ALTERNATIVES TO SLASH-AND-BURN

Population growth and deforestation— the case of Rondonia in the Brazilian Amazon

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Population growth and deforestation— the case of Rondonia in the Brazilian Amazon

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In Rondonia, Brazil, it is not local population pressure that has converted the forest to agriculture. Instead, deforestation appears to be driven by the increase in migrants to the area and by road building (Moran 1993), both of which are encouraged by Brazil's aggressive colonization programme.

Relationships between population growth and land-use change have long been identified as 1 of the major causes of deforestation (Allen and Barnes 1985). However, while the demographic factor is statistically valid at a regional scale, it is not at a local scale (Skole and others 1994). Here the relationship becomes much more complex, with a large number of factors at play.

Some authors have also pointed out that the expansion of the frontier into the Amazon is an eminently urban phenomenon (Becker 1996). The ratio between the urban and the rural populations continues to increase, and total population growth is influenced more by the cities than by the rural areas.

If we look at the landscape patterns in Rondonia, it is easy to identify many large parcels of pasture (fig. 1). These are cattle ranches, employing only a few people, averaging 1 herder per 300 hectares (Moran 1993). This link between livestock and deforestation was pointed out by Hecht (1993), who related it to the land market, the value of ancillaries, the larger macroeconomic context, and individual economic strategies.

Land speculation has also contributed to the loss of the forests of Rondonia (Mahar 1989). Given the continued use of the rule that anyone clearing forested land has 'improved' it and thereby gains the right to sell 'the improvements', a brisk land market has developed. In the Theobroma *municipio* (Rondonia), the colonization programme started in 1978, and since then more than 80% of the allocated parcels have been sold. This implies that these policies have encouraged people to move. But to where? Until now there has been no study to address this. We have assumed that some go to the city. But we know also that others are moving to new frontiers, probably to speculate on new lands. And it is certain that there are now internal flows of migration within the Amazon.

Thus the deforestation process in Amazonian Brazil cannot be linked strictly to population growth. To understand it, we need a deeper comprehension of the different time-scale processes operating in forest conversion. Here we try to identify and analyse these complex relationships in the state of Rondonia and the municipio of Theobroma.

Urban and rural population

The perception of the Amazon is that it is a rural area, a frontier for poor farmers looking for land and clearing the forest. But as Becker (1996) says, 'the urban centres absorb more migrants than do the rural areas' and 'the Amazon is an urbanized forest'. Thus the common perception of the Amazon could be far from the reality.

The total population in Rondonia increased from 36 935 in 1950 to 1 221 290 in 1996, a 330% increase in 45 years (fig. 2). This increase occurred mainly during the 1970s and 1980s, when the colonization programmes were implemented by the government through the Superintendencia del Desenvolvimenta del Amazonia (SUDAM) and the Banco de Amazonia (BASA). However, it began with the completion of the 1500-km Cuiaba-Porto Velho highway (BR-364) in 1968, which was followed by a wave of migration. At the

same time, the regional make-up of the newcomers changed (Mahar 1989). Whereas the vast majority of Rondonia's original settlers had come from the north and northeast through the Madeira and Amazon Rivers, most of the new contingent were experienced small-scale farmers from the state of Parana.

After this phase of colonization through inmigration, since 1991 there has been a phase of population stabilization and probably an increase in internal migration.

In Rondonia, the ratio between urban and rural populations was balanced until the 1980, when the urban population started to grow faster than the rural. According to the annual population growth rates (fig. 3), the period between 1970 and 1980 appears as the main immigration flux, most of it in the rural areas. After this period, the total growth rate decreased, until by 1996 the growth rate was only 1.6% (0.4% for the city of Porto Velho), close to the national rate of 1.2%.

Thus urbanization of Rondonia has followed colonization. Now more migrants are going to the urban centres than to the rural areas. These nuclei are also absorbing the excess rural workforce, because a large part of rural activities, particularly on large- and medium-sized properties, are limited to clearing lots on the establishment and raising a few head of stock, and so labour demand in these areas is limited and then only for limited periods (Becker 1996).

