Contradictions in Agricultural Intensification and Improved Natural Resource Management: Issues in the Fianarantsoa Forest Corridor of Madagascar

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The international development profession is periodically buffeted by the infusion of new conceptual approaches that have a broad impact on both policies and project interventions at the local level. In Madagascar, as in many other countries, the government and donor organizations are turning to an ecoregional approach to natural resource management. Ecoregional planning is an outgrowth of the integrated conservation and development strategies (ICDPS) that prevailed in the 1980s and 1990s (Larson et al, 1998). It represents a major shift from the previous focus on preserving species diversity to a more encompassing view of maintaining habitat diversity, evolutionary phenomena, and adaptations of species to different environmental conditions around the world. As articulated by the World Wildlife Fund (one of the leaders of the new conservation paradigm), ecoregions are defined as:

…relatively large units of land or water containing a geographically distinct assemblage of natural communities sharing a large majority of their species, dynamics, and environmental conditions. Ecoregions function effectively as conservation units because their boundaries roughly coincide with the area over which key ecological processes most strongly interact (Olson et al, 1997: p1).

Because the approach favors the protection of larger areas, ecoregional conservation and development strategies often seek to connect existing protected areas with biological corridors. As one of the key proponents of the approach notes, “in order to stop the destruction of native biodiversity, major changes must be made in land allocations and management practices. Systems of interlinked wilderness areas and other large nature reserves, surrounded by multiple use buffer zones managed in an ecologically intelligent manner, offer the best hope for protecting sensitive species and intact ecosystems” (Noss, nd., p.10). Corridors connecting one protected area to another enable the flow of species across larger distances, thereby contributing to species survival over evolutionary time.

In Madagascar, policies have shifted away from the focus on protected area management to a broader regional and spatial analysis and a set of corresponding interventions at multiple scales from the village to the national level. The second phase of the 15-year Madagascar National Environmental Action Plan strongly supports a

1 The views expressed in this paper are those of the authors and do not engage USAID or Chemonics International.
spatial perspective. USAID has both actively promoted this approach and revised its own environmental program in response to these concerns.

The ecoregional approach, insofar as it looks at vast territories and focuses on more than excluding populations from circumscribed protected areas, implies a close attention to the human element of conservation. In reality, it is in most cases impossible to exclude populations from such vast areas. Instead, it is necessary to solicit their collaboration in conserving natural resources that would otherwise be subject to human threat. In this context, issues such as population, migration, and large scale agricultural intensification necessarily take on a high profile in ecoregional planning.

This paper reviews the way one USAID financed project (The Landscape Development Interventions Program, or LDI) has addressed these issues in a program that seeks to reduce human pressure on a forest corridor that connects two major national parks in the Fianarantsoa region of Madagascar. Initially, LDI focused on agricultural intensification as the primary strategy for reducing pressure on the natural forest. As the project evolved, however, several contradictions implicit in this approach began to surface. Among these were (1) the possibility that intensification and increasing incomes for some farmers might actually be contributing to greater rates of deforestation and (2) the realization that structural factors related to the deterioration of transport systems were likely to dwarf the positive impacts of the project’s extension activities. In the absence of reliable transport, farmers were likely to disintensifying their agricultural production and replace sustainable agricultural production systems with unsustainable practices. This would, in turn, result in a corresponding increase in the rate of deforestation as people sought to expand agricultural holdings.

This paper focuses on these complexities in the relationship between agricultural intensification and conservation, with specific attention to the relationships between transport, agricultural intensification, and sustainable natural resource management as these three factors are currently playing out in the LDI conservation and development program. It focuses especially on the impact the Fianarantsoa-Côte Est Railway (FCE), has both on both agricultural intensification and conservation in the Fianarantsoa Region as it crosses the threatened forest corridor on its way from the highland to the coast.

