

University of Oxford Centre for Brazilian Studies

Working Paper Series

Working Paper CBS-36-2002

**Is deforestation a solution for economic growth in rural
areas?**

Evidence from the Brazilian Mata Atlantica

by

Carlos Eduardo Frickmann Young

Federal University of Rio de Janeiro

and

Visiting Fellow, Centre for Brazilian Studies (January – July 2002)

Is deforestation a solution for economic growth in rural areas?

Evidence from the Brazilian Mata Atlantica¹

Carlos Eduardo Frickmann Young²

ABSTRACT

This paper questions the automatic relationship between deforestation and economic growth, an argument that is usually presented by those defending the conversion of forests into agricultural land. This supposition that deforestation is a means for economic growth has been used recurrently by the lanwdoners lobby in the Brazilian congress (*bancada ruralista*) aiming at the reduction of the minimum area of mandatory conservation in private properties, established by the Brazilian Forest Code. However, an analysis of *municípios* in Brazil's South Region shows that there is no consistent correlation between deforestation and the expansion of agricultural activities in the period 1985-1995/96. Therefore, to allow more deforestation in the *Mata Atlântica* will not increase agricultural employment and production significatively, at the expense of higher levels of threat to an ecosystem that is already very fragile.

RESUMO

Este artigo questiona a relação automática entre desmatamento e crescimento econômico, argumento usualmente apresentado pelos que defendem a conversão de florestas em áreas de uso agropecuário. Esta suposição de que o desmatamento é uma alavanca para o crescimento econômico tem sido recorrentemente usada pela bancada ruralista em seu intuito de reduzir as áreas mínimas de conservação em propriedades privadas previstas no Código Florestal

¹ This paper is the result of the research project “Signals of the Atlantic Rainforest. Phase 1: Agriculture and deforestation in Atlantic Rainforest areas”, sponsored by Fundação SOS Mata Atlântica. I am deeply grateful to Marcia Hirota (SOS Mata Atlântica), for her invaluable collaboration with data and comments. All errors and mistakes, nevertheless, are my entire responsibility.

² Associate Professor, Instituto de Economia, Universidade Federal do Rio de Janeiro, and BP Research Visiting Fellow, Centre for Brazilian Studies, University of Oxford. Email: young@ie.ufrj.br
Research assistance for this paper was provided by Marcos Thanus Andrade, Ana Carolina Marzullo and Fernanda Cabral, Environmental Economics Research Group, Instituto de Economia, Universidade Federal do Rio de Janeiro. Email: ambiente@ie.ufrj.br

Brasileiro. Contudo, uma análise de municípios na Região Sul do Brasil mostra que não há correlação consistente entre desmatamento e aumento da atividade agrícola no período 1985-1995/96. Ou seja, permitir maior desmatamento dos remanescentes de Mata Atlântica não irá gerar aumento significativo do emprego e da produção agrícola, ao custo de ameaçar ainda mais a preservação de um ecossistema já muito fragilizado.

1. Deforestation and development in Brazil

The loss of forest areas in Brazil, particularly in the Atlantic Rainforest (*Mata Atlântica*), is deeply related to the foundations of the country's rural economy since colonial times. Even though there were frequent changes in the dominant commodity in the colonial (and, afterwards, imperial) economies, there was always a pattern of "boom-and-bust" in the exploitation of Brazil's natural resources: abundance leading to a fast and predatory exploitation, followed by a long term decline, either caused by increasing scarcity or, in contrast, falling prices because of continuously growing supply. The most important economic cycles under Portuguese colonial rule and during the Empire (1822-89) - Brazil wood, sugar cane, cattle, gold, coffee - were all linked to some kind of predatory exploitation of natural resources, with severe damage to the environment but without the capacity to constitute sustainable forms to overcome the economic and social contradictions of colonial and post-colonial Brazil.

In the case of Brazil wood (*Caesalpinia echinata*), the first product of large commercial interest for the Europeans after their arrival in 1500 and abundant in coastal areas, the extraction was so accelerated that in 1558 large sized reserves could not be found less than 20 km from the coast. Bueno (1998) estimates that around two million Brazil wood trees were cut in the first century of exploitation,

and in 1605 the Portuguese Crown was already settling forest rangers to control the cutting. But the result was ineffective, and the tree that named the new colony soon became a rarity.⁴

The Atlantic Rainforest also came under severe attack from sugar cane plantations from the late 16th century.. The conversion of forest land to sugar cultivation and the supply of fuelwood (required for the boilers in the sugar production process) resulted in a strong deforestation pressure in the more fertile litoral areas. Given the adequacy of the soil for this type of cultivation, sugar cane plantations remained the basis of the regional economy in the Northeast “Zona da Mata”, though of declining importance in other areas.⁵ Moreover, its negative impacts were not restricted to deforestation. The main outcome of centuries of slavery-based cultivation and land ownership concentration was the huge social disparity between a rich landowning elite and the vast majority of enslaved labourers or impoverished smallholders. Even after the abolition of slavery (in 1888), the social conditions of workers in the sugar cane regions remained among the worst in the country. The forest was gone, but the wealth it generated had not created an adequate social structure.

The combined cycles of cattle ranching and gold mining in the 17th and 18th centuries were important in the expansion of the Brazilian frontier. They also constituted an important source of deforestation. Dean (1996) described how environmentally damaging were the gold mining techniques, and the huge demand for land conversion into pastures that was caused by the cattle boom. In both cases the social benefits were temporary and/or of small magnitude. Gold extraction was intensive in the use of slaves, thus increasing the need for more imports of slaves from Africa. Cattle ranching remains as the main single form of land occupation in Brazil to this date, but it is characterized by very low productivity

⁴ In Portuguese, the tree is known as *pau-brasil*, because of the red paint extracted from the stumps (*brasa* means blaze).