Colonization and ranching

Most of the migrants hoped to settle in 1 of the 7 colonization projects that the National Institute for Colonization and Agrarian Reform (INCRA) established on 2.7 million ha between 1970 and 1975. For a nominal price, people could obtain 100-ha lots, along with basic services and infrastructure. But as the size and speed *of* migratory flow increased, there were high impacts on the rainforest, in official settlement projects as well as in newly invaded areas at the margins of these settlements. Then in 1981 the growing socioeconomic problems in Rondonia led the government to pave BR-364 as part of the larger Northwest Brazil Integrated Development Program (POLONORO—ESTE). Another increase in migration that followed the construction of the BR-364 further increased deforestation.

These settlers started clearing and burning patches of forest for annual crops for 1-3 years of cultivation, depending on soil fertility, and then established pastures on the original patch. In Theobroma, 46% of the land has been cleared, comprising 26% pasture, 8% fallow, 7% annual crops and 5% perennial crops (Fujisaka and others 1996). In the area colonized by small-scale farmers, pasture is predominant and is still increasing because of these practices. Census data on Rondonia for the 1970-85 period (fig. 4) show approximately the same pattern of land use as seen in Theobroma District. Pastures predominate over all the other land uses combined.

During the same period, large ranches of more than 10 000 ha have been created through SUDAM—in 1987 alone, 579 were created (Hecht 1993)—and outside SUDAM. The SUDAM ranches cover approximately 8 763 000 ha. But there are many other ranches that have been established outside this project by entrepreneurs and speculators, such as the ranches of Theobroma (fig. 1). Because those who clear land have a stronger legal claim to a parcel than those who do not, there is ample incentive to clear as much land as possible. And under the threats of agrarian reform, land in effective use—that is to say, cleared—cannot be expropriated under the terms of the 1988 constitution. So pasture is the cheapest and easiest way to claim possession rights through occupation. Once obtained, rights of possession can be sold either formally or informally, depending on whether the migrant has occupied the land long enough to qualify for a definitive title (Mahar 1989). Figure 5 shows the difference in real prices between cleared land and forest. The extremely high potential gains from speculation are 1 of the main driving forces

of deforestation. But the value in these coveted rights to the land is not because of the land's intrinsic characteristics—as soil fertility is low, productivity of the land decreases rapidly after it is cleared. Instead the value is linked to its ability to capture institutional rents such as credits and subsidies in the larger economy, what are called unproductive profit-seeking activities.

Population and deforestation

Population density varies greatly across the *microrregiaos* (administrative units above the municipio) (fig. 6). The extremes are Guaraja-Mirim, a remote area along Rio Madera and the border with Bolivia, with few colonization projects but many indigenous protected areas, and Cacoal and Ji-Parana, the main and the oldest colonization areas along the BR-364 highway.

The other microrregiaos have similar population densities—about 4 inhabitants per square kilometre—but the extent of deforested land can vary between 8 and 32%. The Porto Velho microrregiao is very large (63 000 km^2), and its population density is highly influenced by the city of Porto Velho itself. On another hand, Colorado do Oeste is a region with huge ranches and few small farms, so population density is low, even though the percentage of deforested areas is high. If we exclude these 2 cases— Porto Velho and Colorado do Oeste—the correlation coefficient between population density and deforestation in the microrregiaos becomes high: $r^2 = 0.93$.

At the municipios scale, demographic studies are not easy because many municipios have been created during the last 20 years—there were only 10 municipios in 1970, 25 in 1980 and 40 in 1994.

However, we can look at the variability between municipios over the whole state of Rondonia, using estimated deforested areas of 1993 (SEDAM/SEPLAN 1996) and the estimated population of 1994 (IBGE in press) per municipio (fig. 7). Even though the points in figure 7 appear dispersed, there is a linear relationship with a correlation of $r^2 = 0.60$. If we look at more detail, we note that some rural municipios have a higher proportion of deforested areas proportion than would be expected (fig. 7). These municipios are the oldest colonization areas—Corumbiara and Cabixi in Colorado do Oeste, Theobroma and Valo do Paraiso in Ji-Parana, Castanheiras and Ministro Andreazza in Cacoal, and Sao Felipe d'Oeste in Vilhena. This means that the relationship between population density and deforestation proceeds at different rates, which appear to depend on household strategies for occupying the land. This assumption has to be confirmed by looking at the process of deforestation at a more detailed scale within a municipio.