The hypothesis that the train line has a positive impact on the forest is suspect for many in the conservation community, which is more accustomed to viewing transport systems as threats to nature than as potential saviors. Indeed, road and rail transport systems do often facilitate immigration into otherwise inaccessible areas and promote exploitation of resources that might otherwise be spared from human pressures. These criticisms may ignore another set of equally important questions, however, including the critical role of transport in permitting agricultural diversification and intensification, and the role that those processes play, in turn, on reducing pressures on the forest.
The Application of the Ecoregional Approach in the Malagasy Highlands

The Forest Corridor

In the Fianarantsoa Region, LDI’s ecoregional approach is focused primarily on preserving the highland forest corridor between Ranomafana and Andringitra National Parks. The corridor in the Fianarantsoa Region (which is actually part of a longer corridor that stretches over much of the Malagasy highland) is a 450 km long band of forest. It is the last vestige of what was once a vast forest that covered the north-south escarpment between Madagascar’s east coast and the highland plateau. Now the Moist Forest Ecoregion has been reduced to a narrow band, ranging from about 4 to 15 kms wide. Rainfall ranges from a high of 2500 mm per year on the eastern escarpment to about 1500 mm a year on this high plateau to the west. [MAP 1 ABOUT HERE]

One particularly key part of the corridor from a conservation perspective (and therefore the area where LDI has invested the greatest effort) is the forest that connects Ranomafana National Park with Andringitra National Park approximately 160 kms to the south. This 1,005,395 ha of low, montane, and high montane forests represented about 10% of the province’s total landmass at the time of the national forest inventory of 1994. These parks, and the corridor between them, represent especially interesting ecosystems because of the great altitude differences in a relatively small area. Endemic species of flora and fauna abound both in the world renowned protected areas and in the corridor that connects them.

This forest keenly interests both conservationists who are concerned with the maintenance of Madagascar’s extraordinarily rich biodiversity and also local populations for whom the forest serves multiple functions including the protection of watersheds and...
the purveyor of goods of economic value (wood, crayfish, frogs, etc.). Yet, the corridor is becoming increasingly fragmented and there is a widespread concern that the forest may disappear entirely as farmers expand their fields and clear-cut the hillsides for tavy (slash and burn) agriculture. This fragmentation is particularly severe in the low altitude (500 – 800 m) humid tropical forest (S. Goodman, personal communication, 2000). As land is cleared and thinned by agriculture and forest product extraction, there is a reduction in habitats essential for the reproduction of flora and fauna, leading eventually to declines in biodiversity. Indeed, there is evidence that loss of the forest corridor may lead to certain species extinctions since some animals (such as the charismatic bamboo lemurs, *Hapalemur aureus* and *H. simus*) have no other known habitat on earth.

In addition to these biodiversity concerns which attract the attention of the world community, the disappearance of the remaining forest would have an immediate impact on neighboring populations who use a multitude of forest products in their daily lives; they collect wood and vines for construction and gather honey, crayfish, firewood, resins, and medicinal plants from the forest. But the effects will not be limited to those who live in and near the forest. Deforestation may also affect vast expanses of productive valleys and rice fields below if the hydrological balance of the region’s watersheds (most of which originate in the corridor) is disrupted. While there have been few rigorous hydrological studies of these questions, farmers fear that deforestation will lead to flooding during the rainy season (because water no longer infiltrates the denuded hillsides above) and water shortages during the dry season. Some farmers already suspect that forest clearing is leading to diminished rice harvests and they fear that if the forest is cleared they will be longer be able to produce two rice crops a year in their lowland fields (Freudenberger 1999).

**Pressures on the Forest Corridor**

While maps of the corridor make it look as though this is an intact and uninhabited band of forest, in fact studies of the region have found ample evidence of fragmentation (Hagen, 1999, Duggan, personal communication). Before 1990 there were very few people who actually lived in these primary forests. Most activity was limited to collecting wood and other products, but in a way that did not significantly alter the structure of the forest. This situation is rapidly changing, however. As recently as ten years ago, villagers report that there were no more than a few dozen families living in the forest; now there are as many as ten to twenty families from each village adjacent to the corridor who have moved into the forest and begun cultivation (Freudenberger et al 1999; Freudenberger 1999). This is true on both the east and west sides of the forest band. The Tanala ethnic group inhabits the east side of the forest, while the west is the traditional property of the Betsileo. Both groups are now sending pioneers to occupy lands that fall within their traditional ethnic territories but are well inside the forest. Villagers estimate, for example, that as much as 25% of the forest corridor under Tanala control has already been claimed by private interests. At this time, the majority of these property “rights” have not yet been activated and the land is not yet cleared but there are clear signs showing intent and indicating ownership (such as banana trees planted in the far interior of the forest) (Freudenberger et al, 1999).

