Social and Environmental Consequences of the Mexican Reforms: Common Pool Resources in the Ejido Sector

by

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1. Introduction

The ejido sector is a fundamental component of Mexican agriculture and rural society. It consists of 28,058 ejidos and indigenous communities, includes over 3 million ejidatario households, and covers about one-half of the Mexican territory (INEGI, 1988). Ejido land consists of both individual plots and common access lands. Approximately one-third of all ejido land is used for agriculture, livestock, and housing by individual ejidatarios who have usufruct rights over, and in some cases legal title to, the land.[1] The other two-thirds of all ejido land is of common access by the ejido members, and 53% of this common land is used for grazing, 37% is forested, and 10% is used for agriculture (SRA, 1994). This common access ejido land accounts for most of Mexico's pasture and forest land. Approximately 70% of Mexico's potential productive forest (that which is not in conservation) is owned collectively by the ejidos, 5% is owned collectively by indigenous communities (which are also part of the ejido sector), and 25% is owned individually (World Bank, 1989). Since such a large share of Mexico's natural resource base is under ejido control, policies that affect the sector's ability to manage its common pool resources, or that alter its land use decisions, can have important efficiency, welfare, and environmental consequences.

Both range land and forest land in the ejido sector have suffered from the classical cooperation failures associated with common property ownership: under-provision of effort and over-appropriation of resources (Ostrom, 1990). In particular, cooperation failures have led to an inability to monitor borders and enforce rules, resulting in widespread overgrazing and illegal tree cutting by both ejidatarios and non-ejidatarios. Ejidos have also had problems coordinating the profitable exploitation of the common resources, and have had low levels of long term investment in the resources. Cooperation failures have lowered the value of the common land to individual ejidatarios and have thereby increased the incentives to occupy and subdivide the common land for individual appropriation (Baland and Platteau, 1997). In some instances, this encroachment on the common land is likely to have resulted in an excessive conversion of forest land to pasture or agriculture relative to the socially optimal level, and has resulted in a loss of economies of scale and risk diversification in natural resource use (Nugent and Sanchez, 1993).

Poor common property management is reflected in high levels of environmental degradation. The average rate of deforestation estimated from eight studies of deforestation in Mexico during the mid-1980s, is 675,000 hectare per year, an area that is currently equivalent to 2.0% of Mexico's 34 million hectares of potentially productive forest (World Bank, 1995). In addition to deforestation, overgrazing on pasture land creates problems with soil compaction, nutrient depletion, and weed infestation, that lowers the carrying capacity and productivity of the land. Run-off resulting from soil compaction and vegetative depletion can lead to erosion and ground water contamination (Kaimowitz, 1996).

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[1] Reform of Article 27 of the Mexican constitution in 1992 began a process of land reform which has permitted the titling of individual ejido plots in some ejidos under certain conditions. The land reforms and titling programs are discussed in detail in section 4.1.

Recent reforms of the land tenure system and of the Forestry Law have directly affected the rules governing the use of the ejido common resources. These and other policies have impacted the ability of ejidos to manage their common resources and have altered incentives to subdivide common lands. In this paper, we examine how recent reforms have impacted, and are likely to affect in the future, the use and management of Mexico's common property natural resources located in the ejido sector.

The paper proceeds as follows. In section 2, we use a 1994 survey of 275 ejidos to characterize common property use in the ejido sector. We analyze the importance of common pool resources for the ejido and examine how well these resources are being managed. Section 3 presents a discussion of the major issues of common property resource management, economic rationales for maintaining land in commons, and factors that affect the incentives for communities to divide their common land. In Section 4 we discuss the impact of recent changes in the Agrarian Law, the Forestry Law, and other domestic programs on common property use and environmental management in the ejido. Section 5 presents an empirical estimation of the relationship between cooperation, rule-making, common property management, and the environment. In section 6, we present a description of the evolution of the use and legal status of the common property areas of nine ejidos, focusing on the reasons why certain ejidos chose to divide their common property lands, while others did not. We conclude with a discussion of the policy implications derived from this study.

2. Common Property Resources in the Ejido Sector

In 1994, Mexico's Ministry of Agrarian reform together with researchers from CEPAL-Mexico and the University of California at Berkeley conducted a nation-wide survey of the ejido sector. The survey of 275 ejidos and 1,548 households included a questionnaire directed at the ejido leadership which asked about the management of ejido affairs, the extent and use of common property resources, and the decision-making process at the ejido level. A general description of these ejidos is presented in de Janvry, Gordillo, and Sadoulet (1997). In this section, we use information from the ejido-level survey to quantify the importance of the common property resources and examine how well these resources are being managed.

About two-thirds of all land in the ejido sector is of common, rather than individual, access. Of this common access land, 53% is used for livestock grazing, 37% is in forest, and the remaining 10% is used for agriculture. Of all the ejidos in the survey, 20.7% have no common land, while 18.1% have between 90% and 100% of their land in commons. Table 1 presents the distribution of ejidos with different shares of common land. As shown in the table, the share of the total ejido land that is in commons varies widely.

Table 2a distinguishes the use of ejido land based on the share of common land in the ejido. Three groups of ejidos are represented: Group A with some, but less than 40% of all land, being in commons; Group B with between 40-80% of all land in commons; and Group C with more than 80% of its land in commons. As shown in the table, the ejidos for which common property is a larger share of the total have much more total land, but less is used for human settlements and individual plots. As shown in table 2b, the use of common land changes slightly as the share of common land increases. Ejidos with larger shares of common land tend to have a larger share of this land in forest, and a smaller share in agriculture.

Common property resources are a source of collective income for the ejido. Table 3 indicates the percentage of ejidos deriving collective income from common pool and non-common pool sources. Forest income was the most frequent source of collective income from common resources (9% of all ejidos), followed by non-renewable resources (5%), and by renting pasture land (5%). Note that the fraction of ejidos earning income from these sources is low in comparison to the extent of these resources. For example, ejidos in Group C have an average of 94% of all land in common, yet only 30% of these ejidos derive some kind of community income from their common property. In terms of forest land, ejidos in Group C have about 37% of all their land in common forest, averaging 2,572 ha per

ejido, yet only 18% of the Group C ejidos derive community income from their forests. The low level of community income relative to the common assets endowments is an indication that these jointly owned resources are being appropriated for individual rather than collective exploitation.

Table 4 describes how common pasture is used for all ejidos with common pasture and for three groups of ejidos that differ in their endowment of common pasture per member. Group I consists of those ejidos with some common pasture but less than 6 hectares per member; Group II consists of ejidos with between 6 and 25 ha of pasture per member; while Group III consists of ejidos with more than 25 ha of pasture per member. As shown in the table, most pasture land is used for grazing cattle, with the grazing of goats, sheep, and horses being more common in the ejidos with larger shares of common land. In absolute numbers, Group III grazes only 2.35 times the number of livestock as Group I, despite having about 16.2 times the amount of pasture land. Hence, the stocking rate is only 0.22 head/ha for Group III compared to 1.46 head/ha for Group I. This disparity reflects both the quality of the common pasture, and the extent of over-grazing. Ejidatarios belonging to ejidos with common pasture each grazed an average of 10.35 head of livestock on their common pasture land, indicating that common pasture is an important resource for many individual ejido members.

Common property resource management by the ejido depends on the ability of the ejidatarios to cooperate. Table 5 presents some indicators of ejido-level cooperation for all ejidos and for ejidos with different concentrations of common property resources. About one-half of all ejidos failed to have regular assemblies and about 45% lacked ejido governance rules. Ejidos with a larger share of their land in commons were more likely to meet regularly but less likely to have governing rules in place. The data indicate that significant mismanagement of ejido common pool resources may originate in the weak ability of the ejido to cooperate as a group.

Table 6 indicates the prevalence of different rules for managing common pasture lands, distinguishing between ejidos with different quantities of common pasture land per ejidatario. The table indicates the low rates at which ejidos have established rules to govern their common lands. The fact that only about 25% of all ejidos with common pastures have limits on the number of head of livestock that can graze on the commons suggests that a large portion of the ejidos may have an over-grazing problem. This fact corresponds to the high levels of weed problems and indications of recent erosion on the common pasture land, as indicated in table 7. This table presents some indicators of successful common pasture management, and some indicators of environmental degradation. From tables 5 to 7 we can conclude that about one-half of all ejidos show little evidence of cooperation, and these non-cooperating ejidos seem to include those ejidos with sizable common property resources.

In sum, the ejido survey indicates that common resources in the ejido sector are extensive, with important forest, pasture, and agricultural resources under collective management regimes. Despite the size of the common property resources, these resources only provide a source of collective income for about 20% of all ejidos. Benefits from the common lands, especially common pasture lands, appear to be derived primarily via individual appropriation. In terms of pasture land, indicators of mismanagement (erosion and weed problems) and low levels of cooperation (few rules, infrequent meetings) indicate cooperation failures resulting in problems with common pasture management. Low levels of community income from the forest sector and indications of poor cooperation also suggest that there are inefficiencies in the management of forests resources. Based on analysis of the 1994 ejido survey we can conclude that there is a serious problem of cooperation failure and mismanagement in the extensive common pool resources located in the ejido sector.[2]

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[2] While ejido common property resources have received remarkably little attention in the literature, the conclusions of this section are consistent with results from other studies. Suarez (1989) provides the following figures for the late 1980s: of the 7,200 ejidos and *comunidades* with forests, only 16% extracted timber through an ejido-level organization, 14% leased their forests to lumber companies, and 70% had no commercial activities. Madrid (1994) examined the level of organization and quality of management of 1,348 forested ejidos and *comunidades* that used

3. Issues of Common Property Resource Management, Efficiency, and Division

In this section we discuss some of the major issues surrounding common property management, the economic rationales for keeping land in commons, and factors that contribute to a division and eventual dissolution of the commons. We also discuss some of the environmental consequences of poor cooperation, and encroachment on common lands.

Common property is owned by a group of individuals who have rights to the resource and must jointly determine how it will be managed. Without a functioning governing institution or effective cooperation among the group members, common resources will, in many instances, be depleted more quickly than would occur under individual ownership (Fisher, 1990). Absence of a governing structure may result in open access to the commons, where individuals -- both group members and non-members -- are free to extract the common resources, resulting in the classical "tragedy of the commons" (Hardin, 1968). With open access, individuals have an incentive to extract resources until the profit they earn on the marginal unit extracted is zero. As long as marginal profits are positive, individuals will be inclined to extract additional resources from the commons, and resource extraction will tend to exceed the socially optimal level.

Ejido common property resources are owned by the members of the ejido, and the use of the resources is legally restricted to the ejidatarios and other individuals to whom the ejidatarios grant access. Because access to the commons can be restricted, these resources can, in principle, be managed at an economically optimal level -- as if the resources were owned by a single agent. Optimal resource use can be achieved if there is an institutional arrangement in place that can effectively control the behavior of group members (Bromley, 1992). These controls can be self-imposed and self-enforced by the group, or can be imposed and enforced by an outside agent -- e.g., by a firm to whom the ejido has granted rights over the common land, or by an individual hired to manage the common resources.