- *The relationship is low, at the scale of the microrregiaos, between population density and deforestation, because of their large extent and their high heterogeneity.*
- *The relationship is low, at the scale of the municipios, between population and deforestation, because of the behaviour of the oldest colonization areas, where population is increasing slowly but deforestation is still high.*
- *The strategies of colonists in occupying land are varied, and they influence the rates of deforestation at upper scales.*

Deforestation process at farm scale

The deforestation process can be analysed through ranches or small farms. Figure 8 shows differences between the 2 in Theobroma municipio: deforestation by small-scale farmers started between 1973 and 1978 and reached more than 55% of the total area of the

district in 1996; deforestation by ranch owners—*fazenderos*—started between 1978 and 1987, proceeded at a slower rate and reached about 35% of the total area.

It would appear that ranch owners waited until colonization by small-scale farmers was well established. But during the 3 years of 1993 to 1996, they began to quickly clear their land. Reasons for this could be that by this time the population had grown sufficiently to provide available labour and also that some small-scale farmers were beginning to encroach at the edge of the ranches.

At the small-farm scale, samples have been chosen in the municipio of Theobroma and grouped by period of colonization. In fact, colonization of new lots appears to have occurred at only 3 periods: 1973-78, 1978-87 and 1993-94. New lots were not cleared during the periods 1987-93 and 1994-96. Sample size, with 100 ha in each farm:

- 12 farms for 1993-94
- 24 farms for 1978-87
- 12 farms for 1973-78

Each farm is characterized at each period by its land cover—forest and non-forest—and is identified also by its road access: type of road (secondary or tertiary) and distance to the primary (paved) road. Results show that the actual proportion of land cleared on lots depends on the length of time since clearing started (fig. 9). They also show that the limit of 50% of forest—on allocated lots, farmers are engaged vis-a-vis SUDAM in conserving half of the land as primary forest—has been exceeded on lots cleared during 1973-78 (about 76% deforested) and 1978-87 (about 66% deforested).

As the lots that are cleared last are far from the paved road, there is also a strong relationship between the proportion of land cleared on the lots and the distance to the BR-364 highway (fig. 10).

- Deforestation by fazenderos started later than deforestation by small farmers. They waited before clearing their land.
- 1988-93 was a period of remission in deforestation.
- Most of the plots have been deforested at more than the legal 50%.
- Between the date of the 1 st clearing on plots and the proportion of deforestation, the relationship is strong.
- Between the date of the 1 st clearing and the distance to the paved road, the relationship is strong.

Population and deforestation process over scales

As mentioned, population density is not the sole driving force behind deforestation, because populations have different strategies for land-use management.

By integrating what we have seen on urban and rural population at the state scale, colonization and ranching at the municipio scale, and the deforestation process at the lot scale, we can identify 3 processes—or strategies—over time:

- *Colonization of lots by small farmers.* New settlers clear about 40% of their lots for farming—food crops, fallow and pasture. This process is started near the paved road but then expands away from it up to about 60 km. This will probably continue at the same rate over the next decades as land is available. These colonization areas have a very low population density, less than 4 inhabitants per square kilometre, and an annual deforestation rate of about 3%.
- *Speculation on cleared land.* After colonization, speculation drives a new deforestation process. Both small farmers and fazenderos convert their forest into pasture only. Small-

scale farmers are expecting to sell their lots to realize a large capital gain. Fazenderos are occupying their land to get title. This process is occurring in the oldest colonization areas. Population density is between 4 and 12 inhabitants per square kilometre, and the annual deforestation rate is about 7% for small farms and 4.5% for fazenderos (Theobroma figures). In colonization projects like Theobroma, deforestation by small-scale farmers will obviously stop when 100% of the forest on the plots will have been cleared, which will be in only a few years on the oldest plots, allotted in the 1970s. Deforestation by the fazenderos will continue longer because forest still remains on their land.

- *Colonization of space through roads.* The colonization projects started 20 years ago along the BR-364 road are the nucleus of population settlement and deforestation. Few new colonization projects will appear. Now there is a process of diffusion of the colonization, sometimes far from the nucleus, at about 100 km from the paved road. These areas are strongly related to the nucleus along the paved road for goods, services and administration. Rates of deforestation are highly correlated to the distance to the BR-364. But there is also a process of colonization of remote areas after a new road opens: Ariquemes to Campo Novo de Rondonia, Cacoal to Costa Marques (along Rio Madera) and Jaru to Machadino d'Oeste. These new roads are penetrating deep into the forest, far from BR-364 (for example, 388 km from Cacoal to Costa Marques). They probably will create new urban centres as nuclei, but these developments are too recent for us to try to evaluate the process.