At the outset of the LDI program, intensive field research was conducted on the factors motivating Betsileo and Tanala families to occupy the corridor and the impact of their activities on the environment (Freudenberger 1998; Freudenberger et al, 1999;
These studies found that while the patterns of occupation of the two groups are somewhat different, the effect is the same: scattered homesteads sprinkled throughout the forest. The Tanala, who favor upland farming, tend to choose farm sites that are high in the forest where their upland fields will have good sun exposure. The Betsileo, who are specialists in irrigated and terraced rice, look for water catchments and depressions where they cultivate irrigated rice, only later expanding to the surrounding hillsides. In looking for the most propitious sites for their preferred type of agriculture, both groups tend to penetrate far into the forest, rather than limiting their exploitation to the more easily accessible parcels on the periphery and adjacent to existing communities. These initial homesteads then become magnets attracting new colonists and accelerating further fragmentation.

The now familiar factors driving this occupation are also similar on the east and west side of the corridor, though there are some relatively minor differences. The principal driving forces are in both cases rapid population growth and declining soil fertility with pursuant reductions in agricultural production per capita or family. While population statistics are not highly disaggregated, statistics from the region and interviews with farm families suggest that growth rates in both the Betsileo and Tanala areas adjacent to the forest exceed 3%. As many as half the families in the case study villages had more than ten children. This results, of course, in serious land fragmentation as holdings are subdivided with each successive generation, a problem that is even more acute on the Tanala side where both male and female progeny inherit land and families are left with a multitude of often widely dispersed and very small parcels (Equipe Ralaivao, 2000).

Agricultural production typically consists of a field of irrigated rice (usually a very small parcel of ¼ to ½ ha for all but the wealthiest families and one or more upland fields that rarely total more than ½ ha). These upland fields are planted with a rotation of rice and manioc, followed by at least three years of fallow. In the traditional system, after only five to ten such cycles the land is considered barren by the farmer and is left in long term fallow, often for 50 years or longer. Yields on both the irrigated rice fields and the upland fields are notoriously low. A 1 ha lowland rice field typically produces 0.75 to 1.5 tons of rice, while a 1 ha upland field produces only 300-400 kg (Etude Ralaivao, 2000). There are few efforts to enhance soil fertility (aside from multi-year fallows) in the traditional system. In most of these communities only the wealthiest 20% own cattle and while those few farmers who apply manure do get significantly better yields, this is not an option for the vast majority of farmers.

Most farm families (especially on the Betsileo side of the corridor where water shortages limit irrigated rice production to one harvest a year) produce only a fraction of their food needs (typically enough to cover 4-6 months of consumption). For the rest of the year they undertake a variety of off-farm or salaried jobs to eke out their survival.

One of the longer term survival strategies of these populations is to expand their land holdings by moving into the forest and clearing a new parcel. On the Betsileo side of the corridor, where food security is more precarious, this strategy is primarily used by the wealthiest 20% of the families, who are food secure but are trying to assure the future of their offspring by expanding family landholdings (Freudenberger et al, 1999). (As discussed below, this raises one of the fundamental contradictions in LDI’s agricultural intensification activities by challenging the assumption that intensification, by raising revenues and increasing food security will reduce pressures on the forest.) The remaining 80% essentially find themselves too poor to think very far into the future. They
need activities that will immediately feed their families from day to day, and are thus too preoccupied with day to day survival strategies during the hungry season to be able to invest in forest clearing (Freudenberger et al, 1999). On the Tanala side, farmers (at least those who own irrigated rice fields) can usually get two harvests a year and are thus largely food self sufficient; as a result poverty poses less of a constraint to acquiring forest lands (Freudenberger 1999) and farmers from all economic classes engage in forest clearing.