A group can efficiently manage its commons if it is able to cooperate. Cooperation can be sustained at the group level when a sufficiently large portion of the group cooperates. When an individual can be assured that a critical number members will cooperate, then the payoff to the individual from cooperating will be greater than the individual gain he would get by not cooperating (Runge, 1984; Wilson and Thompson, 1993). The payoffs to cooperation versus non-cooperation will depend, in part, on the potential benefits from free-riding, on the punishments incurred from cheating, and on the transactions costs associated with achieving cooperation. Factors that have been associated with successful group management include effective monitoring of group members, a well defined and bounded resource, and efficient enforcement systems (Wade, 1988; Ostrom, 1990). Smaller groups are usually better able to organize because users internalize a larger share of the benefits of their own actions (Olson, 1982), they are better able to observe the behaviors of others (Sethi and Somanathan, 1996), communication among the group is easier, members are more likely to identify with the group (Ostrom, 1994), social sanctions may be more effective because of closer social ties (Ellickson, 1991), and transactions costs associated with governance are smaller. Higher group heterogeneity will also tend to increase the costs associated with communal governing (Libecap, 1989; Milgrom and Roberts, 1992).

While a large group -- such as most ejidos -- may be unable to cooperate, smaller coalitions within the group may be able to efficiently manage its common resources, for the reasons given above. These smaller sub-group coalitions

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private technical services in 1993 and 1994. The study found that 69% of the ejidos had no organization and significant resource degradation, 27% were had a "struggling" organization and some resource deterioration, while only 4% had a high level of organization, and good resource management.

may be able to make contracts or side payments (often not observed) with the larger group to sustain control over the resources (Libecap, 1989; Wilson and Thompson, 1993). For example, a wealthy ejidatario, or a coalition of ejidatarios, may convince the other members of the ejido to grant them the right to cut the common forest or graze on common land, in exchange for a fee. The outcome with side payments may be a Pareto improvement for the members of the large group and may have beneficial environmental consequences compared to a non-cooperative outcome.

Unregulated access to the commons is an extreme case resulting from the of absence rules. More commonly, there will exist some rules, but these rules are inadequate or imperfectly enforced. Rules tend to be poorly enforced by groups because cooperation is costly to individual members. Members in the group have an incentive to shirk in the amount of effort they put into managing and maintaining a common resource (building fences, patrolling borders, planting trees, attending meetings). Groups can reduce the costs of cooperative management by hiring a manager for the resource. However, because a hired manager also has an incentive to shirk, the group must be able to monitor the performance of its manager. If the individual costs of monitoring a manager are high, then groups will be vulnerable to corruption and mismanagement.

While lack of cooperation may lead to over-exploitation of a resource in many instances, it may in some cases actually result in beneficial environmental consequences. For example, if fixed costs to logging (building roads, moving equipment, making contracts) make it profitable to log only if a minimum number of trees will be cut, and if individuals acting alone are unable to cut this minimum number of trees, or are unable to make individual contracts with firms, then non-cooperation may result in the trees not being cut. This can preserve the resource if there is no better alternative for the land. On the other hand, if tree farming is not profitable for the ejido, due to an inability to cooperate, then the ejido will have an incentive to convert the forest to individually more profitable uses such as pasture -- which may result in more resource degradation, and a socially-inferior outcome, than if there were cooperation.

One of the main efficiency arguments for keeping natural resources under a common property regime is the economies of scale that can be achieved by keeping the parcels from being subdivided. For example, common pasture land that is shared by several farmers does not need to be fenced within the outer perimeter of the pasture. Fencing small individual plots within the commons is costly, and can interfere with cultivation. Likewise, the collective management of individually owned herds can reduce the cost of livestock supervision (Dahlman, 1980; Bingswanger et al., 1989). In forested areas, there are economies to scale in road construction, mill construction, contracting, etc., that may be lost when forests are subdivided.[3] When the subdivision of common land lowers the profitability of the resource, the land is more likely to be converted to other uses that do not preserve the natural resource.

There may also be efficiency gains to common versus private property that result from the costs associated with monitoring and enforcing individual property rights. Particularly when resources are dispersed and the value of the resource per area of land is low -- as with low quality pasture or forest --, the costs associated with maintaining individual rights may make common ownership less costly.

A third reason why common management may be more efficient is that large common areas can present lower risks for users compared to a situation where the commons are divided (Wilson and Thompson, 1993; Nugent and

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[3] Evidence that there are economies of scale in contracting with forestry firms in Mexico is given by the portion of ejidos contracting with forestry firms as a function of their forest assets. No ejidos surveyed with fewer than 20 ha of forest land contracted with firms, while 12% of ejidos with between 20 and 200 ha contracted, 17% of ejidos with between 200 and 2000 ha contracted, and 46% of ejidos with more than 2000 ha of forest land contracted with forestry firms (SRA, 1994).

Sanchez, 1993). For example, if there are variations in pasture yields across space, due to climate or other environmental factors, then livestock herders will likely face a lower variability in their supply of forage if they have access to a large grazing region relative to a situation where they are constrained to graze within smaller individual subdivisions of the larger region.

The recent reforms have affected the process whereby ejido common pool land is converted to exclusive individual use. Both ejidatarios and non-ejidatarios have encroached upon common land, either cutting forests and grazing or cultivating the land in order to obtain usufruct rights, or cultivating common pasture for the same purpose. When squatters clear common land with the intention or hope of attaining usufruct or property rights over the land, there are often negative environmental consequences. This issue has received a lot of attention because of the deforestation resulting from requirement in certain countries (especially Brazil and Ecuador) that settlers of frontier land "improve" the wilderness by clearing forests in order to gain property rights (e.g., Browder, 1988). We discuss in the next section how the recent land reforms may have encouraged encroachment and deforestation.

A negative environmental consequence of squatting on common pool land results from the fact that when there is even a small probability of being evicted from the land, squatters are more likely to reduce their investments in long-lived assets such as forests and soil conservation practice, in favor of less sustainable activities which yield higher returns in the short run (Mendelsohn, 1994). Also, when squatters graze animals on common lands they deplete the resources and contribute to over-grazing, resulting in soil fertility depletion, erosion, etc.

In the next section, we discuss some of the legal and illegal ways in which ejido common pool land has been converted to individual use. As we mentioned above, the inability to coordinate resource extraction (due, for example, to an inability of the group to cooperate, form intra-group contracts, or monitor a resource manager) can make exploitation of the common lands unprofitable, thereby increasing the incentive for ejidatarios to colonize the common land. Likewise, when there are few economies of scale or risk-diversification payoffs to be gained from keeping the land in common, the main economic incentives for cooperation will not be present, and ejidatarios will be more likely to try to divide the common land.

4. Policy Reform and Ejido Common Property Management

In this section, we analyze how recent policy reforms have impacted, and are likely to impact, common ejido resources. In particular, we focus on how the reforms have affected the ability of the ejidos to manage the common resources in terms of their ability to cooperate or to form associations with private firms. We also examine how the reforms have influenced the conversion of common property to private parcels, both formally and informally, and whether this conversion has had environmental consequences.

4.1 Agrarian Reform and Common Property

Article 27 of the 1917 Mexican Constitution established the ejido system of land tenure. Farmers of ejido land were granted usufruct over individual plots but could not, until the reforms of 1992, sell or rent the land. Article 27, and later the passage of the Agrarian Code of 1934, established a system for expropriation and redistribution of land, a process that continued with varying degrees of intensity until 1992. During this period, redistributed land was given not to individuals but to indigenous communities and *ejidos.* In the indigenous communities all the land is held in common by the community members, however some members have access to individual plots in a property rights system determined by and specific to the community. Like the communities, a few ejidos have collective use of all land, but most have an area of individual plots separate from a common pool area. Despite a formal distinction

between the individual and common pool regimes, in many ejidos it is usual that part of the commons are worked individually.[4]

In 1992, Article 27 of the Constitution was modified so that 1) land redistribution ended; 2) ejidatarios could sell or rent their land; 3) foreign and domestic firms gained the right to own land; and 4) courts were established to resolve land claim disputes. The purpose of the reforms was to modernize the ejido sector by privatizing the individually controlled plots and creating a land market. This would allow the most efficient producers to obtain access to the land, encourage long term investments in land, and permit ejidatarios to use their land for collateral.

While the reforms allow an ejido, by act of its general assembly, to distribute individual agricultural land parcels to its members, it does not permit common lands (where most forests are located) to be parceled or sold. However, after demarcating communal resources, ejidatarios can form legal associations with private enterprises to enter into joint ventures for forest management and exploitation. Therefore, even though the forest lands cannot be individually parceled, they can be held in joint ventures with firms in which ejido members have tradable shares. This change places increased importance on how rules governing the allocation of rights or shares within the community are decided and implemented.

If the ejido completely parcels out its farm land and disintegrates as an entity, the new law states that the communal land will revert to the public domain. However, the law does not specify how this reversion will occur, or who will be compensated. Hence, it would appear that ejidatarios who plan to disband have an incentive to extract all value from the common land before they lose control over it. Hence, there is a serious risk of considerable environmental damage on common lands as individual plots are privatized. A superior policy would allow the ejido, upon disintegration, to sell the forest to an individual or to the government at a fair compensatory rate (World Bank, 1995).

Article 56 is a little noticed section in the 1992 Agrarian Law that could have important implications for the parceling of the common land. The article gives the ejido assembly the right to change the limits of common and assigned land and to grant individual parcels to new ejidatarios, allowing incorporation into the ejido of a potentially large number of new members.[5] This law, in effect, permits the ejido to redefine the common land. To date there has been little use of this provision, but the potential exists for widespread use.

Land Titling and *Procede*

The basic task of *Procede* is to give ejidatarios individual titles over their plots. The title, or *Certificado Parcelario*, allows ejidatarios to legally rent their land, a right they did not formally have. The title is not a full private property title in that it contains several limits and "safeguards" that prevent ejidatarios from selling land to non-ejidatarios, from subdividing plots, or from bequeathing land to more than one person. The *Certificados Parcelarios* are given per plot and include a map showing boundaries with other plots. By formalizing land tenancy over private parcels the titles should help reduce the number of land conflicts and increase tenure security.

While the *Certificado Parcelarios* grant rights over individual parcels they do not extend to rights over the common ejido land. A second document, the *Certificado de derechos de uso comun*, certifies that a person is member of the

[4] It is not unusual for common land to be farmed individually during the cropping season, and pastured communally during the fallow season (McCarthy, de Janvry, and Sadoulet, 1997).

[5] Ejidatarios have not been able to legally subdivide their land in order to pass their land to more than one child. Children of ejidatarios who had not yet inherited (or could not legally inherit) land often live in an ejido as officially landless households. These households either earn wage labor, or have access to land as illegal tenants or occupants. Unlike ejidos, in indigenous communities all heirs are incorporated into the community.

ejido and has the right to a specific percentage of the benefits of common land. Ejidatarios cannot sell their rights to the common land, but the ejido assembly can grant a buyer of an ejido plot rights to the commons. The separation of rights to individual and common property permits ejidatarios to sell their land without having to share their commons with additional people or to include them in assembly votes.[6]

The 1992 reforms do not permit the common area in the ejidos, or any land in the indigenous communities, to be individually titled or privatized. However, this restriction can be circumvented in two ways. First, not all the ejidos have a well documented division of land between individual and commons. Hence, these ejidos have flexibility in defining what their commons are, and how many individual plots need titling. Second, *Procede* has the role of recognizing and formalizing the historical use of land, even if this land was illegally used. Hence, if the assembly argues that occupied plots on formerly common land have been individually maintained for a long time, and *Procede* agrees, then the new maps of the ejido will reflect this shift from common to individual property. As the case studies in section 6 illustrate, *Procede* frequently grants titles to informally appropriated land, even when the appropriation created severe environmental degradation. The case studies also indicate that even when *Procede* officials refuse to accept proposed tenure changes, ejidatarios may continue to operate without their official blessing. That is, the community's informal internal system of individual property rights appears to be impervious to externally imposed changes in legal tenure.