Three distinct processes are occurring in Rondonia at different rates and in different locations. We are fairly certain that population will increase and deforestation continue over the next few decades. But this population will probably become more and more urban. And the land use will become increasingly market driven, for example, through mechanized cultivation of soybean on large-scale farms. This has occurred in the neighbouring state of Mato Grosso and is already appearing in Rondonia. These developments will mean that the relationship between population and deforestation will become less obvious.

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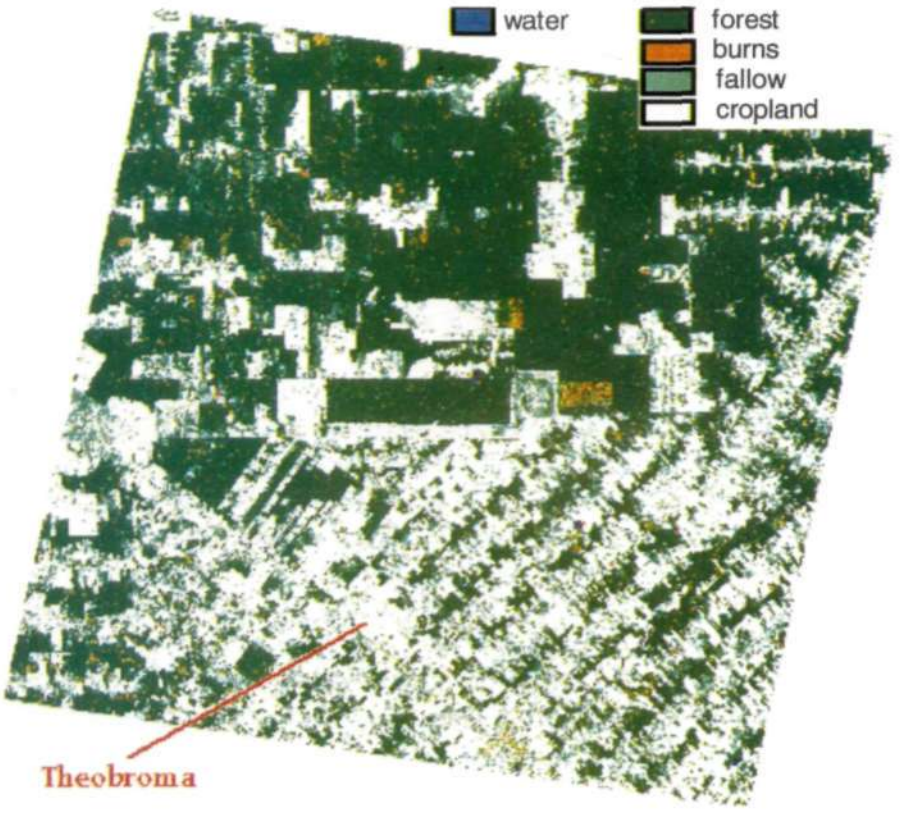

Figure 1. Land-cover image derived from a 1996 Spot image.