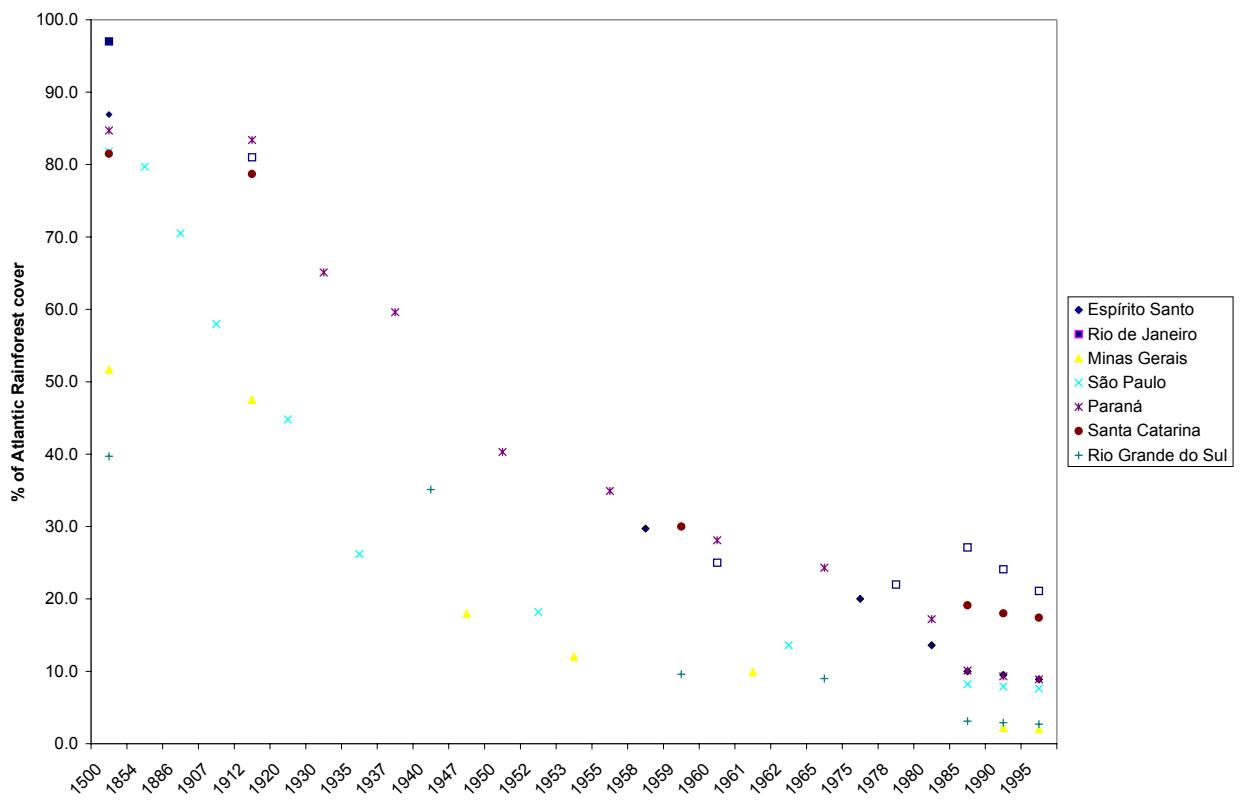
and labour demand, with restricted possibilities for income generation and changes in the social *status quo*.

The coffee expansion in the 19th century had important parallels with the sugar cane cycle, particularly in its first stages when slave labour was extensively employed. It quickly became the most important economic activity in the newly independent country, and the degree of natural resource consumption it caused was far more dramatic. After slash-and-burn practices exhausted the soils of the Paraíba valley, where massive erosion compromises agricultural activities until today, the coffee plantations entered the São Paulo plateau, which was more suitable for cultivation and where European migrants replaced slaves in its cultivation. However, the westwards march of coffee cultivation continued to have a negative impact on the Atlantic rainforest (see Graph 1) and, although not as perverse as in the Northeast, inequality of in the distribution of wealth remained at very high levels.

Graph 1. Percentage of remaining Atlantic Rainforest cover, per state, 1500/1995⁶

⁵ Lessa (2000) argues that the growing scarcity of fuelwood in the surroundings of the sugar cane plantations in the city of Rio de Janeiro played a major role in its decline. This is an interesting comment, since it relates the deforestation to both the boom and the bust of sugar cane plantations in areas of limited forest resources.

⁶ There are important discontinuities in the time series since this graph adds up results obtained from different studies using very distinct methodological procedures. Only after 1985 the data are properly comparable.



Source: Own elaboration, based on Fundação SOS Mata Atlântica *et alii* (1998)

Deforestation in 20th century Brazil cannot be dissociated from the problem of land concentration and the social instability it causes, particularly because of the structural surplus of labour. This problem is aggravated by modernization or other disturbances in the rural labour markets. With only rare opportunities for establishing themselves as smallholders or wage labourers, migration to “empty” forest land on the frontier becomes one of the few remaining options for the landless rural workers who opt not to move to the urban slums.⁷

Thus, the expansion of the agricultural frontier at the expense of forests has been used historically as a “safety valve” to accommodate the social imbalance caused by the extremely unequal distribution of resources in rural Brazil. First the Atlantic rainforest, and then the *cerrado* savannahs and the Amazon rainforest were

constantly reduced to mitigate land conflicts and, thus, avoid a proper agrarian reform. However, after some time, the limitation of the newly occupied frontier to settle all demands for land creates a basis for new conflicts and migration inflows towards forests yet to be converted.

The evident failure in this process of “forests for development” in terms of creating a prosperous and equitable rural society has not, however, changed the usual perception that deforestation is a necessary price to pay for improving economic and social conditions. Indeed, three interconnected “myths” remain deeply accepted without much questionning for their theoretical or empirical foundations:

- (a) the most important pressure factor for deforestation is ever-increasing rural population growth;
- (b) rural economic growth is only possible through deforestation; and
- (c) deforestation is a necessary condition for improving rural employment and living conditions.

These arguments are, once more, being used in the ongoing debate about the Brazilian forest protection law (the Forest Code, 1965, with minor changes in 1989). The current legislation establishes that a minimum area of forest reserves must be kept in privately owned land - at least 20% of the area if the property is situated in an area originally covered by the Atlantic Rainforest, 50% in the *cerrado*, and 80% in the Amazon - and areas of permanent preservation (forests covering springs and waterways, and on the hills and hilltops). Moreover, these forest reserves must be comprised of native species, thus not including industrial plantations of exotic species, such as pinus and eucalyptus. The Forest Code was largely ignored in the past, but there is a recent trend for environmental agencies to enforce the law, largely as a consequence of NGO and press vigilance. The

⁷ Branstromm (2000) presents a very interesting discussion about the links between labour relations and deforestation in southeastern Brazil in the 1915-1965 period, showing how the chosen labour regimes in the coffee groves (contractual planting, sharecropping and colonato) intensified forest-to-coffee conversion.

enforcement of the Code would not only halt deforestation but also force most landowners to reforest their properties in order to achieve the minimum levels of native forest cover.

Not surprisingly, the powerful lobby of landowners in the Brazilian Congress started a campaign to ease these legal requirements. This lobby argues that more deforestation must be legally allowed in privately owned properties in order to increase agricultural income and employment. Among other measures, it is trying to reduce the minimum forest reserve area, and to include a new concept of “forest compensations” in which industrial plantations of exotic species could be accepted as a replacement for declining native forests. This, of course, would endanger even more a biome already reduced to less than 7% of its original status, with major consequences for biodiversity conservation and other environmental services provided by the forest (soil control, water flows and microclimate regulation, landscape values and ecotourism, etc.).

The economic and social data, however, shows that the three arguments used in defence of more deforestation are far from being logically acceptable, at least in the Atlantic Rainforest region in the last decades. Section 2 shows that the rural population of the Southeast and South states in Brazil has declined consistently for a long period: the net loss of rural population in the last 40 years in these regions (where the Atlantic rainforest is mostly concentrated) was over 7.5 million people. Yet deforestation in each of these states increased continuously: the estimated loss of Atlantic rainforest remainings in the period 1985-95 surpassed 1 million hectares.