Environmental Implications of Land reform and Titling Programs

The recent agrarian reforms and titling programs have had a mixed effect on the use and management of common land. The reforms have created incentives to deforest land in order to convert the common land to private parcels, but have also enhanced common property tenure security which promotes profitable resource exploitation and sustainable forestry.

By maintaining the private/common property rights dichotomy, the Agrarian Law maintains the incentive for individuals to encroach on common land to establish individual property rights. This process of encroachment on common land to establish ownership has been occurring for a long time in Mexico. In fact, previous agrarian reforms (1934 and 1947) have been criticized as having contributed to deforestation by encouraging encroachment and neglecting the forest sector (LEEC, 1993). The past reforms established guidelines for obtaining land tenancy that required occupation and use of the land for agriculture or livestock. Hence, *campesinos* were indirectly encouraged to clear forest lands in order to obtain legal claims to land. In order to maintain usufruct rights, ejidatarios were required to work their own land. This made land that was set aside for forest production subject to appropriation and deforestation as the low input requirements associated with keeping the land forested may not have qualified as "working" the land.

Historically, some common lands have been converted to individual use through implicit or explicit internal agreements. In these cases, members of the community are granted the right to transform the commons into personal agricultural or grazing land. The claim to land is solidified by working the land: e.g., by transforming it from forest or secondary vegetation to an established pasture, plantation, or cornfield. Prior to the 1992 reforms, the Secretariat of Agrarian Reform occasionally bestowed legal status on past encroachment on the commons with a policy called *regularizacion*. In the Southeastern states, the transfer from commons to individual use has occurred informally

[6] Even when an ejidatario sells all his individual titled plots he still retains his ejidatario status (voting rights and share of the commons). The ejidatario can cede his ejidatario rights while he is alive, or bequeath them to an heir.

without requiring lands to being brought into production. In a process known as *parcelamiento economico*, the commons are divided equally among members, leading to de facto individualization of the common land.[7]

The changes to Article 27 did little to address the process of encroachment, whereby common land is occupied in order to gain official title to the land. As mentioned above, changes in the law have allowed ejidos to redefine common and individual lands, even when these changes occurred informally and at the expense of the common land. In some cases, this has lead to an over-conversion of forest land to livestock and agricultural uses compared to a social optimal, loss of economies of scale in common resource use, and increased exposure to risk. In other cases, the titling of previously common land as individual parcels has removed the incentive for individuals to occupy and use the land in order to gain title over it, with beneficial environmental and efficiency consequences.

By not allowing the common lands to be parceled, the reforms permit inefficient and environmentally damaging resource management practices to continue in many ejidos. Certain ejidos have been unable to cooperate, leading to open access problems and excessive resource depletion. Lack of coordination within some ejidos may prevent these ejidos from even leasing their common land out for exploitation. In some ejidos, an environmentally superior outcome would result if the ejido were permitted to either subdivide the common land or sell all the common land to a private party or the government. Whether the land should be subdivided or sold as a whole depends, in part, on the efficiency gains (economies of scale, risk diversification, etc.) associated with efficient management practices.

There have been some positive environmental consequences to the land reforms. Titling has served in some instances to promote secure property rights of communities and ejidos over their common lands and forests by, among other things, clearly defining boundaries and rights over the common land. In some cases this has reduced contraband timber cutting and promoted cooperation in the formation of associations with private firms (for example, see the description of ejido Corregidora in section 6).

The biggest environmental consequences of the reforms are likely to result from the provision of the law that allows ejidos to form business associations with private firms. Associations with lumber companies are expected to lead to higher profits on forest land, which could promote sustainable forestry systems. However, success of this strategy requires a transparent system for distributing the returns from organized extraction. Laws and practices governing the distribution of forest benefits have been criticized as ambiguous and variable (World Bank, 1995). Some communities may prefer to maintain an inefficiently managed locally controlled lumber operation rather than form a potentially more profitable association with a firm due to a lack of transparency in how the profits will be distributed. That is, ejidatarios may prefer low certain wages to a share of higher profits from a contract, if they perceive that their share may be subject to expropriation. In such cases, there is a role for the state in providing assistance to ejidos in how to contract and establish transparent systems of profit sharing.

4.2 Reforms to the Forestry Law

The 1986 Forestry Law was enacted as a response to deforestation, illegal logging, and declining timber production in the previous decade. The 1986 law granted the state strong regulatory powers and provided for a direct role for government agencies in most aspects of forest management and production. After the land tenure reforms of 1992, the Forestry Law was rewritten to reflect the spirit of deregulation and free enterprise that was guiding Mexico's development strategy. The reforms also eliminated regulations that were viewed as hindering economic relationships between the social sector (the ejidos and indigenous communities) and private forestry firms.

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[7] While individuals may gain usufruct rights over these common lands, they do not in general gain the right to sell the land to someone outside of the ejido.

Since the reforms of 1992, production has remained stagnant, and illegal cutting has continued to be a problem, with an important share of the forestry activity operating outside of the formal sector of the economy (SEMARNAP, 1997). Over the same period, international concern about environmental degradation and domestic awareness of environmental issues have expanded. In May 1997, pressure mounted to reform the Forestry Law again in order to address some of the environmental concerns that had emerged since 1992. The 1997 reforms are an attempt to 1) re-impose some regulations and safeguards on the forest sector; 2) maintain a market framework that permits the private sector to function efficiently; and 3) introduce a system of incentives to promote sustainable commercial logging. These recent reforms are the culmination of an unusual process for Mexico of public debate on the Executive's Initiative both by Congress and by civil organizations (Zorilla, 1997). The main changes to the Forestry Law in 1997 include the following:

1) Reinstatement of the requirement to show proof of origin of timber and non-timber forest products at all stages of production, including transportation, processing, and inventory. These new requirements will be implemented through a simpler system than the one that was in place in the pre-1986 period. The new approach only requires purchasers to show receipts, and the primary producers to show extraction permits -- which they can now obtain from private technical service agents, rather than exclusively from government agencies.

2) Regulation of forestry plantations. Previously, plantations were considered to be an agricultural activity and as such were not subject to the same environmental regulation as natural forests. The new law requires that plantations present an Integral Sustainable Management Plan, which must specify the plantation's program for replanting and harvesting. In addition, plantations are prohibited from expanding into most natural forests areas.

3) Regulation of the professional standards of the Forestry Technical Services. In the early 1990's, technical services were privatized. Forest owners were required to use the technical services, but they gained the freedom to choose from among various private providers. Experience with the private provision of technical services led to allegations of collusion, lax monitoring, and corruption. The 1997 law provides for more oversight over the provision of technical services, while maintaining a private delivery system.

4) Deregulation of small-scale forestry activities. In response to complaints by small-scale forest owners of over-regulation, the new law exempts operations with fewer than 20 hectares from some of the more complex and expensive regulations, such as those requiring environmental impact assessments and management plans.

5) The provision of direct subsidies to forestry activities. The Government of Mexico established two programs designed to support commercial forestry activities. The first, *Programa de Desarrollo Forestal* (*Prodefor*) is directed towards natural forest management, while the second, *Programa de Desarrollo de Plantaciones* (*Prodeplan*) assists tree plantations. Under *Prodefor*, forest owners will receive credit guarantees and resources to partially cover the costs of technical services, management plan preparation, environmental impact assessments, and technical and organizational training. The objective of the subsidies is to initiate sustainable forestry programs in ejidos and indigenous communities that have significant forest resources but little capital. Under *Prodeplan*, tree plantations will receive a lump sum payment per hectare for the planting and maintenance stages of production. *Prodeplan* will allocate resources via a "bidding" program where individual projects will compete for the subsidies with matching funds. Those projects that ask for less money per hectare will be served first, until all the financial resources allocated to these programs are disbursed. The objective of the subsidy program is to level the playing field for Mexican producers who are competing against subsidized growers from the main trading partners, the US and Canada. Both the *Prodefor* and *Prodeplan* projects will provide local governments with matching funds from the federal government for road building.

<u>Environmental Impacts of the changes in the Forestry Law</u>

The recent changes to the Forestry Law are in may ways a reaction to the dramatic deregulation that occurred in 1992. Reinstatement of the requirement to show proof of origin of timber and non-timber forest products, regulation of forestry plantations, and regulation of the Forestry Technical Services are all attempts by the state to reassert control over the forestry sector. On the other hand, the move to promote sustainable commercial forestry through the two subsidy programs can be seen, not as a return to the old strategy of command and control, but rather a move towards the use of financial incentives to achieve desired policy objectives. To the extent that the changes can control illegal cutting and promote sustainable commercial logging, the changes will have a beneficial effect on the resource base. Skeptics have claimed that the oversight of the technical service providers remains insufficient, even after the change in the laws, and that costs of supervising this sector would actually make it more efficient to absorb the technical services back into a government agency (SEMARNAP, 1997).

One of the most controversial aspects of the new forestry policies is the introduction of the subsidy programs. The subsidy programs are designed to promote *sustainable* commercial forestry by concentrating funds on the planting and maintenance stages, and by requiring a sustainability plan. However, the funds allocated to sustainable aspects of the plan are small. Support to pay for the sustainable management plan is only about $US 3.50 per hectare, while support for forest maintenance is only about $US 15 per hectare (Prodefor, 1997).

Probably the greatest danger that these subsidy programs pose to the environment is the economic activity that these projects may stimulate, not in the projects themselves, but in nearby unregulated forest areas. Encouraging commercial logging in a particular region reduces the costs of logging in nearby areas: the subsidies provide for road construction which will make transportation cheaper and more available; mills may locate to the region reducing transportation costs; and information about markets and business associations will spread. It is estimated that the *Prodefor* will result in an additional 4,900 km of roads to be constructed before the year 2000, at a cost of 110 million dollars (Prodefor, 1997). Road construction and the results of other subsidies will tend to promote cutting in areas close to the subsidized projects, but will not necessarily encourage replanting or harvesting in these areas. Hence, an evaluation of the success of the recent policy reforms projects should not only examine the projects themselves, but should also consider wider regional effects.

4.3 Domestic Market Reforms

Agricultural Subsidies and *Procampo*.

In part due to reduced trade protection resulting from NAFTA and GATT, the government of Mexico introduced *Procampo*, a temporary subsidy scheme based on the area of land planted in 10 staple crops. The subsidy takes the form of a lump sum paid per hectare for each crop cycle. In 1996-1997 the subsidy was about $US 50 per hectare for maize. The subsidies were justified on the grounds that the would ease the transition from high domestic prices to lower world prices (especially for maize), and that they leveled the playing field for Mexican growers competing with subsidized US and Canadian growers. In addition, the lump sum transfers were regarded as less regressive and distortionary than alternative subsidy schemes.