Because rapid population growth and declining agricultural production are not restricted to the areas immediately adjacent to the forest corridor, on both sides immigration into the corridor is occurring both from the villages who are the traditional landowners of the corridor (and have been saving the forest as a sort of land reserve for many generations) and from areas further away. This finding argues strongly for the ecoregional approach (and, as we shall see shortly, the need to scale up agricultural intensification activities to communities that may be quite distant from the forest). The area of Masoabe, on the Betsileo side, for example is one of the most densely populated rural areas of the Fianar region and is a major source of immigrants into the corridor. On the Tanala side, many of the immigrants come from the plains closer to the coast where there are no longer existing reserves of fertile land and fragmentation and soil infertility has made farming a precarious undertaking for much of the population.

When farmers move into the forest, they reproduce the same (unsustainable) production techniques that they use on their more established fields. While there is a perception that newly cleared fields produce higher yields, farmers report that even these fields often produce yields that are disappointingly low (Freudenberger et al, 1999). Other farmers complain of severe declines in tavy yields after the first couple of years, and the yield of all crops is reduced by bird and wild boar damage. After two or three years of cultivation, soil fertility begins to decline, once again requiring fallow and the need to clear more land. Hence, intensification efforts are relevant not only for the sending communities but equally (and perhaps especially) for the new homesteads in the forest which, it must be noted, are in most cases devilishly difficult to access and therefore hard to serve with traditional extension approaches.

In short, the Tanala on the eastern and the Betsileo on the western side of the corridor face pressures that while perhaps different in their details, are fundamentally similar: too many people trying to make their livelihoods on too little and too unproductive land. And so, the forest corridor is threatened, caught between the demographic and economic pressures of the Betsileo on the high plateau to the west and the Tanala who occupy the lower hillsides to the east … all of whom are motivated primarily by the basic human need to assure their and their children’s food security.

**Agricultural Intensification in an Ecoregional Strategy**

As noted above, LDI Fianarantsoa’s ecoregional strategy consists primarily of reducing the pressures on the 160 km long forest corridor that extends from the northern borders of Ranomafana National Park to the southern tip of the Pic d’Ivohibe (south of Andringitra National Park). Initial project strategies consisted primarily of attempts to reduce anthropogenic pressures by promoting agricultural intensification and rural income diversification through conservation enterprises, including eco-tourism. (The project also works closely with a USAID funded health and family planning program to
extend services into these areas.) The strategy was to restore more village land into production by rehabilitating the large areas of hillside farmland that are now so degraded that they are no longer planted and to increase yields on currently farmed upland and irrigated fields. As such, the theory held, farmers would be able to get more from what they already own rather than having to clear new land in the forest.

Given the agricultural production system described above, it was quickly evident that intensification strategies would have to address irrigated fields, upland agriculture, and degraded lands that have been withdrawn from production. There are four principal reasons for this: first, a significant number of poorer families have no, or almost no irrigated land and would thus be excluded if the project did not have an upland component. Second, the cultural value Malagasy place on their irrigated rice fields make many reluctant to experiment on these fields and initial evidence suggested that adoption rates might well be low, and slow, for the irrigated rice package. Third, the irrigated rice package requires a sufficiently sophisticated set of requirements and inputs (particularly regarding the control of water) that many farmers would not have the resources needed to adopt the package. And fourth, given the high rate of population growth, it is unlikely that, even under the most optimistic projections of adoption rates, the impact of any two interventions alone would be sufficient to significantly alleviate pressure on the forest. In short, given the high rates of population growth (which will result in a doubling of the population in the next 20 years even if nascent family planning programs begin to have an impact), all production systems will have to become both higher yielding and more sustainable in order to have any reasonable chance of significantly alleviating pressures on the remaining natural resources.