However, the fact that more deforestation has not lead to more economic growth or rural employment is better understood using data at the level of *municípios* (counties). Section 3 describes the methodology and preliminary results of an empirical analysis comparing the information provided by the the agricultural census of the Brazilian Geographical and Statical Institute (IBGE) on the number of employees in rural establishments, area for cultivation and pasture, and cattle herd, and the inventory of remaining forest areas in the Atlantic rainforest (a joint

effort of Fundação SOS Mata Atlântica, National Institute of Spacial Research – INPE, and Instituto Socioambiental - ISA) for the three Southern states of Brazil (Paraná, Santa Catarina and Rio Grande do Sul) in the period 1985-1995/96. The results clearly indicate that there is no obvious correlation between deforestation and better agricultural performance, which provides the argument for the main conclusion of the paper (section 4): the proposed changes in the Forest Code would not improve agricultural performance, at least in the Atlantic Rainforest area, while causing huge environmental and social damage.

2. Destroying myths about deforestation in the Atlantic rainforest

2.1 Deforestation and population growth

One of the most frequently quoted causes of deforestation is the pressure caused by population growth in rural areas. Indeed, in the last two centuries there was an impressive trend of population growth in the Atlantic Rainforest domain, which today concentrates more than two thirds of the Brazilian population (170 million). However, if this relationship between population growth and deforestation were automatic, a reduction, or even a reversal, of deforestation trends when demographic growth is reduced or becomes negative would be expected.

Unfortunately for the Atantic Rainforest, this expectation has not been fulfilled. Negative rural population growth rates have been observed in every Southeastern Brazilian state since the 1960s, and the same pattern has been hapenning in the Southern states since, at least, the 1970s (table 1).

Table 1. Change in rural population, Southeastern and Southern states, 1960-2000

State	Change in rural population, 1960-70	Change in rural population, 1970-80	Change in rural population, 1980-91	Change in rural population, 1991-2000
Espírito Santo	-147.583	-161.849	-39.538	-42.323
Rio de Janeiro	-225.042	-181.571	-299.020	-39.009
Minas Gerais	-390.615	-1.111.062	-359.794	-744.761
São Paulo	-1.283.720	-715.872	-505.773	163.321
Santa Catarina	214.797	-199.644	-122.590	-197.460
Rio Grande do Sul	135.505	-608.375	-361.382	-273.322

Source: Demographic Censuses, IBGE

The combined net loss of rural population in these states in the last forty years was more than 7.5 million people. Nevertheless, there was no reduction in the trend of deforestation in the same period. Considering only the 1985-1995 period, the accumulated loss of forest areas in Brazil Southeast and South regions surpassed 1 million hectares (table 2).⁸

⁸ The Northeastern states that belong to the Atlantic Rainforest dominium were excluded because of the lack of comparable data.

Table 2. Atlantic Rainforest reduction and remaining forest in the Southeast and South regions, 1985-95

State	Deforested area 1985-90 (in hectares, ha)	Deforested area 1990-95 (ha)	Forest remaining as % of original forest area
Espírito Santo	-22.484	-28.696	10,3%
Rio de Janeiro	-165.454	-22.484	11,0%
Minas Gerais	-69.168	-92.938	3,9%
São Paulo	-75.711	-63.740	9,0%
Paraná	-156.687	-79.026	10,5%
Santa Catarina	-106.312	-59.397	21,4%
Rio Grande do Sul	-57.003	-48.793	6,7%

Source: Fundação SOS Mata Atlântica *et alii* (1998)

It is clear from the tables above that demographic pressures alone do not explain the reduction of the Atlantic rainforest, since the rural population has been steadily declined over a long time but the deforestation process has still advanced. There are important implications for forest conservation policies: (i) demographic control policies and reduction in migration inflows do not necessarily solve the deforestation problem; and (ii) socio-economic causes of deforestation are not restricted to demographic issues, even though our theoretical and empirical knowledge on these matters is still insufficient.

2.2 Deforestation, rural employment and living conditions

Another myth about deforestation is that it is a price to pay for employment creation and the improvement in living conditions. However, considering the seven states of

the South and Southeast regions, in the period 1985-96, there was a net loss of 2.4 million jobs in agriculture activities (table 3) despite the continuous loss of forest remains. This is probably the most important evidence that allowing more deforestation will not result in the solution of the chronic unemployment in rural Brazil, as alleged by the landowners lobby in their quest to change the Forest Code.

Table 3. Change in the number of rurally employed, 1985-96

State	Change in rural employment
Espírito Santo	-47.572
Rio de Janeiro	-147.638
Minas Gerais	-660.084
São Paulo	-442.159
Paraná	-567.431
Santa Catarina	-168.593
Rio Grande do Sul	-370.910

Source: Agricultural Censuses, IBGE

A similar myth is that deforestation is a way to improve the living conditions of the rural dwellers, thus being socially justifiable even in the scenario of a declining population. There is a notable lack of studies addressing this issue, but it is clear that the average income of the rural population living in the already deforested areas is very low, even in the richest states of the Southeast. Moreover, the average rural income in all states belonging to the Atlantic Rainforest dominium is lower than the Brazilian official minimum wage, the situation being worst in the

Northeast. Finally, the disparity between rural and urban income is considerable, the former being less than half of the later for all states except São Paulo (table 4).

Table 4. Average monthly income of people over 10 years old (in R\$), 1999⁹

State	Rural	Urban	Absolute difference	% Difference
Southeast				
Espírito Santo	150	343	193	128,7%
Minas Gerais	125	315	190	152,0%
Rio de Janeiro	151	425	274	181,5%
São Paulo	262	451	189	72,1%
South				
Paraná	156	378	222	142,3%
Rio Grande do Sul	215	429	214	99,5%
Santa Catarina	181	405	224	123,8%
Northeast				
Alagoas	95	207	112	117,9%
Bahia	90	217	127	141,1%
Pernambuco	79	220	141	178,5%
Rio Grande do Norte	109	250	141	129,4%
Sergipe	75	256	181	241,3%
Paraíba	90	306	216	240,0%

Source: IBGE/National Household Annual Survey (PNAD), 1999

⁹ In August 1999, at the date of the survey, the exchange rate was US\$ 1 = R\$ 1.815.

Table 5 also shows that illiteracy, another indicator of social development, remains very much below desirable levels. Even in relatively rich states, such as Rio de Janeiro, about 20% of the adult rural population remains illiterate. Again, the performance in the Northeast states is considerably worse. In Sergipe, for example, literacy is over 25% higher in rural than in urban areas.