Procampo distributes subsidies based on the area of crops planted in particular crops in the base year. In subsequent years producers are free to alter their cropping patterns allowing for an efficient allocation of resources. For producers to receive the subsidy, their land must be officially registered in the *Padron de Productores*. The *Padron* was to be administered in a single year based on past behavior in order to prevent farmers from switching crops or expanding their cultivated area to claim more subsidies. However, after the first year many complaints arose from producers claiming to have been unjustly excluded or underrepresented in the registration program. The government eventually amended the *Padron* to address these complaints.

There are several ways in which *Procampo* may have had negative environmental consequences. First, to the extent that farmers were given the incentive to clear forest land in order to register their land for the *Procampo* benefits, the program may have resulted in excessive deforestation. Future changes in the *Padron* are expected to be minimal, creating few further incentive to clear land for the subsidies. Second, *Procampo* was designed to continue providing subsidies for a set period of time as long as the farmers keep their land in production. SAGAR, the agency through which payments are given, allows *Procampo* subsidies to continue if farmers ask for permission to switch crops, establish a pasture, or have a forestry plantation. However benefits are canceled if land goes to fallow. Hence, the program encourages growers to keep land in production rather than allow it to revert to its natural state, which may include forest. Finally, it is likely that *Procampo* is inhibiting the reforestation of certain areas due to misinformation about how the program is administered. According to preliminary results of the 1997 Ejido Survey, a large number of farmers believe that they must either continue to produce the same crop they had at the beginning of *Procampo* to be able to continue to receive payments, or switch to other basic grains. Apparently, many growers do not understand that forest plantations qualify for the *Procampo* program.

Policy shift away from ejido-level economic transactions

A major component of the "modernization" of the ejido sector has been a move away from ejido-level transactions towards ejidatario-level transactions. The movement is most explicit in the reforms to the rural development bank, *Banrural*, which dramatically reduced lending to groups of ejidatarios, and shifted its lending to individual ejidatarios. Following the decrease in group lending, crop insurance also became increasingly distributed on an individual rather than a group basis. Similarly, agricultural technical extension services were largely privatized and changed from being a free government provided service to one available on an individual pay-for-service basis (de Janvry, Gordillo, and Sadoulet, 1997).

This "individualization" of agricultural policy has reduced, to some extent, the importance of the ejido as an instrument with which to obtain services from the state. With fewer benefits to be obtained at the ejido level there is a weaker economic incentive to cooperate at the ejido level, resulting in the ejido being a less effective organization for managing common property. Reduced cooperation can have important environmental consequences including: 1) increased over-grazing of common pasture lands; 2) reduced monitoring and border enforcement leading to increased tree poaching by ejidatarios and non-ejidatarios; and 3) reduced long term investment in the common resource. In addition, reduced cooperation lowers the value of the common land to individual ejidatarios because the ejido is less able to make profitable management decisions. Lower profits on common property increases the incentive to subdivide the common land into parcels for private exploitation, resulting in potential diseconomies of scale.

5. Common Property Resources in the Ejido Sector: Cooperation, Rules, Common Property Management, and the Environment

In this section, we specify and estimate an empirical model that relates ejido cooperation, rules governing common pasture land, common pasture management practices, and environmental outcomes. We specify an empirical interrelationship between cooperation, rules, management, and the environment that is illustrated in figure 1. As shown in the figure, exogenous characteristics directly affect cooperation, rule making, pasture management practices, and the environment; rules determine pasture management practices and environmental outcomes; and pasture management practices determine environmental outcomes. The model is estimated using information from the 1994 ejido-level survey.

Exogenous variables include variables that explain cooperation, and that influence rule making, management practices, and environmental outcomes. Based on our discussion in section 3, the variables that are expected to

influence cooperation include 1) *group size*, or the number of ejido members; 2) *group heterogeneity*, measured by the difference between the largest and smallest plots in the ejido; 3) level of *social cohesion* or norms, measured ejido age and whether the majority of ejidatarios are members of an indigenous ethnic group; 4) quality of *border definition*, measured by whether the ejido has had border conflicts with neighbors, and disputes over common property borders within the ejido; 5) *exit options*, measured by the level of out-migration from the ejido; and 6) *resource scarcity*, measured by common pasture land per member, community incorporation pressure, local land scarcity, local poverty, and local deforestation These variable may also influence the types of rules being formed (e.g., stocking limit rules may depend on land scarcity); pasture management practices (e.g., if land is less scarce, then there may be less pasture renting); and environmental outcomes (e.g., more common border conflicts may imply more open access among members and worse environmental outcomes).[8]

From the survey, we observe such indicators of cooperation as whether an ejido has frequent (monthly) assemblies, attains a quorum at its assemblies, or has an internal set of rules. The survey also provides information about the rules and regulations that ejidos have enacted to govern their common pasture land. These rules cover the use of post-harvest crop stubble, general obligations associated with use of the pasture, stocking limits, and other aspects of pasture use (rotation of crops on common pasture, weed control, soil improvements, cultivation of pasture). As shown in figure 1, cooperation only depends on exogenous characteristics, while rules are determined by exogenous characteristics and the level of cooperation.

Common pasture management practices recorded in the survey include whether the ejido has prevented the use of its common pasture by outsiders, constructed fences around the common land, or rented the common land to individuals or firms. As shown in figure 1, common pasture management practices are determined by how well ejidos cooperate, the rules they have in place to govern their resources, and other environmental factors. The environment is the ultimate indicator of cooperation, rule making, and management practices. We use the absence of weeds as an indicator of a good environmental outcome. As shown in the figure, environmental quality depends on ejido-level cooperation, pasture management rules, and pasture management practices.

The relationship between the variables illustrated in figure 1 can be expressed in the following set of equations:

(1) $c_i = z_1\alpha_{1i} + u_{1i}$ for i measures of ejido-level cooperation

(2) $r_j = z_2\alpha_{2j} + c\beta_{2j} + u_{2j}$ for j types of common pasture rules

(3) $m_k = z_3\alpha_{3k} + c\beta_{3k} + r\gamma_{3k} + u_{3k}$ for k common pasture management practices

(4) $y_l = z_4\alpha_{4l} + c\beta_{4l} + r\gamma_{4l} + m\delta_{4l} + u_{4l}$ for l environmental outcomes

In our application, all of the dependent variables are dichotomous, so each equation is estimated using a probit model. The endogenous variables c, r, m, and y are simultaneously determined. However, because the four sets of equations form a triangular system which is fully recursive, the equations can be estimated consistently equation by

[8] The measure of deforestation is the percentage loss in forest cover in the municipality between 1980 and 1990 and was obtained from Klaus Deininger and the World Bank; local land scarcity is constructed as the reciprocal of the product of the average farm size in the municipality multiplied by the average corn yield in the municipality and was derived from the 1990 Mexican Agricultural Census; the marginality variable is from CONAPO?; ejido incorporation pressure is defined as the number of ejidatarios plus non-ejidatarios living in the ejido divided by the number of ejidatarios; the level of out-migration at the ejido level was constructed using household data from the 1994 SRA ejido survey.

equation (Greene, 1993). Note that the errors across the four sets of equations may be correlated, but it is not feasible to estimate the covariance matrix for a multivariate probit model when the number of equations is so large ($i + j + k + l = 10$). Hence, our estimation approach is not efficient, but produces feasible consistent estimates.

Because rules and outcomes are only observed in relationship to common pasture use, we limit our estimations in all four sets of equations to ejidos with common pasture (n=142). Missing observations on some of the rules, outcome and management indicators further reduce the sample size in their associated equations. So as to maintain the maximum possible degrees of freedom, missing values for the endogenous variables (cooperation, rules, and practices) were replaced with their predicted values when they entered as explanatory variables.[9]

Comparison of Means and Estimation Results

Before discussing the estimation results, it is instructive to compare the means of the explanatory variables for ejidos with different values of the dichotomous dependent variables. This exercise illustrates average differences between ejidos with different levels of cooperation, regulation, and common property management performance.

Table 8 lists mean values of the exogenous characteristics based on the three indicators of cooperation. The table shows that ejidos displaying cooperation (have either internal rules, frequent assemblies, and/or quorums at their assemblies) have, significantly fewer members, less heterogeneity, less common pasture per ejidatario, and less poverty, more border definition problems, and higher levels of out-migration. Only the correlation between higher levels out-migration and cooperation is contrary to our expectations.

Table 9 illustrates the mean values of the exogenous variables, and the cooperation variables (when observed), for the ejidos with and without four types of rules. Ejidos with more rules are, as expected, more likely to have fewer members, higher levels of local deforestation, fewer ejido border conflicts, and are more likely to be an indigenous community, and have internal rules and quorums at their assemblies.

Table 10 presents the mean values for the exogenous variables, cooperation variables, and rule indicators for ejidos with different management practices. The ejidos that enforced their common property borders, constructed fences, rented pasture, had significantly fewer members, less heterogeneity, greater land scarcity, less poverty, and were more likely to have ejido border conflicts, frequent assemblies, quorums, and general-use rules. Table 11 lists the variable means for the two environmental outcomes. The ejidos with no weed problems, and no indication of erosion, had significantly less land scarcity, fewer migration assets, and were less likely to have border conflicts (both ejido and common property), frequent assemblies, and quorums at their assemblies, but were more likely to have stocking limits. All these results are consistent with expectations except for the correlation between the absence of internal rules and assemblies and positive environmental indicators.

Tables 13 through 16 present the results of the probit estimations for the cooperation, rules, management, and environment variables, respectively. The results of the estimations are summarized in table 17 which gives the signs of all the variables that were significant to the 5% or 10% level. Most of the signs of the difference in means tests summarized in table 12 are consistent with those of the probit estimations.

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[9] For example, in the survey there were 127 observations on whether the ejido had prevented intrusion, however there were only 73 observations for whether the ejido had rules on post-harvest stubble use. So that all 127 observations of the independent variable (prevented intrusion) could be used in the probit, the missing observations on the post-harvest rule indicator were replaced with predicted values (the estimated probability) of having the post-harvest rule which were obtained from the probit on this rule.

In terms of ejido-level cooperation, the probit estimations reveal a strong negative relationship between the number of members in an ejido and the frequency of ejido assemblies and whether a quorum is attained at the assemblies. These results corroborate our expectations that group size inhibits cooperation. Having common property border problems is shown to be positively associated with having internal rules and achieving a quorum, suggesting that the existence of problems that need resolution may provide a motive for cooperating. Other factors that increase cooperation include less plot size disparity, less common pasture per member, lower incidence of poverty, less incorporation pressure, more ejido border conflicts, and more migration.

The ability to cooperate proved to be important in the formation of pasture management rules, in influencing pasture management practices, and in determining environmental outcomes. In particular, having frequent assemblies was positively associated with having general use rules for the pasture, achieving a quorum was negatively associated with fence construction, and positively associated with the absence of weeds. Pasture management rules were also shown to affect management practices and environmental outcomes. Having rules about the use of post harvest stubble was negatively associated with renting pasture, and having general pasture use rules was strongly positively associated with preventing intrusion onto the commons, and constructing fences. Having stocking limits was, as would be expected, was strongly associated with a positive environmental outcome. Having prevented intrusion on the common pasture was associated with more weed problems -- perhaps because having prevented intrusion is more of an indication of problems with intrusion than of good management.