In terms of potential yield increases, the most promising results have been experienced in irrigated rice production (Uphoff, 1999). The amount of land that can be put into irrigated rice perimeters is a small fraction of most village territories, however. The far greater land area is devoted to upland crops that are, in the vast majority of cases, devoted to the highly unsustainable production of annual crops such as rice, manioc, and beans. The project is encouraging farmers to replace these annual crops with perennial tree crops that will protect the soils against erosion, maintain soil fertility, and produce continuously without the need for a fallow that increases the amount of land that must be put into production. Unfortunately, as we shall discuss in the next section, this critical element of the project (because it is the only viable option for the vast majority of village lands) has run up against serious constraints that severely hamper adoption.

The packages proposed by the project thus included the following components:

- **SRI (système riziculture intensive)** and **SRA (système de riziculture amélioré)** techniques that include improvements to soil fertility through heavy composting, introduction of new seed varieties, and cultural practices such as water control. Most emphasis is placed on SRA because introduction of proposed techniques require less labor and capital investments.
- Production of Royal Carp in fish ponds associated with rice production.
- Rehabilitation of degraded hillsides (**tanety**) with agroforestry (especially fruit tree production) and vetiver grass plantings.
- Diversification of the household economy with conservation-based enterprises such as beekeeping, production of essential oils, and citrus production.
LDI-Fianarantsoa began its interventions working with some 700 farmers in communities immediately adjacent to the forest corridor. Two years later, interventions had expanded to some 2200 farmers belonging to 164 rural associations. The project offered agricultural intensification techniques to these farmer associations in return for their pledge to try to reduce slash-and-burn agriculture and other destructive extractive practices. Those agreeing to these conditions received agricultural training and information, supply inputs, and micro-credit.

In most villages, increases in rice production on small experimental plots have averaged about 20% and in some cases have risen to as much as 70%. Rates of adoption of improved potato production, beekeeping and fish culture were quite high during the first year of activities: among the 700 farmers associated directly with LDI Fianarantsoa since the beginning of the program, 23% have adopted fish culture practices and constructed 143 fishponds. During the first year alone, farmers purchased 15,000 Royal Carp fingerlings at market price. Approximately 22% of all farmers now grow potatoes as an off-season crop. Within the first six months of the project, over 40% of the farmers built and stocked over 300 beehives. 51% of all farmers now build compost piles.

The rehabilitation of tanety hillsides has commenced in 70% of all villages with the extension of practice such as planting vetiver grasses on contours, planting biomass banks of leguminous shrubs for compost and as a source of pollen for bees, or tree planting for individual and community woodlots.

Demand is growing rapidly as non-participating farmers observe the successes of their neighbors. While LDI has conducted participatory field evaluations to determine what social category is participating most actively in the program activities, no general trends have yet emerged (LDI, 2000). LDI Fianarantsoa works in most of the villages directly adjacent to the forest corridor (some 169 villages) but project staff remain concerned that even with these positive rates of adoption the impact is still very small on the broader landscape. One problem is that the project’s activities have focused on the communities immediately proximate to the corridor, while studies now suggest that much of the migration pressure emanates from highly populated communities far from the corridor. LDI possesses neither the financial resources nor the institutional capacity to start programs in these distant places.

