	0.72	0	1
Ownright	forest owner's right to harvest	166	0.67	0	1

Table 15: Probit Estimates of User Group's Behavior

Independent Variables	New Technology		Regeneration		Monitoring		Co
	Coef.	Z Stat.	Coef.	Z Stat.	Coef.	Z Stat.	Coef.
Resource Characteristics							
Topography dummies (1=flat, …, 5=steep)	0.3562	1.70*	0.0151	0.08	1.1656	2.64***	0.8402
Log of forest size (hectare)	0.1037	0.48	0.2344	1.20	-0.2766	(-1.01)	0.4978
External Enforcement							
Government organizations (#/1,000 hectares)	0.2803	2.00**	0.1038	1.09	0.2951	1.71*	0.6837
Community-based organizations (#/hectares)	-0.1772	(-1.83)*	-0.0954	(-1.53)	0.0403	0.21	-0.5485
Forest specific organizations (#/hectares)	0.0828	1.17	0.0317	1.04	-0.2623	(-1.13)	0.0828
Private organizations (#/hectares)	-0.2145	(-1.65)*	-0.0159	-0.29	-0.3885	(-2.64)***	0.0544
Internal Enforcement							
dummy,local gov owned forest land (ref=nat. gov)	-2.3286	(-1.72)*	-0.9508	(-0.88)	-6.0826	(-2.34)**	.
dummy, village owned forest land (ref=nat. gov)	-1.1218	(-0.49)	.	.	1.1446	0.67	.
dummy, privately owned forest land (ref.=gov)	.	.	.	.	7.8989	2.24**	.
Forest level governance							
Forest owner have right to harvest product (1=yes)	0.2322	0.4	-0.4273	-0.75	0.0637	0.07	-1.0191
Other group harvest from this forest (1=yes)	-0.0976	(-0.10)	5.7037	1.45	.	.	.
User groups' characteristics							
Distance to forest (1=within 1km, …, 4=>10km)	0.5549	1.21	-0.0941	(-0.29)	-2.0641	(-2.48)**	-0.2181
Log of group size (num. of ind.)	0.0332	0.25	0.1425	1.11	-0.1204	(-0.76)	-0.1308

Age of the user group (years)	0.0053	0.03	0.0619	0.32	0.4778	1.69*	-0.1732
dummy, user group includes owner of forest (1=yes)	1.3782	1.21	.	.	.	.	.
User groups have right to harvest trees (1=yes)	0.4217	0.72	-0.1119	(-0.22)	-1.1218	(-1.33)	0.8117
wealth heterogeneity in the user groups (1=yes)	0.4507	1.14	0.1031	0.23	3.1551	2.63***	1.7537
Gender factor							
Mixed group dummy (ref=male dominated)	-0.8211	-1.44	-0.5436	-1.03	1.7983	2.18**	0.1424
Female dominated group dummy (ref=male dom.)	-1.2915	(-1.84)*	-0.8283	(-1.29)	.	.	0.8702
Regional fixed effect							
Latin American region dummy (ref=Africa)	2.4886	2.19**	3.1457	3.89***	4.4446	2.21**	-0.1568
Number of observation	63		71		53		70
Wald Chi2	49.53		66.67		63.79		57.94
Prob > chi2	0.0002		0.0000		0.0000		0.0000
Pseudo R2	0.3606		0.4617		0.5682		0.6176

Note:
(i) ***, ** and * representively represent significance at 1%, 5% and 10%;
(ii) Standard errors are robust to heteroskedasticity
(iii) For the new technology regression, two kinds of internal enforcement (other types of forest land and privately ownership) are not included in the regression because of perfectly prediction of explanatory variables.
(iv) For the regeneration regression, three kinds of internal enforcement and forest owner dummy are not included in the regression due to identification problem
(v) For the monitoring regression, one internal enforcement (other types of ownership), forest owner dummy, dummy of other group's

access and female dominated group dummy are not included in the regression due to the identification problem

(vi) For the conflict regression, all the internal enforcement dummies, forest owner dummy and dummy of other group's access

are not included in the regression because of identification problem.