It is instructive to trace through some of the direct and indirect affects given by the results. These effects are illustrated in figures 2 through 7. The figures illustrate the net effects of the direct and indirect effects of a marginal change in the exogenous variable on the cooperation, rules, pasture management practices, and the environmental indicator.

As shown in figure 2, a lower probability of having frequent assemblies and consequently general use rules means a lower probability of preventing intrusion and therefore fewer weed problems. However, a lower probability of achieving a quorum implies more problems with weeds. The net effect of a marginal increase in the number of ejido members is a small decrease in probability of not having weed problems (-0.0003).

Figure 3 illustrates how having a majority indigenous ethnic population directly increases the probability of having prevented intrusion, but also decreases the probability of having general use rules which indirectly decreases the probability of preventing intrusion. The combined effect results in indigenous communities being more likely to prevent intrusion which increases the probability of weeds. At the same time, indigenous communities are significantly less likely to have stocking limit rules which implies more weeds. The net effect is that a majority indigenous ethnic community has a lower probability of not having weeds (-.1926), than a non-indigenous community.[10]

In terms of plot size disparity, a more heterogeneous community is less likely to achieve quorums, or have stocking limits, both effects diminishing the probability of not having weed problems (-0.0007). Common property per member is negatively associated with preventing intrusion on the common pasture. Hence more pasture means less problems with intrusion, and less need for preventing intrusion. With a lower level of intrusion there is a lower probability of having weeds. Hence, more common pasture per member results in a better environmental outcome.

More poverty, as shown in figure 6 increases the likelihood of cooperating (having a quorum) and of making rules (general use rules), and decreases the probability of preventing intrusion. The combined effect of more cooperation and less intrusion is to increase the probability of not having weeds. However, this effect is outweighed by the direct

[10] The effect on the probability of a change in a dichotomous variable, such as whether or not the community has an ethnic majority, is the discrete change in the dichotomous variable from 0 to 1.

negative effect of poverty on weeds, so that the net effect is decrease in the probability of not having weeds (-0.1965). Perhaps lower income means a lower value of time which makes time-intensive cooperation less costly, but lower incomes are associated with higher discount rates which makes investment in environmental preservation more costly.

As shown in figure 7, incorporation pressure serves to decrease cooperation (quorums) but promotes rule making. The reduced cooperation, combined with more intrusion, results in more incorporation pressure having a negative net effect on weeds (-.0384). Finally, as shown in figure 8, common property border conflicts are directly negatively associated with the environmental outcome, but positively associated with cooperation which mitigates the direct negative effect. It is likely that common border disputes (it is not clear from the survey question whether these conflicts occur among ejidatarios, or between ejidatarios and non-ejidatarios) create a need for internal rules with which to discuss the conflicts, and a quorum is more likely because ejido decisions may be important in resolving the conflicts. The net effect of having border conflicts lowers the probability of not having weeds by -0.2377. Hence, after controlling for the fact that conflicts can improve cooperation, more conflicts result in worse environmental outcomes.

Conclusions from Empirical Results

Taking together the results of the mean comparisons and the probit estimations, our results confirm that ejido cooperation, particularly having frequent assemblies, was important in establishing rules for governing the commons. Pasture management rules influence management practices, and are positively associated with environmental quality. Cooperation is also with associated pasture management and achieving a quorum at assemblies had a direct positive affect on the environment. These results suggest the importance of promoting cooperation at the ejido level. In terms of the factors that influence cooperation, rule-making, pasture management, and the environment, our main conclusions are the following:

1. Ejidos with more members are less likely to cooperate, which results in less rule making, and more environmental degradation. This result suggests that current policies that allow more individuals -- usually relatives of current ejidatarios -- to become ejidatarios, may negatively impact ejidos' ability to cooperate in the future. This result also suggests the need to promote and facilitate the formation of sub-coalitions within an ejido. A functioning market for the use of ejido common resources would allow sub-groups to rent the use of the commons and encourage smaller management organizations. In the case of common pasture, an ejido could sell the rights to graze, with revenues from the sale of this right being distributed among the members. Alternatively, ejidatarios could be granted the right to graze a certain number of heads of livestock, which they could then sell to other individuals.

2. More group heterogeneity, as measured by the difference in size between the largest and smallest land holdings, has a negative effect on cooperation and rule making which increases environmental degradation. Group heterogeneity has increased in ejidos over time as ejidatarios have encroached upon and appropriated common lands for individual use. As we document in the case studies in the next section, the land titling program, *Procede*, can be used to validate past unequal incursions, or to equalize land holdings by compensating some ejidatarios with more land as the commons are divided. *Procede* should be particularly hesitant to "regularize" land appropriations that have resulted in highly unequal resource distributions, as this heterogeneity will diminish the ability of the ejido to cooperate and make rules.

3. The amount of common pasture per member of the ejido is negatively associated with the ability to prevent intrusion on the commons and positively associated with good environmental management. Also, more common pasture per member reduces cooperation (internal rules), however this effect does not have a significant environmental impact.

4. Pressure from non-ejidatarios living in the ejido to be incorporated into the ejido has a negative affect on cooperation, but is positively associated with rule making and ability to prevent intrusion on the commons. The net effect of ejido incorporation pressure on the environment is negative. Policies that reduce incorporation pressure by involving non-ejidatarios into the decision making process of the ejido, can help reduce intrusion pressures, but may make ejido level cooperation more difficult as it increases the number of members, and will reduce pasture per member. On the other hand, policies that promote out-migration from the ejido, such as increased resources for education, will reduce incorporation pressure without raising the number of ejidatarios or reducing pasture per member. Incorporation pressure can also be reduced by promoting local non-agricultural employment opportunities.

5. Common property border conflicts are directly negatively associated with a good environmental outcome, but they tend to promote cooperation (having internal rules and achieving quorums) which mitigates the negative effect. Procede, and other programs that reduce common property border disputes, may thus remove some of the past incentives for cooperation, but should positively affect the environment.

6. Case Study Analysis of Division of the Commons

In this section, we analyze the evolution of the legal status and use of the common property resources in nine ejidos. These descriptions are based on information collected in the ejidos during two national ejido-level surveys which were conducted in 1994 and 1997, and on information gathered from first hand interviews in 1997 with ejidatarios from the ten ejidos, and with officials from *Procede* and the Secretariat of Agrarian Reform. This analysis focuses on explaining past informal encroachment or division that occurred prior to 1994 and independently of the 1992 Agrarian Reform, and the division which occurred after 1995-96, and was spurred by the opportunity that *Procede* provided to redefine the common lands.

We group the nine ejidos into two categories distinguished by their historical encroachment and recent division (or not) of the commons. The first group of four ejidos consists of those ejidos that had divided most of their common land by 1994, the year of the first ejido survey. These ejidos had less than 24 % of their land left in commons by 1994. Three of the four ejidos in this group cleared most of their commons and converted the land from forest to agriculture or pastures, while one assigned individual ownership to its common forest, but with the forest remaining intact. The second group of five ejidos did not divide their commons before 1994, and had relatively little encroachment on the commons. These ejidos still had a significant share of their total land (at least 40 %) in common in 1994. Of these five ejidos, two did not change the status of their commons between 1994 and 1997, while another two divided and titled most or all of their common during this period. The fifth ejido in the second group changed the status of its commons to an individual unassigned plot area in 1997, with the land serving as a common reserve for future generations. Summary statistics for the ejidos are presented in tables 18 through 21.

6.1 Case Study Ejidos that Divided Their Common Land before 1994

<u>Plan de Ayala, Campeche: Early division of the commons and partial titling.</u>

Plan de Ayala was established in a lush tropical forest with 43 members, most of whom were previously farm workers on large private ranches. Rapid deforestation following the formation of the ejido in the early 1980s, transformed the lush forest into cornfields and enclosed pasture. Through the process of land clearing, the common land was informally divided among the ejidatarios. Originally, 57% of the ejido's land was classified as common property. By 1994, 2700 of the 2,856 hectares of ejido land, were in individual plots, with the rest in the urban zone -- there are no real commons left. Land is unequally distributed in the ejido because members cleared plots of

different sizes, and because informal land transactions were frequent in the community. Land holdings average about 60 hectares, with the largest land owner controlling 127 hectares, and the smallest 20 hectares.

The rapid deforestation and individualization of the common land resulted from several factors. Inexperience in managing common assets and a lack of government support for cooperative endeavors contributed to the inability of the ejido to organize a profitable collective forestry operation. Another factor cited by interviewees was the relatively high profits that could be earned by opening up new agriculture and cattle ranching fields. Finally, establishing rights over the land by clearing it served as a method of obtaining usufruct rights to the land. These usufruct rights were being considered by *Procede* in 1997.

Chilar, Campeche: Inequality and fairness in dividing the commons

El Chilar was established in 1966 with a total land area of 3,100 hectares. By 1994, the ejido had informally allocated 71% of its total land to individual plots, distributing 50 hectares to each of the 44 official members. A part of the individual plot area is composed of rainfed agricultural terrain or grasslands established over deforested areas, with remaining area unassigned forest. The ejido has 740 hectares of common land, a share of it covered by water for most of the year. The ejido has no organized activity in the commons, and treats it as an open-access source of firewood and non-timber forest products.

The ejido decided to take advantage of the opportunity to divide the commons that was presented by the new land reform initiative. The low value of the common land and the fact that this land was not being profitably used by the community contributed to the desire to divide the commons. At the same time, division of the commons represented a way of providing more land to individual ejidatarios to pass on to their children. Rather than a haphazard and potentially contentious process of encroachment into the common area, the ejido decided to seek a formal arrangement.

When this ejido first met to discuss the division of their commons they agreed to divide the common area by giving each member a share of equal size, leaving only the flooded area as common. However, before *Procede* initiated its work in the ejido, the internal agreement collapsed. Some ejidatarios argued that land quality was heterogeneous and that the plots should vary in size. Others argued that the older members of the community should receive land closer to the town, while the younger men should receive plots that were further away. Finally, an agreement was reached which took into account differences in land quality, location and the people receiving the land. The resulting allocation was submitted to the *Procede* officials for titling.

Paraiso, Quintana Roo: Encroachment leads to inequality, division of commons stops it.

Paraiso was founded as a collective ejido in 1971, with 33 members and an initial endowment of 5,300 hectares of medium-sized forest. The ejido never operated collectively, and since its founding, land was worked individually. Individual control of the land accrued to those who could clear forest and work the land. By 1994, the ejido had divided 4,250 hectares among themselves, leaving 940 hectares as common land, and 110 for the town area.

The process of establishing usufruct rights over the land lead to a high degree of inequality in land holdings within the ejido. The poorer families, who relied exclusively on family labor to work the land, could only claim about 7 hectares each. On the other hand, richer families who hired in labor could work plots of 50 hectares or more. Some wealthy ejidatarios who managed to register their wife and adult children as new ejidatarios were able to lay claim to several hundred hectares of land.