Table 5. Adult literacy, % of total population, 1999

	Rural	Urban	Difference
Southeast			
Espírito Santo	81,2%	88,8%	7,6%
Minas Gerais	74,9%	89,5%	14,6%
Rio de Janeiro	78,0%	92,9%	14,9%
São Paulo	87,4%	93,0%	5,5%
South			
Paraná	82,7%	89,5%	6,7%
Rio Grande do Sul	87,5%	92,1%	4,6%
Santa Catarina	87,8%	92,3%	4,5%
Northeast			
Alagoas	49,6%	72,7%	23,2%
Bahia	60,6%	82,0%	21,4%
Pernambuco	53,4%	79,0%	25,6%
Rio Grande do Norte	63,1%	76,6%	13,5%
Sergipe	55,7%	81,3%	25,6%
Paraíba	58,7%	81,5%	22,8%

Source: IBGE/National Household Annual Survey (PNAD), 1999

Thus, the Atlantic Rainforest has been destroyed by an agricultural system incapable of solving the chronic problem of rural poverty. The data presented above also considers populations living in other biomes, including the drylands of the Northeast where the social conditions are the worst in Brazil. The trend of low income and high illiteracy remains in states that are almost entirely within the Atlantic rainforest, such as Rio de Janeiro, Espírito Santo and Paraná, and the Northeastern state with lower rural income is the one with highest proportion of original Atlantic rainforest cover (Sergipe).

2.3 Economic causes of deforestation

As already discussed, the constitution of an agriculture production regime based on very large properties that absorb most of the land, while the vast majority of rural workers are either landless or share tiny landholdings, results in a continuous pressure for “producing” new land through deforestation, in order to increase the surplus of the former and/or guarantee the subsistence of the later.

In the Northeast and Southeast, small properties (up to 50 ha) occupy less area than large properties (over 1000 ha), and even in the less unbalanced South more than half of the land is located in properties over 200 ha (table 6). Altogether, properties of up to 50 ha occupy only 20% of the total agriculture land; however they concentrate 36% of the total output and 70% of the occupied personnel. In contrast, the properties with more than 1000 ha generate less than 3% of the total jobs, and 21% of the total output, despite occupying 27% of the total land (tables 7 and 8).

Table 6. Area and size of agricultural establishments

	Total area (ha)			% Total area		
	Northeast	Southeast	South	Northeast	Southeast	South
Up to 50 ha	15.013.888	9.385.253	12.419.105	19,2%	14,6%	28,0%
From 50 to 200 ha	17.363.178	15.731.257	8.924.138	22,2%	24,5%	20,1%
From 200 to 1000 ha	22.431.297	21.634.349	12.962.278	28,6%	33,8%	29,2%
More than 1000 ha	23.487.733	17.335.034	10.054.844	30,0%	27,0%	22,7%
Total	78.296.096	64.085.893	44.360.364	100,0%	100,0%	100,0%

Source: IBGE/Agricultural Census, 1995/96

Table 7. Value of output and size of agricultural establishments

	Output (in R\$ Millions)			% Output		
	Northeast	Southeast	South	Northeast	Southeast	South
Up to 50 ha	1.851	2.583	4.092	44,4%	24,3%	45,6%
From 50 to 200 ha	648	2.458	1.724	15,5%	23,1%	19,2%
From 200 to 1000 ha	815	2.733	1.949	19,5%	25,7%	21,7%
More than 1000 ha	857	2.863	1.216	20,5%	26,9%	13,5%
Total	4.171	10.638	8.981	100,0%	100,0%	100,0%

Source: IBGE/Agricultural Census, 1995/96

Table 8. Employment and size of agricultural establishments

	Total employed			% Employed		
	Northeast	Southeast	South	Northeast	Southeast	South
Up to 50 ha	6.660.358	1.992.253	2.705.533	81,5%	57,9%	80,0%
From 50 to 200 ha	895.195	776.306	395.401	11,0%	22,6%	11,7%
From 200 to 1000 ha	449.365	462.055	202.223	5,5%	13,4%	6,0%
More than 1000 ha	170.369	207.989	78.343	2,1%	6,0%	2,3%
Total	8.175.287	3.438.603	3.381.500	100,0%	100,0%	100,0%

Source: IBGE/Agricultural Census, 1995/96

The cattle ranching system, based on extensive use of pastures with very low per hectare productivity, has one of the most aggressively harsh effects on the environment. Pastures occupy most of the area under agriculture use: more than half of the establishments in the Northeast and Southeast, and over a third of properties in the South (table 9). However, the total pasture area is even higher since mixed cultivation-pasture systems also occupy a relevant share of the properties. One must remember that cattle ranching is typically low intensive in labour demand, in contrast to cultivation (permanent and temporary cultivation, horticulture and greenhouse products). Nevertheless, the total area dedicated to cultivation is half of that designated to pastures in the Northeast and Southeast, and only in the South, where the presence of medium-sized, family based commercial landholdings is more common, the area under cultivation is equivalent to that designated to animal husbandry.

Table 9. Economic use of land in rural establishments, 1995/96

	Northeast (ha)	Southeast (ha)	South (ha)	Northeast (%)	Southeast (%)	South (%)
Temporary cultivation	15.891.571	10.068.698	16.724.168	20,3%	15,7%	37,7%
Horticulture and greenhouse products	194.701	422.015	216.881	0,2%	0,7%	0,5%
Permanent cultivation	5.634.317	6.794.044	950.628	7,2%	10,6%	2,1%
Animal husbandry	41.350.392	33.591.090	17.130.877	52,8%	52,4%	38,6%
Mixed production (cultivation and animal husbandry)	12.418.782	8.899.035	6.705.205	15,9%	13,9%	15,1%
Forestry and forest plantation	2.339.183	2.501.067	2.571.285	3,0%	3,9%	5,8%
Fishing and aquaculture	35.825	32.558	26.350	0,0%	0,1%	0,1%
Charcoal production	431.324	1.777.385	34.969	0,6%	2,8%	0,1%
Total	78.296.096	64.085.893	44.360.364	100,0%	100,0%	100,0%

Source: Agricultural Census 1995/96

Value generation in animal husbandry is considerable lower than in vegetal production (tables 10 and 11), causing great disproportion between the area dedicated to pastures and its economic contribution. It must be remembered that small animals are usually raised under confinement, requiring much less land than cattle ranching (and generating more jobs). If only large animals are considered, the contribution of ranching does not exceed 18% of the total, with the exceptions

of the states of Minas Gerais and Rio de Janeiro (always failing, however, to reach the same proportion of the area destined to these activities).

Table 10. Value of output, per activity, 1996 (R\$ mil)¹⁰

State	Total	Vegetal		Animal	
		Total	Cultivation	Total	Large animals
Espírito Santo	1 082 501	859 420	695 584	223 081	150 444
Minas Gerais	6 409 086	3 615 838	3 165 234	2 793 248	2 187 061
Rio de Janeiro	630 441	335 481	215 622	294 960	198 232
São Paulo	8 412 369	6 009 674	5 602 112	2 402 695	1 368 702
Paraná	5 562 875	3 724 668	3 438 159	1 838 207	877 738
Rio Grande do Sul	6 169 907	3 854 115	3 585 874	2 315 792	1 104 976
Santa Catarina	3 270 471	1 601 137	1 379 296	1 669 333	343 603

Source: Agricultural Census 1995/96

Table 11. Value of output , per activity, 1996 (%)

State	Vegetal		Animal	
	Total	Cultivation	Total	Large animals
Espírito Santo	79,4%	64,3%	20,6%	13,9%
Minas Gerais	56,4%	49,4%	43,6%	34,1%
Rio de Janeiro	53,2%	34,2%	46,8%	31,4%

¹⁰ In 1996, the average exchange rate was US\$ 1 = R\$ 1.004.