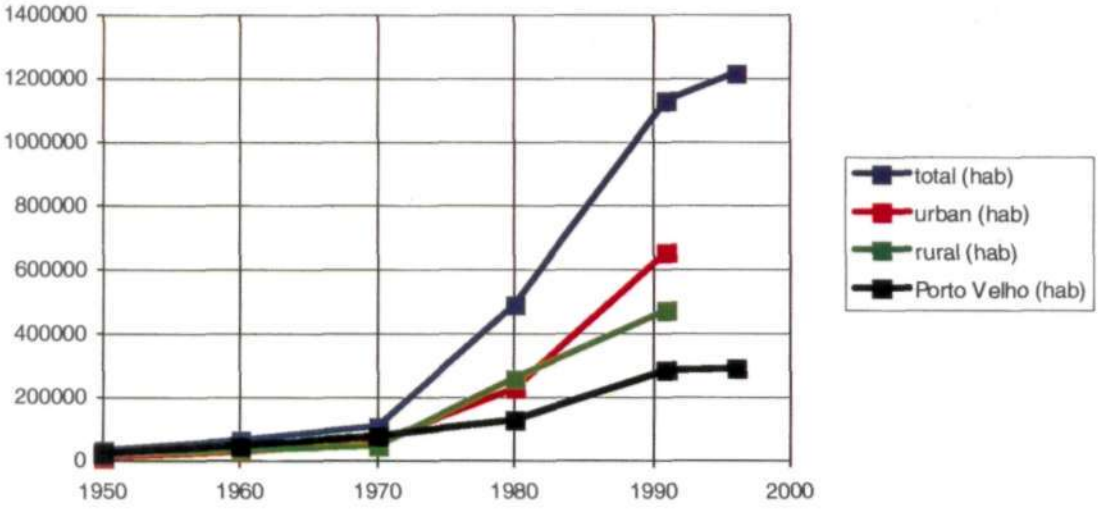

Figure 2. Demography in Rondonia state (rural and urban) and in its capital, Porto Velho.

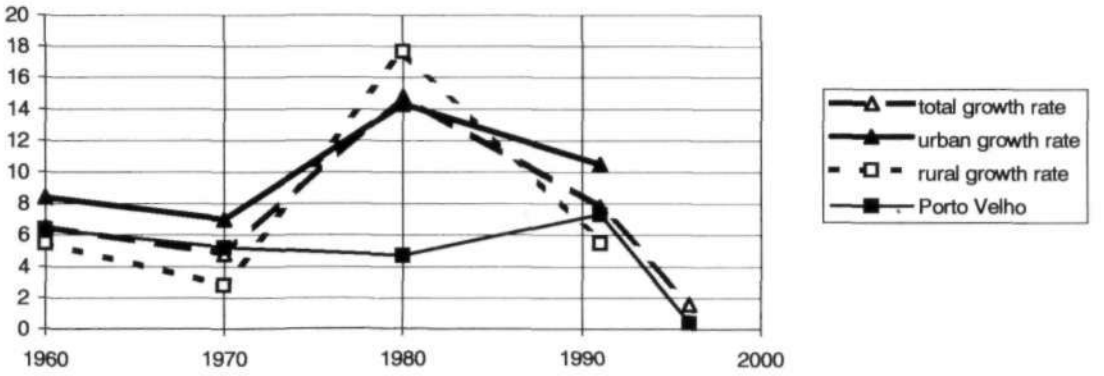

Figure 3. Population growth rate in Rondonia state and its capital, Porto Velho (source: IBGE).

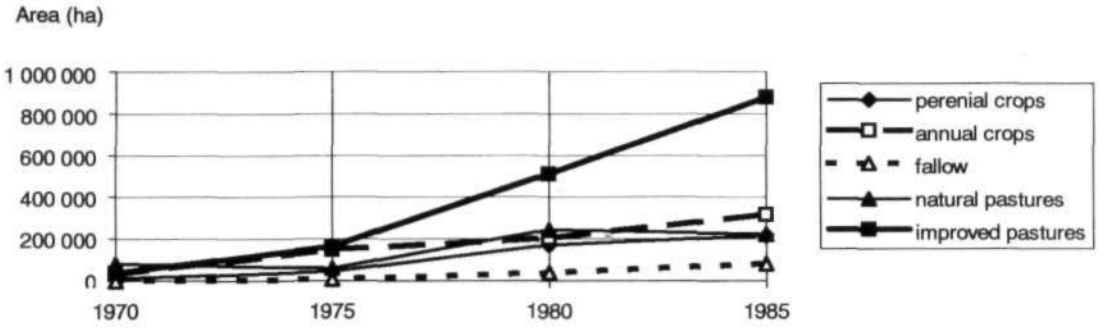

Figure 4. Land-use changes in Rondonia (source: IBGE).