In anticipation of *Procede*'s titling program, the ejidatarios decided that to avoid further unequal encroachment onto the commons they would allocate 100 hectare plots to each member, regardless of whether the land had been converted from forest to agricultural or cattle ranching. In addition, to ejido assembly approved an increase in the number of ejidatarios, the land for these ejidatarios coming from a further reduction in the commons form 17% to 9% of the total. The ejido decided that this arrangement would be enforced within the ejido, even if it was not recognized by *Procede*. While some of the wealthier families opposed the division of the commons, the majority eventually prevailed and *Procede* was petitioned to approve the internal arrangements.

Caanlumin, Quintana Roo: Informal extra-legal division of commons

Caanlumin is an ejido in the tropical forest region of the state of Quintana Roo. The ejido was formed in 1976 as a collective ejido with 3,850 hectares of the land shared by its 40 members, the majority of whom are of Mayan ancestry. The ejido was created in a region of medium-high forest containing valuable tropical woods and *chicle* trees. Soon after the ejido was established, ejidatarios began clearing small plots for agriculture. Unlike some other ejidos in the region, Caanlumin sold their better timber stock quickly and failed to create an organization to promote long term forest management. By 1996, extensive individual unauthorized timber extraction had resulted in severe degradation of forest quality and significant loss of forest to agriculture and pasture.

Despite its status as collective ejido, not long after its formation the ejido established an internal agreement assigning 3,200 hectares of the total ejido land as individual plots, and 480 hectares as common property. The remaining 170 hectares were zoned as an urban area, where housing and additional individual agricultural plots are located. The internal division has not created conflicts within the ejido, and boundaries of private plots have been well respected by all members.

Their reasons for dividing the commons can be explained by the combination of three factors. First, the ejido had never had profitable cooperative activities -- such as managed forestry projects -- carried out in the commons, nor did it plan any in the near future. Without a successful cooperative solution, individual exploitation was more appealing. Second, an early division of the commons was seen as a way to preclude open-access timber depletion. Third, titling was seen as a way to protect future individual investments on the land.

When *Procede* started working in the region, the ejidatarios in Caanlumin knew about other collective ejidos dividing their commons, and they agreed to try to formalize their division of the commons. In the case of Caanlumin, *Procede* officials refused to formalize the division because the land was officially classified as tropical forest. The Ley Agraria, forbids the transfer of common land to individual use when it is tropical forest. Despite *Procede*'s repudiation, the ejido now behaves as if their informal agreement were valid.

6.2 Case Study Ejidos That Had Not Divided Their Common Land by 1994

Corregidora, Tabasco: Enhanced cooperation after successful division of commons.

The ejido, Corregidora, is located near the Guatemalan border and the Peten rainforest, 2 hours by dirt road from the nearest urban center. Of the ejido's total area of 1,203 hectares, 300 are registered as individual plots, 700 as common property, and 203 as "urban" -- an area that includes the village, plus additional individual agricultural plots. The ejido was established as a collective in 1969, but since its foundation members have worked their agricultural land individually. In 1994 the village had 81 households, consisting of the families of the 24 official ejidatarios, avecindados, and children of ejidatarios.

Some of the individual ejido plots are not all well-suited for agriculture or livestock. Staples such as corn and vegetables are cultivated on 64% of the land allotted for individual use, but most of the remaining area is hilly and covered by low tropical forest. Ejidatarios argue that cattle prices do not offset the cost of converting and maintaining this area as pasture, so it remains unused. About 70 hectares of the original forest were converted to grasslands, on which ejidatarios pasture horses. The ejido has no written regulations on the use of this common pasture, but there are informal agreements within the ejido for the community to work several days every year on pasture maintenance.

In the past, several individually managed small-scale operations have extracted palm and timber from the common forest, selling to local traders. These activities had no organization or management plans and they resulted in declining palm tree stocks and deforestation in the more easily accessible areas. By 1995, the ejido has extracted virtually all of its commercially-sized trees from its common property forest. There remains 438 hectares of medium tropical forest, with some immature stands of valuable species such as cedar and mahogany.

In 1996, when *Procede* began land titling in the region, the ejidatarios decided that they would register many of the non-ejidatario families living in the ejido as full-rights ejidatarios -- increasing membership in the ejido from 24 to 41 members. They also decided that they would divide most of their commons, in both the occupied and unoccupied open-access areas. The ejido assembly assigned 40 hectares to each original ejidatario, and 26 for each new member, leaving no land as common. The ejidatarios believed that granting individual rights to the forest would eliminate open access competition for forest products, and create incentives for individuals to replant palm and other tree varieties or establish coffee, cocoa, and other types of plantations. Procede validated the ejido's internal agreement to divide the commons, officially reducing the amount of common land from 58% of the total to 22%

Most of the ejidatarios that were interviewed claimed that the results of the common property division had been very positive. Corregidora now has a forestry management plan which includes reforestation provisions and group sales to a private firm. Under the plan, each ejidatario receives payment for the timber that is extracted from his or her plot. With the support of federal agencies, ejidatarios have established a nursery for cocoa and palm, and a reforestation of individual plots is taking place. In this ejido, the division of the commons eliminated the open-access problem, and allowed for the profitable exploitation of the common resources. The division of the commons may also have enhanced ejido-level cooperation, as the ejido became a mechanism through which individuals were able to derive income from the previously degraded common resources.

Petcacab, Quintana Roo: Keeping collective property with individual rights over yields.

Petcacab is a large ejido, with a total area of 46,000 hectares, of which 3,000 hectares (6.5%) was formally registered as individual plot area in 1994. The area of individual control is a relatively small percentage of the total area, but with such a large total area and only 74 official ejido members, the plots average 40 hectares per member -- a relatively large amount compared to other ejidos. In 1994, Petcacab had 43% of its total area registered as common property, all 20,000 hectares of which is tropical forest. The ejido also has an unusual 23,000 hectares (50%) registered as an urban zone, but this area is actually composed primarily of individual plots and common forests.

Petcacab is one of the more successful forestry ejidos in the region, maintaining a large tropical forest under a sustainable management plan. The ejido households receive a sizable and expanding share of their income from forestry activities. In 1994 they received 93,000 pesos in net benefits from forestry activities, of which 45% went to the ejido for reinvestment in the forestry firm and for building community infrastructure, and the rest was divided among members.

The solid performance of the Petcacab's forestry activities can be attributed to long term support from governmental and non-governmental programs, to a strong multi-ejido association specialized in forestry, and to an efficient ejido-level organization. The multi-ejido association designs and obtains government approval for the ejido's management plans (which includes the volumes and areas to be cut), and negotiates prices and other sale conditions with buyers. The ejido-level organization manages the sawmill and is responsible for the delivery of timber products. Before 1996, the ejido-level organization also coordinated forestry labor and tree cutting, but the ejidatarios were not satisfied with its performance. They felt that, for the total sales volume handled, the administrative costs of the ejido-level organization were too high, so they completely overhauled the system. Now each member extracts his own allocation of timber -- a proportion of the total quota handed down by the multi-ejido association. The individual allotment is proportional to the individual's share of the commons. Each member pays for the sawmill services directly and delivers the processed timber to the ejido organization on time for it to be sold.

Petcacab had 74 official members in 1994, but by 1997 it expanded the number of members with official ejido status to 206, with most of the new ejidatarios being relatives of the original members. Many of the new ejidatarios already had individual plots as land sales had always been permitted in the town area which was large enough to accommodate a large number of sales. The new ejidatarios were admitted after years of participating in forestry activities and helping to build the ejido forestry organization. An important motivation for incorporating more ejidatarios into the ejido was the ejido inheritance law that prohibited bequeathing rights to the ejido commons to more than one child. By becoming official ejidatarios, many children of an ejidatario can receive an official share of the commons -- albeit a smaller share than the original members possessed.

When *Procede* approached the region in 1996, the ejido assembly discussed breaking up their common land, but the overwhelming majority opposed it. The ejidatarios decided that they needed the commons to remain the property of the whole ejido to be sure that it would be devoted to forestry and thereby maintain the economies of scale needed for its long term management. The profitability of the cooperative endeavor counterbalanced the incentives to privatize the common lands. After carefully measuring the ejido land, *Procede* redefined all but 3% of total land as commons. The 3% that is not commons includes a more realistically sized town area of only 0.5% of the total, and a private plot area of 2.5% of the total. Some private plots are officially located in the common area, but these continue to be managed individually.

La Manga, Tabasco: A division of the commons in anticipation of *Procede*

La Manga is a relatively old ejido, formed in the late 1930s, and located about thirty minutes from the city of Villahermosa. At its formation, La Manga had 610 hectares (49% of its total land) registered as individual plots. This land was equally divided among its 61 members so that each had 10 hectares. By 1996, individual ejidatario land holdings had become less equally divided, still averaging close to 10 hectares, but varying significantly from family to family. In 1994, the ejido officially had nearly 49% of its total land registered as common property. The common area is composed of grassland (87%) and a lagoon. In 1994, 80 head of cattle grazed on the 535 hectares of common land. About 82% of the herd belonged to the ejidatarios, with the remaining owned by avecindados who paid a use fee to graze on the commons.[11]

In 1994, La Manga reported having 163 avecindados, a relatively high number compared to the number ejidatarios. The high number of avecindados can be explained by the ejido's age and its location. Since the ejido's formation in the 1930s, the community has formed many new families, with only some of these families inheriting ejido rights. Many of the children of the original ejidatarios who do not possess ejido rights have continued to live in the ejido,

[11] Avecindados are neighbors of ejidatarios who live in the ejido community but are not ejidatarios nor directly related to ejidatarios.

either working family land under informal arrangements, or working in the city or the nearby petroleum industry. The proximity to industrial and other work opportunities also makes La Manga an attractive community for new families settle in. In response to the growing population, several ejidatarios have informally divided part of their plots and sold them for housing.

Several factors contributed to decision within the ejido to divide their common land. Some ejidatarios complained about the ability of the ejido to manage its common pasture land efficiently, citing problems with members shirking on their communal duties. A stronger motive for dividing the commons resulted from the demand by the children of the original ejidatarios and new settlers for land for housing and agriculture. The incorporation pressure has resulted in some encroachment onto the commons by ejidatarios and avecindado households with plots near to the common area. This encroachment has been unequally distributed and has created conflicts and social tensions within the ejido. Dividing the commons presented a way for the ejido to equalize land holdings and prevent future conflicts.

When the ejido learned that *Procede* would be starting its work in the region, the ejidatarios reached an agreement to divide their common land. The commons were divided in such a way that all the ejidatarios had access to 16 hectares -- an equal share of the total "usable" land in the ejido -- in effect compensating those with less land. Under this internal arrangement individual plot area increased to 97% of the total area, with 3% of the total classified as "urban". The only area that maintains the common access use is the lagoon. When *Procede* officials asked the ejido assembly to identify individual plots and the boundary of common property, they gave the agency the information corresponding to the internal agreement, and as the land was titled accordingly.

San Jose Montecristo, Quintana Roo: The commons as a land reserve.

The ejido San Jose Montecristo has a total area of 2,193 hectares, 55% of which is under individual control, 41% in common property, and the remainder designated for housing. The ejido was created in 1980, with 58 members, all of Mayan ancestry. In addition to the families formed by descendants of the original members, the ejido reported 7 avecindado households. The ejido's 893 hectares of common property is comprised of pasture land (31%) and low tropical forests (69%). Pasture land is informally shared, with no written rules governing the use of the pasture. In this ejido, the low tropical forests serve primarily as a land reserve, providing land for permanent agriculture as a growing population expands into those areas. There is no other collective activity in the common forests, and no income is derived from it.