São Paulo	71,4%	66,6%	28,6%	16,3%
Paraná	67,0%	61,8%	33,0%	15,8%
Rio Grande do Sul	62,5%	58,1%	37,5%	17,9%
Santa Catarina	49,0%	42,2%	51,0%	10,5%

Source: Agricultural Census 1995/96

Public policies also contributed to this predatory regime of expansion of the agricultural frontier at the expense of forest loss. Export incentives and subsidized credit programmes, especially for cattle ranching and industrial forest plantations, created additional pressures for more deforestation. Other economic factors were the ever expanding demand for timber, the increased road network and real estate development, including the trend for “weekend” second houses in areas with higher degree of forest preservation. These elements remain indicators of progress among local politicians, and no consideration is taken for the long term problems they might create. Many empirical studies have shown that road building is particularly damaging to forest conservation in Brazil (for example, Reis and Margulis 1991, Mahar and Schneider 1994, Young 2001), and the road network in the Southeast and South regions increased from 843.886 km in 1985, to 882.740 km in 1990 and 1.014.114 km in 1994, representing an increase of 20% in only ten years. Easing the access to previously remote areas, roads create the expectation of rising land prices for both agricultural and residential purposes, and the consequent land price speculation boom creates important deforestation trends. This is, by the way, the main risk of “ecotourism” initiatives: if no proper conservation measures are taken, the final result of the inflow of people and economic activities may be the degradation or depletion of the natural resources that the “ecotourism” was meant to preserve.

3. Empirical results of *município*-based analysis

The analysis so far has been based on state-level data, which is far too aggregate. A better understanding of the situation can be obtained if more disaggregate data are considered. This section summarises the preliminary results a recent initiative, the Research Project “Signals of the Atlantic Rainforest. Phase 1: Agriculture and deforestation in Atlantic Rainforest areas”, sponsored by Fundação SOS Mata Atlântica and carried out by the Environmental Economics Research Group of the Instituto de Economia/UFRJ (Young et alii, 2001). The exercise compared data from the IBGE agricultural censuses for the years 1985 and 1995/1996, and the results of the “Atlas of Atlantic Rainforest”, elaborated by Fundação SOS Mata Atlântica, INPE and the Instituto Socioambiental for the periods 1985-1990 e 1990-1995 in the three Southern states - analysis (Paraná, Santa Catarina and Rio Grande do Sul (SOS Mata Atlântica et alii, 1998).

In order to allow the comparability of municipal data in the period, boundaries were considered according to the 1985 map. It means that if a *município* has been divided into two or more during the period, data for 1995/96 were reassembled according to the municipal boundaries of 1985. *Municípios* that are not in the Atlantic rainforest dominium were excluded. A total of 248 *municípios* from Paraná, 178 from Santa Catarina and 168 from Rio Grande do Sul were considered.¹²

Another methodological problem is the comparability between the 1985 and the 1995/96 IBGE Agricultural Censuses. Among other differences, these two censuses were carried out in distinct periods of the year, which creates serious problems of comparison because of the high seasonality in agricultural activities. In order to deal with this, rankings were created organizing the *municípios* according

¹² As in other states, a big number of new *municípios* were created in Rio Grande do Sul in the period. However, in this state 69 *municípios* were created from territory that previously belonged to two or more

to the changes in the variables considered (changes in the remaining Atlantic rainforest area, number of employees in rural establishments, area for cultivation and pasture, and cattle herd). The rankings are in ascendent order, i.e., the *município* with the highest loss (or smaller increase) in a specific variable received the first position, while the *município* with the smallest loss (or highest increase) received the highest position in the ranking (the number of *municípios* considered). Assuming that the methodological differences between the two agricultural censuses occurred uniformly among the *municípios*, the rankings allow to show if the ones with highest deforestation trends were also the ones with better economic performance.

3.1 Results: Santa Catarina

In Santa Catarina, in the period 1985-1995/96, there was a reduction in rural jobs in nine out of the ten municipalities with the highest areas of forest loss. Only considering these ten municipalities, 12,744 rural jobs were lost in net terms, simultaneously to the decrease of 55,137 hectares of Atlantic Rainforest (table 12). The most interesting finding was that nine out of these ten municipalities presented a net loss of cultivation and pasture areas; and in six of them the size of the cattle herd recorded by IBGE in 1995/96 was smaller than in 1985.

municípios. This impedes the reassembling the data by the adopted method of merging the data to the “mother” município, and therefore these cases were excluded from the analysis.

Table 12. *Municípios* with highest deforestation, Santa Catarina, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivat- ion	Change in area under cultivat- ion (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	change in pasture area (ha)
Itaiópolis	1	9858	108	-430	1	-129230	149	4323	46	-1430
Abelardo Luz	2	8042	43	-1552	24	-9724	154	5262	54	-1071
Canoinhas	3	7986	40	-1659	163	1610	174	12622	59	-844
Lages	4	6035	140	-22	3	-37040	2	-10747	1	-39440
Santa Cecília	5	4911	39	-1668	2	-44895	3	-10492	5	-15797
Indaial	6	4453	157	240	60	-4535	76	342	151	2144
Mafra	7	4177	16	-2405	10	-19362	147	4124	13	-6867
Campos Novos	8	3554	55	-1260	12	-17076	139	3401	9	-9052
Taió	9	3114	76	-855	29	-8662	114	1996	61	-759
Ibirama	10	3008	9	-3133	35	-7447	31	-1450	23	-3392

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables)

The examples of Ibirama, Mafra, and to a lesser scale Santa Cecília, Canoinhas, Abelardo Luz and Campos Novos, show that deforestation and rural unemployment evolved side by side in this state. These *municípios* were among the ones with highest deforestation and highest decrease in rural jobs. Considering other indicators of agricultural performance, Itaiópolis was the *município* with

highest deforestation, but also the one with the highest decrease in cultivation area.

The fact that most of these *municípios* also showed important growth in cattle herds indicates that it is very likely that extensive ranching is an important element in the deforestation. However, there remains some notable exceptions, particularly Lages and Santa Cecília, that showed a very poor performance in almost every indicator, despite the high deforestation carried out.

On the other hand, if the ten *municípios* with best rural employment performance are listed, it is clear that most of them showed very low deforestation trends. (table 13). At the same time, in three of them there was an increase of the cultivation area; in seven the cattle herd increased and an increase in pasture land was observed in other three. In aggregate terms, there was a net increase of 8776 rural jobs, compared to a loss of 5743 hectares of forest remainings.