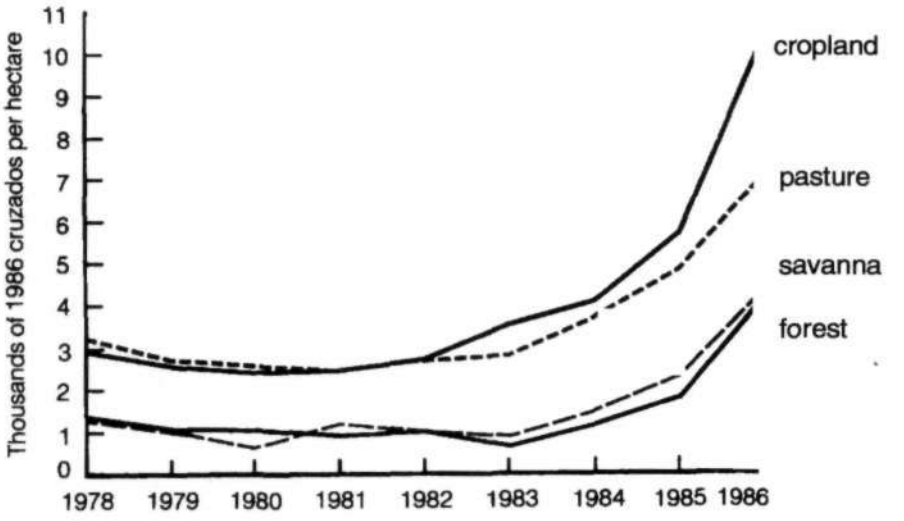

Figure 5. Average land prices in Rondonia, 1978-86 (source: Mahar 1989).

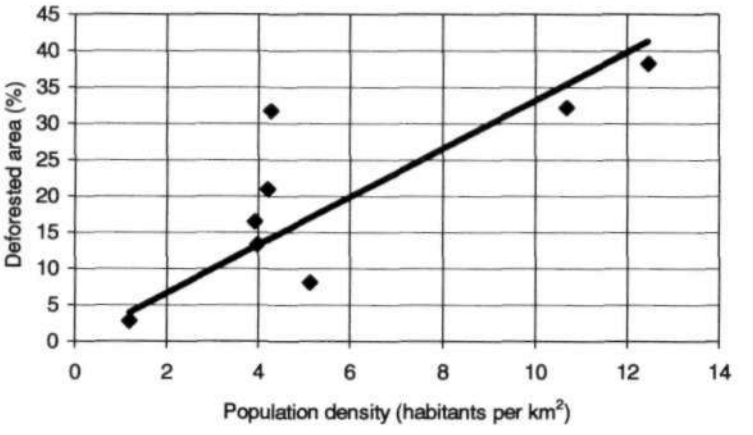

Figure 6. Relation between population density and deforestation at microrregiãos scale (source: IBGE)

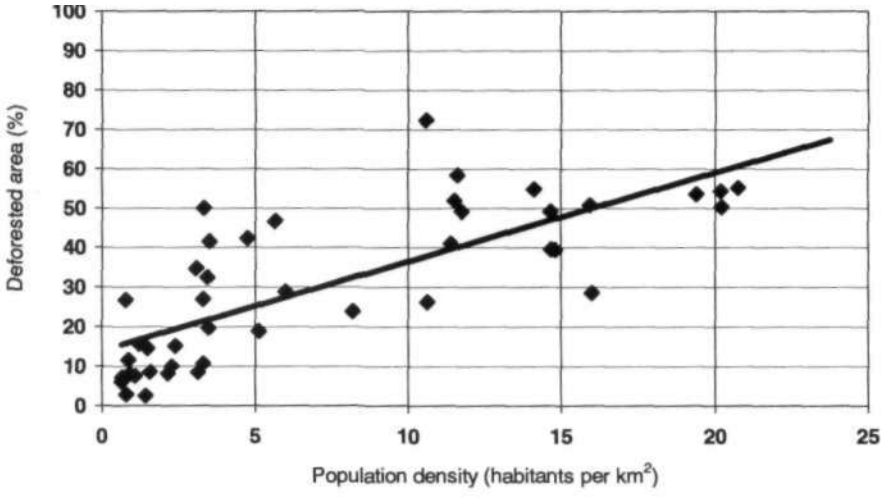

Figure 7. Relationship between population density and deforestation at municipio scale (source: IBGE).