In San Jose Montecristo it has been a traditional practice that as families grow or new households are formed, they would be permitted take land from the commons for their individual use. This encroachment onto the common land was "need-based", and was not guided by a proportional or rule-based system. When the *Procede* began its work in the region, the ejido assembly discussed the possibility of dividing their commons but decided against it, so as to preserve the function of the commons as a land reserve for the future generations. *Procede* formalized the ownership of the current state of land holdings in 1996, and documented the unoccupied land as an unassigned individual plot area. According to the ejidatarios, this would not change their practice of distributing their land to families as the need arose.

In deciding not to divide their commons among current members, the ejidatarios denied themselves the right to bequeath or sell their share of the common land. On the other hand, since common land will be available to children of ejidatarios who wish to remain in the ejido into the foreseeable future, the ejidatarios did not sacrifice the ability of their children to obtain land. Perhaps some of the ejidatarios with large families did not want to divide the commons because their children might have less access to land under that scheme.

Yaxcaba, Yucatan: Traditional community control and land heterogeneity favors maintaining commons.

Yaxcaba is an older collective ejido with a majority of members with Mayan ancestry. Established in 1930, it has a total area of 6,336 hectares, of which only 8% is classified as individual plots, 3% as town area, and the remaining 89% is registered as common property. It has 180 official members, but a total of 320 have applied for the right to become full members, with most of these applicants being second or third generation descendants of the original ejidatarios. Twenty applicants have been officially incorporated into the ejido since 1994, with the remainder working land as part of their parent's or grandparent's households.

Land in the community is fairly equally divided, with each household cultivating plots between one and five hectares. The traditional subsistence agriculture practiced in the ejido follows a slash and burn cropping pattern. In Yaxcaba, all members of the community have the right to clear a patch of forest or secondary vegetation in the common property area. The land is worked for some years until yields fall, and is then abandoned for another plot. The fallow land eventually regains its fertility and any member of the community can again clear the field and work it. Given the average plot size and number of households, land remains fallow for approximately 8 years before being worked again. On most of the land there is no permanent personal claim on the plots: they revert to the community.

The commons of Yaxcaba are low tropical forests with soil of a highly variable quality. Some areas have "Kancab", a fertile red soil that gives high yields, while other areas have rocky shallow soil that gives low yields. Ejidatarios reported that it is difficult to determine the type of soil that lies under secondary forest cover, and it was only possible to ascertain soil quality after the forest is cleared. When farmers discovered low quality soil after slashing and burning an area, they would move on and clear another area until they found "Kancab". This characteristic was important in the decision of the ejido not to divide their common lands.

The representatives of the ejido who were interviewed mentioned that they had rejected the possibility of dividing their commons for two main reasons. First, gaining property rights over the land would bring few recognizable benefits because ejidatarios already had unlimited access to the land. In fact, the traditional system allowed individuals to remain on the land as long as they liked, allowing for the possibility of long term investments or improvements to the land. Second, assigning private rights had the possibility of resulting in situation where some households would have only poor quality land. If this occurred these households would be unable to move to a new area without having to rent land from another ejidatario. Hence, with few potential benefits and the possibility for significant individual losses, the ejidatarios voted to maintain there current system of land tenure.

6.3 Division of the Commons in the Case Study Ejidos

In this subsection we analyze 1) the reasons why some ejidos chose to divide their common lands before 1994, and 2) the decision to divide or not divide the commons between 1994 and 1997. Our analysis of the early division is based on the case study interviews, while our analysis of the later division takes advantage of information from the 1994 and 1997 ejido surveys. Table 20 summarizes the reasons for and against a pre-*Procede* (pre-1994) division of, or encroachment on, the common areas in the case study ejidos, and summarizes why some ejidos sought to title their common lands between 1994 and 1997.

We identify several key reasons why the commons were divided in the case study examples. One of the underlying reasons for dividing the commons is an inability to coordinate resource extraction. When ejidos fail to cooperate, form intra-group contracts, or monitor a resource manager, then joint exploitation of the common lands is less profitable. When joint exploitation of the commons is less profitable than individual exploitation, then there is an incentive to divide the common land. Second, when the common land is such that there are few economies of scale or risk-diversification payoffs to be gained from keeping the land in common, the main economic incentives for

cooperation will not be present, and ejidatarios will be more likely to try to divide the common land. Third, when occupation of the common land leads to usufruct rights over the land, then there is an incentive for individuals to "grab" as much land as possible as quickly as possible. If an individual is able to occupy and control more of the common land than his fair share, he may be better off than if he cooperated in joint resource extraction. Fourth, division of the commons can serve to redress past unequal encroachment onto the commons, or prevent future unequal encroachment. Finally, when there has been open-access resource extraction, or where some individuals have benefited from the resources at the expense of the group, the group may divide the commons as a way of preventing further resource depletion.

Pre-1994 Division of the Commons.

Those ejidos that divided their common lands before 1992 fall into two types: those that cleared their common lands and converted the land to agriculture and pasture, and those that divided the land but left the forest intact. Three ejidos, Plan de Ayala, Chilar, and Paraiso rapidly cleared their common forest land, resulting in pronounced deforestation and environmental degradation. To a certain extent this encroachment was a product of the inability of the ejidatarios to cooperate in exploiting their commons. Lack of cooperation increased incentives for individuals to embark on individual appropriation of the land. The encroachment and informal division of the commons in all these ejidos was, to varying extents, unequal and contentious.[12] Two of these three ejidos moved to legally divide their remaining commons in 1997 in order to minimize future additional conflictive encroachment onto the commons. Because a legal division of the commons requires that a consensus be reached at the ejido level, the legal division appears to have led to a more equitable allocation of the commons than would have occurred if the division had been allowed to progress in an unregulated fashion. [13]

Unlike in the three ejidos where most of the forest land was cleared, in Caanlumin most of the common forest remained intact. In Caanlumin, the ejidatarios of were unable to cooperatively manage their forest resources and the timber became subject to unequal open-access depletion by ejido members. The ejidatarios divided the common forest as a way of prevent unequal open-access resource extraction. By assigning individual property rights over the common resources, the responsibility of monitoring the forest shifted from a large ineffective group (the ejido) to individual property owners. Where cooperation has failed, as in Caanlumin, and where privatization can serve to prevent encroachment, dividing the commons may be the best alternative for preserving natural resources. After dividing and titling the commons, the challenge remains to help these ejidos form profitable forestry organizations to take advantage of the economies of scale that can be achieved by jointly managing their forests, thus inducing them to keep them intact.

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[12] The contentious encroachment onto the commons that occured in these three ejidos is in contrast with the uncontentious encroachment that occurred in San Jose Montecristo and Yaxcaba. These two ejidos had well-established internal systems to allocate common land to members of the community. In San Jose Montecristo, common land is available for permanent settlement by relatives of ejidatarios who remained in the village. In Yaxcaba, there is a slash and burn system where all ejidatarios move throughout the commons. These two ejidos present examples of a land tenure system which serves to regulate the competition for land within the ejido, thereby preventing excessive land clearing and an early division of the commons. Both ejidos chose not to divide their commons early on because their system of managing this land was satisfactory, and dividing the land would offer them few benefits but instead pose new risks.

[13] *Procede* only titles ejido land if the ejido assembly has sorted out its internal boundary problems and if it has resolved, through the Secretariat of Agrarian Reform, its external boundary problems with other ejidos and private property owners. The government of Mexico has pursued a policy of resolving the backlog of land claims (the *Rezago Agrario*) and land disputes (through the *Tribunal Agrario*) which should help reduce tenure conflicts and promote cooperation.

Division and Titling of Common Land between 1994 and 1997.

For the ejidos that still had a significant share of their land in common in 1994, we can use data from the 1994 and 1997 surveys to identify some factors that influenced the decision to divide the commons between 1994 and 1997. Figure 9 lists the nine case study ejidos according to how much of the total land of each ejido was common access. Five ejidos still had a significant share of their total land (at least 40%) in common in 1994. Of these five ejidos two -- Petcacab and Yaxcaba -- did not change the status of their commons between 1994 and 1997, while La Manga and Corregidora divided and titled most or all of their common lands in this time. San Jose Montecristo, the fifth ejido with significant common land in 1994, changed the status of its commons to an individual unassigned plot area in 1997, with the land serving as a reserve for future generations. The remaining four ejidos all had less than 24% of their land in commons before 1994 due to earlier encroachment and division.

Good cooperation in the management of the common resources allows for profitable joint versus individual resource use. The case study descriptions indicate that both Petcacab and Yaxcaba have had successful and non-contentious management and use of their common land. This cooperation is reflected in the measures of ejido-level cooperation presented in Table 20: both Petcacab and Yaxcaba had frequent assemblies and high levels of attendance at the assemblies. The strong cooperation may be in part due to the fact that, as shown in Figure 12, both ejidos are composed exclusively of members of an indigenous ethnic group -- indicating greater group heterogeneity. Similarly, Petcacab and Yaxcaba are, as shown in Figure 13, the oldest ejidos among the nine, implying that they have had the longest time to form social interdependencies which can serve to reinforce group cohesion. In contrast, the four ejidos that divided the commons early are younger ejidos, having been in existence for less than about 30 years. Finally, both Petcab and Yaxcaba were, as shown in Figure 14, located furthest from a market. Being more remotely located is likely to reduce the exit options available to ejido members, making cooperation more desirable.

In deciding how much of the total ejido land to divide between commons and individual plots, ejidatarios will equate the marginal value product of the individual land to marginal value product of the common land. Consequently, all else being equal, we would expect ejidos with relatively small individual plot areas, where land is suboptimally allocated to agriculture, to exert more pressure to divide their commons than those with larger individual plot areas. Figure 10 illustrates that the two ejidos that kept their land in common had about twice the individual plot land per member than did the second group of ejidos that divided their commons in 1997. Similarly, we would expect ejidos with land that is relatively more profitable in agriculture to be more inclined to divide their commons. This result is consistent with the fact that the ejidos that divided their commons had higher corn yields than those that kept the land in common, as shown in Figure 15.

Finally, economies of scale provide an important incentive for maintaining land in common. Figure 11 illustrates the size of the commons for each ejido in 1994. Except for Petcacab and Yaxcaba, the two ejidos that kept their lands in common, all the other ejidos had common areas in 1994 that were probably too small to take advantage of significant economies of scale in exploitation of common resources. We know from the case study that Petcacab's large common forests allowed for profitable joint exploitation, which provided a strong disincentive to divide the land into smaller units.

7. Conclusions

Common pool resources in Mexico's ejido sector are extensive, with large areas of forest, pasture, and agricultural land under collective management. Despite the size of the common property resources, evidence from a 1994 survey of the ejido sector indicates that these resources are poorly managed, and that benefits from the common lands are derived primarily via individual rather than ejido-level appropriation. Information from the survey indicates that there

are widespread cooperation failures leading to environmental degradation in the common pool pasture and forest lands located in the ejido sector.