Table 13. *Municípios* with highest change in rural employment, Santa Catarina, 1985-95/96

Município (1985 boundaries)	Ranking by total deforestat -ion (ha)	Total deforest- ation (ha)	Ranking by change rural jobs	Change in rural jobs	Ranking by change in area under cultiv- ation	Change in area under cultiv- ation (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change in pasture area	Change in pasture area (ha)
Fraiburgo	49	925	178	1347	17	-13781	7	-5367	11	-8016
Ibicaré	171	21	177	1290	111	-1210	97	1170	118	374
Catanduvas	60	759	176	1048	44	-6607	108	1814	50	-1330

Lebon Régis	18	1.979	175	1002	19	-12437	15	-2793	10	-8884
Imbuia	142	132	174	886	173	3256	123	2365	131	788
Irani	129	205	173	864	97	-1683	128	2740	91	-273
Bom Jardim Da Serra	34	1.249	172	703	178	29864	160	6690	177	10315
Pinheiro Preto	175	7	171	574	146	385	65	38	90	-287
Araranguá	157	51	170	539	25	-9479	16	-2629	25	-3081
Navegantes	92	415	169	523	134	-301	152	4612	150	1817

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

The cases of Imbuia and Pinheiro Neto are interesting because of the positive job creation together with very low deforestation. These examples show that deforestation was not a necessary condition for agricultural growth in the region.

The same dissociation between deforestation and agricultural performance is observed if the ranking is organized according to changes in area under cultivation (table 14), cattle herd (table 15) and pasture land (table 16). One important exception is Campo Erê, which presented simultaneous high increases in pasture land, cattle herd and deforestation. However, this *município* was also the one with the highest loss of rural employment, indicating that, even if deforestation has benefitted the expansion of cattle ranching, this certainly did not result in job creation. Another *município* with high deforestation and increase in cattle herd was Canoinhas, but in this case the connection is not so direct because it showed a decline in pasture area.

Table 14. *Municípios* with highest change in cultivation area, Santa Catarina, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultiv- ation (ha)	Change in area under cultiv- ation (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking change pasture area (ha)	Change in pasture area (ha)
Bom Jardim Da Serra	34	1249	172	703	178	29864	160	6690	177	10315
São Joaquim	24	1674	158	243	177	9123	52	-563	176	8524
Otacilio Costa	69	604	119	-259	176	5052	96	1055	86	-341
Alfredo Wagner	54	862	60	-1181	175	4982	144	3793	114	219
Ilhota	52	876	164	383	174	4650	146	4075	152	2242
Imbuia	142	132	174	886	173	3256	123	2365	131	788
Rio Do Oeste	115	309	27	-2060	172	2640	11	-3161	45	-1450
Agrolândia	87	480	88	-662	171	2506	131	2865	143	1185
Vargeão	95	388	147	62	170	2284	140	3431	149	1714
Angelina	81	516	150	143	169	2054	137	3121	82	-409

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

Table 15. *Municípios* with highest change in cattle herd, Santa Catarina, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivat- ion (ha)	Change in area under cultivation (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	Change in pasture area (ha)
Campo Erê	12	2803	1	-5851	91	-2097	178	20588	178	10762
Itapiranga	48	928	42	-1611	102	-1451	177	18422	164	3202
São Miguel D'oeste	16	2222	23	-2177	161	1378	176	17396	175	7221
Mondaí	62	700	52	-1380	160	1342	175	13797	165	3812
Canoinhas	3	7986	40	-1659	163	1610	174	12622	59	-844
Descanso	104	344	22	-2186	76	-3187	173	12600	173	5555
Quilombo	97	384	66	-1134	82	-2605	172	12314	171	5355
São José Do Cedro	42	1120	25	-2109	136	-81	171	10240	167	3993
Coronel Freitas	121	275	7	-3606	38	-7087	170	9504	168	4265
São Domingos	122	256	8	-3394	144	243	169	9295	170	4491

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

Table 16. *Municípios* with highest change in pasture area, Santa Catarina, 1985-95/96

Município (1985 boundaries)	Ranking by total deforestation (ha)	Total deforestation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivation (ha)	Change in area under cultivation (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	Change in pasture area (ha)
Campo Erê	12	2803	1	-5851	91	-2097	178	20588	178	10762
Bom Jardim Da Serra	34	1249	172	703	178	29864	160	6690	177	10315
São Joaquim	24	1674	158	243	177	9123	52	-563	176	8524
São Miguel D'oeste	16	2222	23	-2177	161	1378	176	17396	175	7221
Anita Garibaldi	45	1020	10	-3114	49	-5785	161	6860	174	6181
Descanso	104	344	22	-2186	76	-3187	173	12600	173	5555
Imaruí	29	1434	4	-5313	13	-15921	23	-2011	172	5387
Quilombo	97	384	66	-1134	82	-2605	172	12314	171	5355
São Domingos	122	256	8	-3394	144	243	169	9295	170	4491
São Lourenço Do Oeste	63	695	12	-2839	153	710	168	9046	169	4474

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables)

3.2. Results: Paraná

In Paraná, all of the ten *municípios* with highest deforestation area in the 1985-95/96 period presented negative growth in employment in agricultural activities. In aggregate terms, these ten *municípios* had a net loss of 71127 hectares of Atlantic rainforest, and of 34359 rural jobs. In five of these ten there was also a decline in pasture land, and the total net loss of pastures was of 35237 hectares (table 17).

Table 17. *Municípios* with highest deforestation, Paraná, 1985-95/96

Município (1985 boundaries)	Ranking by total deforestation (ha)	Total deforestation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivation (ha)	Change in area under cultivation (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	Change pasture area (ha)
Laranjeiras Do Sul	1	10.212	158	-930	2	-22.982	246	64.486	247	48.903
Quedas Do Iguacu	2	9.205	60	-3.267	45	-7.296	229	19.682	231	13.362
Tibagi	3	8.499	82	-2.379	247	19.751	237	28.915	10	-15.871
Castro	4	7.848	10	-6.495	246	16.715	57	-858	2	-47.007
Guarapuava	5	6.774	27	-4.828	248	21.941	232	21.001	4	-33.876
Cascavel	6	6.285	11	-6.251	115	-3.048	245	51.036	245	39.382
Catanduvas	7	5.825	56	-3.428	28	-9.344	210	10.695	92	1.526
Palmas	8	5.564	85	-2.308	240	4.955	105	1.355	3	-44.578
Mangueirinha	9	5.519	98	-2.079	222	983	235	26.597	125	3.118
Teixeira Soares	10	5.395	81	-2.394	224	1.239	202	9.123	61	-196

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

If any direct relationship between deforestation and rural employment growth could be established, it would be more of a negative link: 4 out of the 10 state “champions” of deforestation were among the 25% with highest job loss, and only Laranjeiras do Sul was not among the 50% of Paraná’s *municípios* with worst rural employment performance.

However, this suggestion of a negative relationship between deforestation and rural jobs creation does not hold if the analysis is made upon the *municípios* with

best employment performance: in four of them deforestation was low, but the other six presented important reduction in the remaining forest.