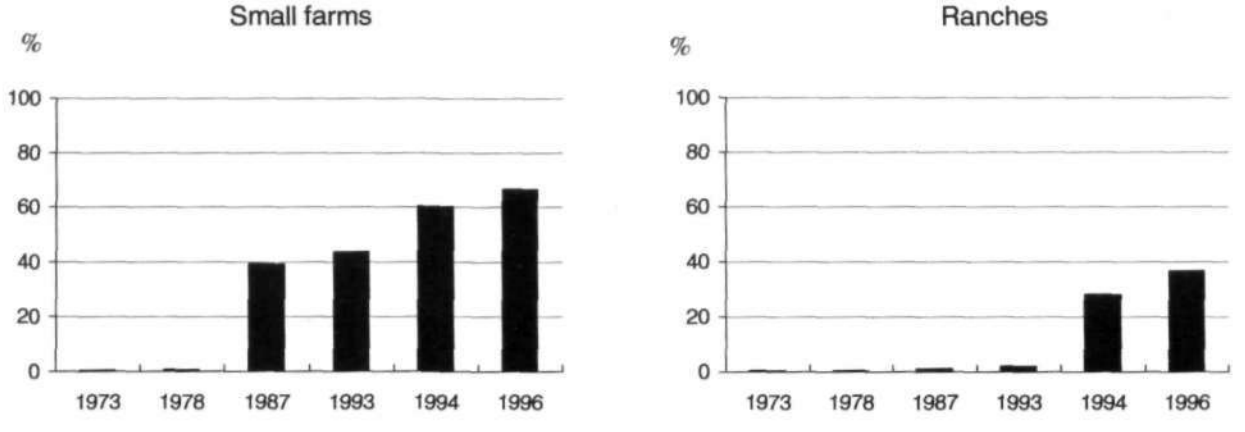

Figure 8. Deforestation at Theobroma District scale for small farms and ranches.

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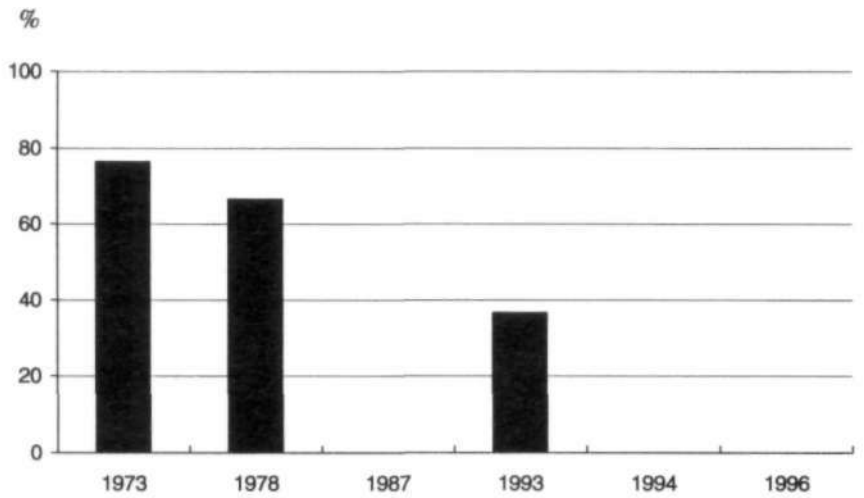

Figure 9. Relationship at farm scale between deforestation and 1st clearing year.

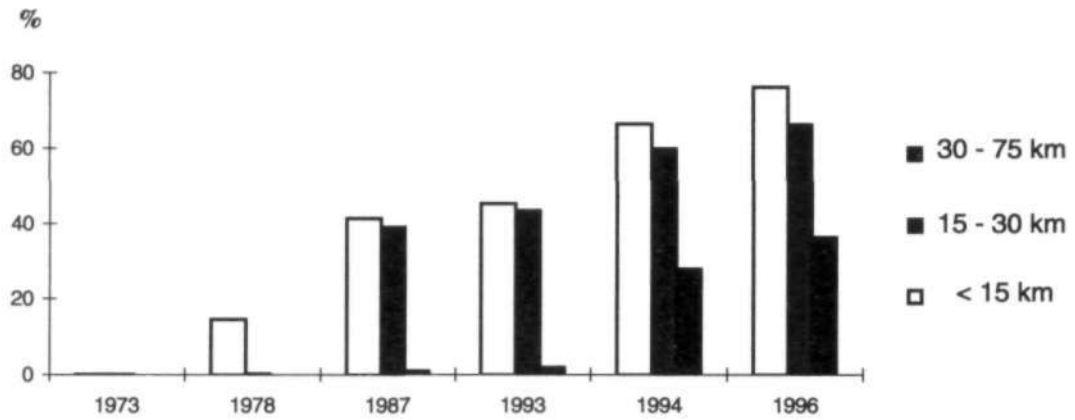

Figure 10. Relationship over time between deforestation and distance to roads.