**Agricultural Intensification and the FCE Railway**

LDI’s initial interventions were very much focused on finding effective ways to extend techniques for agricultural intensification and necessary inputs to participating farmers in the corridor region. A combination of increasing knowledge of the regional economy (developed through a series of RRA case studies) and a calamitous but highly revealing natural disaster that visited the region in the form of two back-to-back cyclones in the early part of 2000 brought the project face to face with another issue that has profound implications for efforts to save the corridor through agricultural intensification: the extreme fragility of rural transport systems in the region. It became increasingly clear that farmers’ decisions regarding land use in general (and, in particular, their decisions regarding the adoption of tanety rehabilitation packages or, alternatively, the expansion of tavy into the forest) are greatly influenced by their access to transport. One of the vital transport arteries in the region is the FCE railway. [MAP 2 ABOUT HERE]
The Fianarantsoa-East Coast (FCE) railway is a rickety, dilapidated narrow gauge rail line that runs from Fianarantsoa in the highlands, crosses the forest corridor about 10 km south of Ranomafana national park, and then continues to the port city of Manakara on Madagascar’s east coast. It was constructed between 1926 and 1936 as part of the French colonial policy to promote export crops (notably coffee) and to transport rice out of the highlands. The line tests the limits of railroad engineering as it descends from an altitude of 1100 meters in Fianarantsoa to sea level in Manakara over a distance of 163 kms. It passes through some of Madagascar’s most spectacular scenery, particularly in the highlands, and is considered a treasure by adventure seeking tourists.

Unfortunately, the same characteristics that give it a certain romantic charm (its ancient locomotives and rails and dramatic scenery) also increase both the general costs of maintenance and its vulnerability to the cyclones that sweep across the region at least once or twice a decade. In February and March 2000 Fianarantsoa was hit by two massive storm systems: Cyclone Eline and Tropical Depression Gloria. The impact on the FCE was immediate and terrible: the line was blocked by 280 landslides that dumped over 150,000 cubic meters of earth on the track. Four major washouts left 100-meter stretches of rail suspended over thin air. For nearly two months there was no transport of bananas, coffee, or fruit from the region. In one highland station a research team found 54 tons of rotting bananas waiting for a train that never came. A rapid reconnaissance of the region told a story of severe hardship for people living up and down the line: local rice crops were badly damaged; the price of rice in village shops (transported to many rice deficit villages even in normal times on the train) immediately rose by 30-50%; farmers were unable to transport and sell their fruit and therefore had no revenues to buy rice or other foodstuffs.

In addition to the disaster relief implications, however, the rail line closing also highlighted a more fundamental concern. Given the extreme fragility of this line (which is threatened as much by mismanagement and the progressive decay of both rails and rolling stock as it is by more dramatic events such as cyclones) what would be the impact on the corridor and LDI’s intensification activities if the line were to close permanently? A series of quantitative and qualitative studies designed to answer just such questions was already in the planning; the cyclones provided the opportunity to sharpen these questions but also forced the project to reconsider whether if should expand its transport interventions as part of the larger agricultural intensification/conservation strategies.
The train serves a population of about 800,000 people and is the only means of transport for some 100,000 people who live in areas that have virtually no road service. As such, it plays a crucial role both in exporting products from the region (especially commercial crops) and importing rice into an area that produces only a fraction of its rice requirements. Approximately 3000 tons of coffee, 6000 tons of bananas, and other fruits including litchis, oranges, and avocados are shipped by train to markets in Fianarantsoa and Manakara each year. In general, coffee is collected from a radius of about 25 kms from the train line (especially to the south since there is no alternative road service), while bananas (which must be transported to railhead by porters) come from a distance of approximately 10 kms.

Transport and Sustainable Production Systems

Case studies of communities served by the train (for example, on the eastern flank of the forest corridor) found that the economy of these Tanala villages has developed around commercial agriculture (Deeg and Freudenberger, June 2000). Typically, in these villages a farm family cultivates a small parcel of irrigated rice in the valley, while planting tree crops on the surrounding slopes. In short, these families are already practicing the relatively sustainable production system based on lowland rice and hillside tree crops that LDI would like to see practiced across the region. Studies in these villages revealed that pressures to expand agricultural lands are significantly reduced where farmers engage in permaculture, producing primarily tree crops. These methods do not solve the problem of increasing population and the subdivision of lands through inheritance with each succeeding generation. They do, however, at least preserve the productivity of existing fields. Many of the lands on which trees are planted have been producing for fifty years or more; if such land had been planted in annual crops it would have long since been taken out of production due to decreased soil fertility, requiring the owner to clear new and fertile fields.