Table 18. *Municípios* with highest change in rural employment, Paraná, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivat- ion (ha)	Change in area under cultiva- tion (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	Change in pasture area (ha)
Umuarama	24	3003	248	7573	23	-9950	1	-53668	72	613
Prudentopolis	26	2784	247	3547	237	3968	225	17114	174	5753
Ortigueira	21	3201	246	3438	7	-15221	248	94801	246	44802
Contenda	123	235	245	2608	226	1316	130	2513	102	2079
Cerro Azul	17	3580	244	2352	241	6728	200	9077	186	6473
Sao Carlos Do Ivai	237	19	243	1899	238	3985	63	-620	53	-478
Bituruna	22	3160	242	1693	215	365	128	2350	34	-2311
Guairaca	161	119	241	822	211	76	46	-2273	162	4987
Mariluz	221	28	240	650	87	-4121	17	-5712	83	1055
Ipiranga	35	2079	239	635	242	7607	140	3054	54	-455

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

No easy connection can be established either between deforestation and changes in area under cultivation (table 19), cattle herd (table 20) or pasture area (table 21). On the one hand, some of the *municípios* with the highest deforestation were among those with higher increases in pasture area and cattle herd (Laranjeiras do Sul) or area under cultivation (Guarapuava, Tibagi, Castro e Palmas). On the

other hand, other *municípios* with good ranching performance or increase in area under cultivation presented low levels of deforestation (São José dos Pinhais, Palmital and Grandes Rios).

Table 19. *Municípios* with highest change in cultivation area, Paraná, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivat- ion (ha)	Change in area under cultivation (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	Change in pasture area (ha)
Guarapuava	5	6774	27	-4828	248	21941	232	21001	4	-33876
Tibagi	3	8499	82	-2379	247	19751	237	28915	10	-15871
Castro	4	7848	10	-6495	246	16715	57	-858	2	-47007
Pirai Do Sul	41	1606	162	-871	245	13297	85	255	8	-18106
Ponta Grossa	31	2391	141	-1159	244	12919	8	-10228	6	-29692
Ivai	43	1576	236	507	243	11628	159	4368	103	2198
Ipiranga	35	2079	239	635	242	7607	140	3054	54	-455
Cerro Azul	17	3580	244	2352	241	6728	200	9077	186	6473
Palmas	8	5564	85	-2308	240	4955	105	1355	3	-44578
Sao Jose Dos Pinhais	124	230	123	-1566	239	4787	71	-265	14	-10210

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

Tabela 20. *Municípios* with highest change in cattle herd, Paraná, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivation area (ha)	Change in area under cultivat- ion (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	Change in pasture area (ha)
Ortigueira	21	3201	246	3438	7	-15221	248	94801	246	44802
Pitanga	19	3329	2	-9088	3	-20634	247	94130	248	68083
Laranjeiras Do Sul	1	10212	158	-930	2	-22982	246	64486	247	48903
Cascavel	6	6285	11	-6251	115	-3048	245	51036	245	39382
Candido De Abreu	51	1223	131	-1428	231	1936	244	48551	244	34066
Reserva	29	2579	22	-5000	13	-11769	243	45662	241	21519
Palmital	95	402	84	-2321	9	-14107	242	39138	240	21359
Toledo	57	992	55	-3445	4	-18157	241	32596	223	10625
Chopinzinho	37	1878	16	-5516	41	-7793	240	32564	232	13774
Grandes Rios	162	117	19	-5127	6	-15311	239	31457	243	23629

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

Table 21. *Municípios* with highest change in pasture area, Paraná, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivation (ha)	Change in area under cultivation (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change in pasture area (ha)	Change in pasture area (ha)
Pitanga	19	3329	2	-9088	3	-20634	247	94130	248	68083
Laranjeiras Do Sul	1	10212	158	-930	2	-22982	246	64486	247	48903
Ortigueira	21	3201	246	3438	7	-15221	248	94801	246	44802
Cascavel	6	6285	11	-6251	115	-3048	245	51036	245	39382
Candido De Abreu	51	1223	131	-1428	231	1936	244	48551	244	34066
Grandes Rios	162	117	19	-5127	6	-15311	239	31457	243	23629
Campo Mourao	33	2147	77	-2536	103	-3581	231	20004	242	21554
Reserva	29	2579	22	-5000	13	-11769	243	45662	241	21519
Palmital	95	402	84	-2321	9	-14107	242	39138	240	21359
Matelandia	62	878	58	-3413	12	-12382	220	14817	239	17428

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

3.3. Results: Rio Grande do Sul

As in the other states, there was a negative change in the overall number of the rurally employed in Rio Grande do Sul between 1985 and 1995/96. In the ten *municípios* with highest deforestation (comprising a total loss of 40146 hectares of Atlantic rainforests), the net loss in rural employment was 24431. It is relevant to note a decrease in pastures and cattle herds in nine of these ten *municípios*, and in seven of the ten there was reduction in the area under cultivation (in the *municípios* where area under cultivation has not diminished that increase was inferior to the reduction in pasture area). For example, in Vacaria, the highest

deforestation in absolute terms was observed (-7.726 ha), but the decrease of pastures (-40.487 ha) far surpassed the increase in cultivation area (+ 3.835 hectares).

Table 22. *Municípios* with highest deforestation, Rio Grande do Sul, 1985-95/96

Município (1985 boundaries)	Ranking by total deforestation (ha)	Total deforestation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivation (ha)	Change in area under cultivation (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	Change pasture area (ha)
Vacaria	1	7726	134	-414	163	3835	5	-35166	6	-40487
São Francisco de Paula	2	6883	87	-1583	128	-1276	47	-4483	39	-7293
Bom Jesus	3	6018	159	-24	159	977	30	-9171	19	-20553
Lagoa Vermelha	4	5658	44	-2726	130	-1061	48	-4394	21	-17522
Nova Prata	5	2951	88	-1546	85	-4032	105	445	59	-3270
Pelotas	6	2514	36	-3283	18	-15492	58	-3167	43	-6264
Canguçu	7	2404	6	-7519	4	-35129	166	15320	163	4569
São Lourenço do Sul	8	2252	24	-3962	8	-28538	38	-6574	49	-4786
Esmeralda	9	1884	115	-924	152	36	112	916	18	-21380
Caxias do Sul	10	1855	51	-2450	117	-1680	45	-5072	30	-10561

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

Moreover, in the *municípios* where high deforestation and large scale expansion of cultivation or pasture land simultaneously occurred, the change in rural employment was always negative. Canguçu illustrates this kind of relationship: it was the seventh in deforested areas (-2.404 ha) but is amongst the ones with

highest increases in pastures (+ 4.569 ha) and cattle herd (+15320 animals). However, cattle ranching in practice is of very low labour intensity, and the total loss in cultivation areas (-35129 hectares, the fourth highest in this parameter) certainly contributed for the mediocre result Canguçu presented in terms of job losses (-7.519 occupations, the sixth worst performance in the state).