Recent reforms of the Agrarian Law, the Forestry Law, and other domestic market policies have affected, and will continue to affect, the ability of ejidos to manage their common pool resources. The reforms have altered individual incentives to cooperate, encroach on common lands, form associations with private firms or individuals, and have impacted land use decisions.

The agrarian reforms initiated in 1992 have had a mixed effects on common property resources. Changes in the Agrarian Law have allowed ejidos to redefine the area allocated to common and individual lands, even when this redefinition occurs at the expense of common land. In some ejidos, the redefinition of common land is likely to have led to an over-conversion of forest land to livestock and agricultural uses compared to the social optimal, resulting in a loss of economies of scale in common resource use and increased risk for ejidatarios. The agrarian reforms have done little to address the process of informal encroachment on common land, and in some ejidos there remains the incentive to occupy and cultivate the common land in order to gain official title to a plot. On the other hand, where there has been individual titling of previously common land, the incentive for individuals to occupy and use the commons in order to gain title over it has been eliminated, with beneficial environmental and efficiency consequences. In addition, titling has, in some cases, helped to define and strengthen property rights over ejido common lands and forests, resulting in less illegal timber cutting and increased cooperation in the formation of associations with private firms. Some of the agreements to divide the common land should serve to help prevent future resource depletion by shifting the responsibility of monitoring the forest from large previously ineffective ejido-level organizations to individual property owners.

By permitting ejidos to form associations with private firms, the new Forestry Law has the potential to increase profits on forest land and thereby promote sustainable forestry systems. However, growth in forestry firm contracting requires transparency in how profits will be distributed. Some communities may maintain inefficiently managed locally controlled lumber operations rather than form more profitable associations with firms if they fear that forestry profits will be mismanaged or expropriated. There is a role for the state in clarifying the laws governing the distribution of forest benefits, and in providing assistance to ejidos in how to contract and establish secure and transparent systems of profit sharing.

Changes in the Forestry Law are designed to help control illegal logging and promote sustainable commercial exploitation of forests by concentrating the transfer of funds on the planting and maintenance stages, and by requiring ejidos to have a sustainability plan. However, the funds allocated to sustainable aspects of the plan are small, while the subsidies directed toward road and mill construction are much larger. There is a danger that the subsidies will encourage deforestation in areas located near areas targeted for support by lowering the costs of logging in those areas. The government should play a more active role in promoting sustainable forestry in regions where timber extraction costs have been reduced by the positive externalities created by infrastructure investments in ejidos.

Procampo, the compensation program designed to ease the transition for farmers toward freer markets and trade, may have had some negative environmental consequences. To the extent that farmers were given the (erroneous) incentive to clear forest land in order to register their land for the *Procampo* benefits, the program may have resulted in excessive deforestation. So as not to create future incentives to clear land to enroll in the *Procampo* program, the government should maintain its commitment not to expand the registry of beneficiaries in the future. *Procampo* may also be having negative unintended environmental consequences by encouraging growers to keep land in production rather than allow it to revert to its natural state, which may include forest. In addition, it is likely that *Procampo* is inhibiting the reforestation of certain areas as many growers do not appear to understand that forest plantations qualify for the *Procampo* program. All these reactions to *Procampo* are based on mis-information or on mis-implementation of the program. It is consequently urgent for the government to review the effective

implementation of *Procampo* and assess the environmental implications of improper implementation of the program.

Some domestic programs -- such as agricultural credit, insurance, and extension -- have recently begun transacting with individual producers rather than with ejidos. This "individualization" of agricultural policy has reduced for ejidatarios the importance of the ejido as an instrument with which to obtain services from the state. With fewer benefits available at the ejido level, there is a weaker economic incentive to cooperate at the ejido level, making the ejido a less effective organization for managing common resources. In a period where Mexico needs to reconstruct a set of agrarian institutions to service the ejido sector, substituting for and improving upon the services formerly delivered by parastatal agencies, the role of the ejido as an organizational unit should not be overlooked. New institutions to access to credit, markets, technical assistance, and insurance are needed. In many situations, the ejido could serve as the community (with advantages of locally public information for monitoring, social capital for enforcement, and continuity in social interactions) within which these institutions would be set up. The ejido may often be too large and too conflictual to serve for this purpose, calling upon the formation of sub-coalitions within the ejido set up to deliver specific types of services. However, what this implies for policy purposes is that the social capital accumulated in the ejido through years of community relations should not be let to depreciate. To the contrary, a proactive approach should be pursued by the Secretariat of Agrarian Reform and NGOs to preserve this social capital, and build upon it to help ejidatarios construct the service institutions which they need to achieve competitiveness in the broader context of the economic reforms.

Economic efficiency and environmental sustainability in the ejido sector will depend critically on the ability of ejidos to cooperate in the management of their common resources. Poor cooperation can contribute to negative environmental consequences including: increased over-grazing of common pasture lands and over-extraction of resources, reduced border enforcement leading to increased poaching by ejidatarios and non-ejidatarios, reduced provision to the maintenance of common pool resources, and lower long term investment in the common resource. In addition, reduced cooperation lowers the value of the common land to individual ejidatarios because the ejido is less able to make profitable management decisions. Lower profits on common property increases the incentive to subdivide the common land into parcels for private exploitation, resulting in potential diseconomies of scale and higher exposure to risk.

The econometric analysis in this paper focused on understanding the relationship between ejido cooperation, rules governing the use of common pasture land, common pasture management practices, and environmental outcomes. The results of the study show that the presence of rules governing pasture management, pasture management practices, and environmental outcomes are all positively associated with cooperation; and that pasture management rules influence management practices and are positively associated with environmental quality. The results emphasize the need to engender and promote cooperation at the ejido level.

The empirical analysis in this paper identified several factors associated with cooperation, rule making, and environmental management practices and outcomes. In particular, we found that ejidos with fewer members, that were more homogenous, and that had less pressure on the land from non-members, were more likely to cooperate. The results suggest that to promote cooperation policies should: 1) Consider the break-up of the largest and most conflictual ejidos into smaller and more homogenous units. Until the reforms of 1992, the authority of government was sufficient to impose a structure of decision-making in ejidos, even when too large and conflictual to manage their own affairs. With the reforms and greater autonomy in management given to ejidos, the endogenous ability to cooperate becomes the determinant of quality management of ejido affairs, particularly common pool resources. Hence, assessing the ability of ejidos to so is now essential, including questioning the size and membership composition of existing ejidos. 2) Short of division, the formation of sub-coalitions within an ejido can be promoted and facilitated. Subsets of members can thus be given jurisdiction over subsets of the ejido resources, eventually achieving successful cooperation within the subcoalitions when it was not possible at the ejido level. 3)

The development of secondary markets for the appropriation of the ejido's common resources can be promoted. If properly managed, these markets can restore efficiency in resource use. 2) Encourage ejido homogeneity by using the titling process to equalize the size of individual land holdings by compensating some ejidatarios with more land as the part of the commons is divided. *Procede* should be particularly hesitant to "regularize" land holdings that have resulted in highly unequal resource distributions, as this heterogeneity will diminish the ability of the ejido to cooperate and make rules. 3) Reduce pressure on the land from non-ejidatarios living in the ejido. Presence of these socially excluded households is nefarious to cooperation among the legal ejidatarios: non-ejidatarios live in the community and press for access to resources while not being included in ejido decision mechanisms. *Procede* can reduce these inequities that undermine cooperation by incorporating these households as full rights ejidatarios settled on previously common pool land. 4) Pressures by non-ejidatarios to be incorporated and to access land can be reduced by either promoting out-migration from the ejido or increasing non-agricultural employment opportunities within the ejido. A regional development policy of employment creation in non-agriculture should thus also be an element to improve cooperation among ejidatarios.

The ejido case studies presented in the paper provide examples of the factors that influence the decision of ejidatarios to divide their common lands. One of the most important factors in the ejidos we examined was the ability to cooperate in managing common pool resources. When ejidos fail to cooperate, form intra-group contracts, or successfully monitor a resource manager, then joint exploitation of the common lands is less profitable, and the incentive to divide the land increases. Second, when the common land is such that there are few economies of scale or risk-diversification payoffs to be gained from keeping the land in common, the main economic incentives for cooperation will not be present, and ejidatarios are more likely to try to divide the common land. Third, when occupation of the common land leads to the granting of usufruct rights over the land that are directly proportional to how much land has been occupied, then there is an incentive for individuals to "grab" as much land as possible as quickly as possible. If an individual is able to occupy and control more of the common land than his fair share, he may be better off than if he cooperated in joint resource extraction. Fourth, ejidatarios may be motivated to divide the commons in order to redress past unequal encroachment onto the commons, or prevent future unequal encroachment. Finally, when there has been open-access resource extraction, or where some individuals have benefited from the resources at the expense of the group, the group may divide the commons as a way of preventing further unequal resource use.

Combining the case study analysis with the 1994 survey data helped identify several characteristics associated with the division of the commons. In particular we found that high quality cooperation and maintenance of ejido resources in common access were associated with a population comprised of members of an indigenous ethnic group, being an older community, and being located further away from a market. We also found that the ejidos that kept their land in common had more individual plot land per member and lower corn yields than did those ejidos that divided their commons. Finally, the ejidos that kept their lands in common had large common areas that allowed them to take advantage of economies of scale and risk diversification in exploiting these resources.

The case studies illustrated that when ejidos are unable to cooperate, they often suffer from open access problems and excessive resource depletion. Lack of cooperation may even prevent these ejidos from forming business associations with outside economic interests or from leasing-out their common land. Carefully selected ejidos should be permitted to either subdivide their common land or else to sell it as an undivided unit to a private party or the government. A division of the commons can serve to help prevent excessive resource depletion by shifting the responsibility of monitoring and patrolling the forest from large previously ineffective groups (the ejidos) to individual property owners. In addition, assigning property rights to the common land can remove the incentive to occupy and clear the land in order to lay claim to it -- a positive effect in terms of efficiency and the environment. After dividing and titling the commons, the challenge remains to help these ejidos form profitable forestry organizations to take advantage of the economies of scale that can be achieved by keeping their forests intact.

For ejidatarios that would benefit from keeping land in common access due to economies of scale, risk diversification, and high costs of division, the fundamental determinant of success in resisting pressures to divide and in achieving socially optimal management is ultimately their ability to cooperate. This is an area in which major policy initiatives are left to be undertaken. Until the reforms of 1992, responsibility to manage cooperation among ejidatarios or to substitute for lack of cooperation through the authority of representative of the state, was vested in the agents of the Secretariat of Land Reform. In the future, the role of this agency will undoubtedly be weakened, both by the constitutionality of the reforms and by its budgetary situation. The ability to cooperate must now be endogenized within every ejido. We identified a set of conditions that facilitate cooperation. What will trigger cooperation will often have to come from outside the ejido. The Secretariat of Agrarian Reform has an important new role to play in helping train ejidatarios to develop their own cooperative management practices. Historically, due to a strong presence of the state and overwhelming concerns for political control, the large ejido sector has been largely out of reach for NGOs. With the reforms, NGOs, eventually funded by public and international resources, should have an increasing role to play in assisting ejidatario communities achieve successful cooperation in managing their affairs, including their common property resources. Cooperation will also allow the social capital accumulated in the ejido to be preserved and used to promote organizations and new institutions in support of the competitiveness of the newly titled smallholders.