These studies also showed clearly, however, the extent to which this relatively sustainable tree based production system depends entirely on a functioning transport system to get the crops to market. Like the families in LDI’s other intervention areas, most of the families in our studies produce only a small fraction (less than a quarter) of their rice needs on the small irrigated parcels they farm on the valley floor. Unlike the other farmers, however, they are able to purchase the rice needed to complete the family ration using proceeds from the sale of their bananas, coffee, and other tree crops. Even the families who are landless, or nearly so, gain revenues from these activities. They earn money that is used to buy rice by working the coffee plantations of landed families, or transporting bananas from the field to the train line. If there is no transport system in the region, and therefore no way to get crops to market, the entire population (whether landed or not) will have to find other means of procuring their subsistence food needs.

Interviews with farmers in the region (Deeg and Freudenberger 2000) suggest that, should transport systems (and especially the train that is critical for the evacuation of low value, high volume crops such as bananas) no longer operate, they will adopt a common strategy to protect their livelihoods. Farmers who have land will immediately cut down their tree crops and replace them with upland rice or manioc. As these fields, inevitably, become infertile, they will search out new lands in the corridor. For farmers without land,
there is no buffer. To feed their families they will need to acquire fields; most plan to move into the corridor in search of this land.

In conjunction with these qualitative findings, a cost-benefit analysis (Railovy et al., 2000) attempted to quantify the pressure on the forest with and without an operating rail system. The study in no way minimizes that existing threat to the forest. Indeed, it predicts that no matter what happens, at least 110,300 ha are likely to be cleared in the next 20 years. However, should the train cease to operate and should farmers currently practicing permaculture switch to annual crops in an effort to produce their own food requirements (the outcome predicted by local residents), the rate of deforestation will be dramatically higher. The Railovy study predicts that in such a case, at least 207,700 hectares of forest will be cleared over the same 20 year period.

Implications for Agricultural Intensification

The implications of these findings for LDI's agricultural intensification efforts are sobering. First of all, it is clear that the impact of the train on sustainable production systems and the corridor far dwarfs the potential impact of the program's agricultural extension efforts. If Railovy et al's conclusions are correct, maintaining the train in operation will spare about 95,000 ha of forest that will otherwise be cleared. The potential impact of agricultural extension activities in the region is a tiny fraction of that figure, even if adoption rates continue to be high. Currently the LDI project works with 1300 farm families, a number that may double by the end of the project. Even the most conservative estimates relating to families living in the communes directly served by the train line suggest that the FCE has an immediate impact on the production decisions (specifically, whether to farm sustainable fruit trees or unsustainable hillside rice) of at least 15-20,000 families.

Second, this story underlines the absolute necessity of functioning transport systems in the regions where the project is promoting agricultural intensification on tanety fields. With the exception of breadfruit (which can be used as a subsistence food crop, but which only grows at altitudes up to about 400 meters) all the other tree crops being promoted by the project depend on transport to regional, national, and in some cases (coffee) international markets. Evidence from the region shows that if such transport is available, farmers are willing to forego rice production on upland fields and buy rice with fruit revenues (Deeg and Freudenberger, 2000). Equally clear, however, if there are no such transport options, they will insist on growing crops for home consumption...and at the moment those crops are produced in ways that deplete soil fertility, render the land unproductive, and promote expansion into the forest.

For the LDI Fianarantsoa program, the continued operation of the FCE railway is thus critically important to efforts to save the forest corridor. From an ecoregional perspective, infrastructures like the railway and feeder roads provide the foundations for a market oriented agricultural system, which in this case turns out to be more ecologically sustainable than the subsistence alternatives.

In light of these analyses, the LDI project took a much more active role in maintaining and expanding the transport networks serving the region. The project was deeply involved in cyclone recovery efforts to restore service on the FCE, and has recently been instrumental in attracting additional funds for the rehabilitation of the rail system as well
as several roads that are key to the evacuation of commercial crops from the areas where the project promotes agricultural intensification activities. The project continues to put significant resources into promoting agricultural intensification, but also recognizes that if there are not adequate transport systems, most of its extension efforts will be futile.

Further Contradictions and Complexities

While the LDI program remains convinced that in the long run agricultural intensification is essential to promoting a more rational use of natural resources in the region, the project staff is perplexed by an evident contradiction in the approach: it is clear that on the Betsileo side of the corridor it is the wealthiest 20% of the population that is engaging in forest clearing. In effect, the biggest constraint to tavy, at least on the west side of the corridor, is poverty. If agricultural intensification activities are successful in making families more food secure, recent history suggests that at least some of these families will invest their surpluses in clearing forest lands (Freudenberger et al, 1999). However, since most people would agree that maintaining people in poverty is an unacceptable approach to conservation, we are obliged to consider other strategies.

This brings us back to an earlier point raised in this paper: while intensification may be a necessary strategy over the long term, it is certainly not sufficient to save the corridor. It is critical that these activities be complemented by equally rigorous efforts to control access and types of exploitation of forest lands. It will also require policies restricting those types of natural resource exploitation that threaten the biodiversity and watershed functions of the forest, and the serious enforcement of those policies. Local populations can play a key role in developing and enforcing policies that favor the collective benefit of saving watersheds relative to the private benefits of clearing individual parcels. Successful agricultural intensification interventions are a critical prerequisite to enabling the enforcement of such policies since, short of military style occupation, there is little likelihood that exclusion or even restriction of activities will be successful if people do not have viable alternatives for assuring their livelihoods.

Realistically, however, we must also recognize that such participatory planning approaches are notoriously hard to implement, particularly in the remote, dispersed, and often distrustful communities adjacent to the corridor. Madagascar’s Government Forestry Service has not proved to be a particularly helpful partner in managing the forest corridor, wracked as it is by internal conflicts, competing political interests, and a personnel that is as scarce on the ground as it is demotivated. Promoting and implementing a common vision of effective forest management among various stakeholders is perhaps the area where LDI has been the least successful to date.

And finally, it is hard to be optimistic in the face of population growth rates that will result in a doubling of the number of people trying to make a living from these lands in only the next 15 to twenty years … even if family planning programs are successfully introduced and widely adopted. Indeed, these future farmers of Madagascar -- and potential practitioners of slash and burn agriculture -- are already born. These statistics allow us little time for idle despair, however. Instead they argue even more forcefully for agricultural intensification, and especially for identifying the major structural factors such as transport that “warp” the whole economy in ways that are more (we hope) or less favorable to the adoption of sustainable agricultural practices.
Conclusions

If the LDI project and other regional actors are to successfully slow the rate of occupation of the corridor, it must find ways to reduce the multiple pressures that are motivating people to increase their land area and expand onto forest lands. The principal factors behind the current expansion appear to be (1) demographic pressures and people’s concern that their children will inherit parcels too small to support their food needs and (2) the progressive declines in soil fertility that render even newly cleared fields largely unproductive after only five or six production cycles. Strategies to reduce these pressures should thus logically include actions (a) to introduce and/or strengthen the provision of family planning services, (b) to improve the productivity of fields currently under production, and (c) to rehabilitate degraded upland fields that are now more or less unusable due to soil infertility.

Agricultural intensification has an absolutely critical role to play in reducing pressures on a forest corridor that is both an international treasure, in terms of its biodiversity, and a regional treasure, in terms particularly of the role it plays in maintaining watersheds. For a project like LDI, however, there is a danger that in getting too caught up in the admittedly challenging questions of how to increase adoption rates at the household level, the project risks failing to deal with the unexpected – and in our case counterintuitive -- consequences of “successful” adoption, such as intensification actually in some cases accelerating deforestation as profits are used to expand agricultural holdings. And similarly, managers may fail to see that the most effective programs may not always be to increase adoption rates among new converts, but rather to ensure that the conditions needed to assure continued practice of existing sustainable agricultural systems are maintained. In the case of the Fianarantsoa corridor, this has meant fighting (often in the face of doubting conservationists) for the future of a very rickety train line whose survival will do more for sustainable agriculture in the region than anything the project’s knowledgeable and highly committed extension agents can hope to accomplish.
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