In contrast, table 23 lists the ten *municípios* with best performance in personnel occupied. There were significant increases in cultivation areas in four of them; and in another four there were positive growth in pastures or cattle herd size. The *municípios* of Charqueadas and Tramandaí are particularly interesting, since job creation was simultaneous to very low deforestation. Charqueadas (deforestation of 115 ha) was the third in terms of job creation (net gain of 397) and also one of the best performers in terms of cultivation area (+2737 ha), pasture area (+3715 ha), and cattle herd (6269 ha). In Tramandaí (only 18 hectares deforested), there was a net gain of 237 jobs, 240 hectares for cultivation and 839 hectares for pastures and 1088 bovines.

Table 23: *Municípios* with highest change in rural occupied personnel, Rio Grande do Sul, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivation (ha)	Change in area under cultivation (ha)	Ranking by change in size of cattle herd (animals)	Change cattle herd (animals)	Ranking by change pasture area (ha)	Change in pasture area (ha)
Cruz Alta	26	919	168	1452	168	20946	82	-1200	14	-24053
Charqueadas	99	115	167	397	162	2737	162	6269	162	3715
Severiano de Almeida	144	24	166	394	141	-646	122	1482	123	-51
Dona Francisca	168	1	165	372	150	-211	106	514	132	180

General Câmara	20	1381	164	341	41	-7925	95	-490	118	-239
Tramandaí	151	18	163	237	156	240	116	1088	148	839
Flores da Cunha	68	281	162	180	129	-1173	80	-1353	139	429
Ilópolis	116	84	161	138	158	588	102	82	106	-589
Feliz	58	361	160	38	127	-1365	76	-1599	117	-247
Bom Jesus	3	6018	159	-24	159	977	30	-9171	19	-20553

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

Tables 24, 25 and 26 also show that deforestation cannot be linked to the improvement of the agricultural performance indicators. Rarely do *municípios* with higher deforestation appear in the list of the best performances for increasing cultivation area, pastures and cattle herds. The exceptions were the already referred to cases of Canguçu and Vacaria, which are (together with Bom Jesus) good examples of where the net conversion from cultivation to pasture is of a higher magnitude than the deforested area.

Table 24. *Municípios* with highest change in cultivation area, Rio Grande do Sul, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivation (ha)	Change in area under cultivation (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	Change in pasture area (ha)
Cruz Alta	26	919	168	1452	168	20946	82	-1200	14	-24053
Jóia	100	112	153	-141	167	7688	154	4487	28	-11506
Palmares do Sul	146	20	89	-1527	166	7618	18	-14145	50	-4605
Tupanciretã	74	264	69	-1956	165	5213	22	-12403	11	-32585
Fortaleza dos Valos	101	111	147	-242	164	3968	163	7566	82	-1735
Vacaria	1	7726	134	-414	163	3835	5	-35166	6	-40487
Charqueadas	99	115	167	397	162	2737	162	6269	162	3715
Panambi	126	60	143	-255	161	2726	164	8691	157	1729
Pejuçara	96	131	149	-228	160	2595	125	1764	67	-2765
Bom Jesus	3	6018	159	-24	159	977	30	-9171	19	-20553

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

Table 25.: *Municípios* with highest change in cattle herd, Rio Grande do Sul, 1985-95/96

Município (1985 boundaries)	Ranking by total deforestation (ha)	Total deforestation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivation (ha)	Change in area under cultivation (ha)	Ranking by change in size of cattle herd (animals)	Change cattle herd (animals)	Ranking by change pasture area (ha)	Change in pasture area (ha)
Dom Pedrito	145	23	117	-863	50	-7195	168	26216	160	2621
Encruzilhada do Sul	21	1199	10	-6510	7	-31197	167	16452	3	-43927
Canguçu	7	2404	6	-7519	4	-35129	166	15320	163	4569
Espumoso	84	209	50	-2462	19	-14011	165	13246	161	3559
Panambi	126	60	143	-255	161	2726	164	8691	157	1729
Fortaleza dos Valos	101	111	147	-242	164	3968	163	7566	82	-1735
Charqueadas	99	115	167	397	162	2737	162	6269	162	3715
Aratiba	155	16	66	-2166	83	-4134	161	5985	156	1661
Três Passos	140	29	12	-5556	45	-7485	160	5662	136	363
Chapada	120	74	73	-1913	105	-2476	159	5541	58	-3292

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

Table 26. *Municípios* with highest change in pasture area, Rio Grande do Sul, 1985-95/96

Município (1985 boundaries)	Ranking by total deforest- ation (ha)	Total deforest- ation (ha)	Ranking by change in rural jobs	Change in rural jobs	Ranking by change in area under cultivation (ha)	Change in area under cultivat- ion (ha)	Ranking by change in size of cattle herd (animals)	Change in cattle herd (animals)	Ranking by change pasture area (ha)	Change in pasture area (ha)
Taquara	109	96	150	-201	104	-2575	62	-2813	168	14039
Arroio do Tigre	132	41	85	-1612	102	-2781	145	3579	167	9361
Santa Bárbara do Sul	51	447	97	-1310	20	-13862	56	-3242	166	5532
Dom Feliciano	34	759	93	-1434	51	-7181	147	3669	165	4879
Cambará do Sul	72	274	157	-61	155	169	136	2923	164	4685
Canguçu	7	2404	6	-7519	4	-35129	166	15320	163	4569
Charqueadas	99	115	167	397	162	2737	162	6269	162	3715
Espumoso	84	209	50	-2462	19	-14011	165	13246	161	3559
Dom Pedrito	145	23	117	-863	50	-7195	168	26216	160	2621
Formigueiro	66	295	94	-1433	91	-3550	133	2281	159	2227

Source: Atlas dos remanescentes florestais (deforestation); IBGE agricultural census (other variables).

4. Conclusion

The results presented in this work, even though preliminary and still requiring more sophisticated econometric analysis, clearly show that there is not an obvious relationship between deforestation and increasing agricultural activity in the remaining areas of Atlantic Rainforest as alleged by those who are trying to reduce the minimum reserve allowance in the Brazilian Forest Code. There was a decrease in rural jobs in the region as a whole and in most of the municipalities

where deforestation was more extensive in the 1985/96 period. A similar relationship was observed for other agricultural performance indicators, even though less pronounced, such as area for pastures or cultivation, and number of cattle.

There were important exceptions, where deforestation was simultaneous with the improvement in some of the performance indicators, especially those related to cattle ranching. Nevertheless, even in these few exceptions, rural employment presented a negative trend in the period. In most cases the improvement of one indicator was simultaneous with the worsening of another one, such as the increasing area dedicated to pastures being parallel to the reduction in cultivation areas. In other words, the substitution of land use in already deforested areas has had more a important impact than any eventual net gain in total agricultural area obtained as a result of deforestation.

Therefore, the final conclusion is that the proposed changes in the Forest Code, aiming at the reduction of mandatory conservation areas, will have very minor economic benefits in the Atlantic Rainforest region (if any at all), in contrast to the huge damage that would be caused to an already threatened ecosystem. It is even possible that these economic gains will become negative, with more loss of employment and production caused by the disruption of the environmental services provided by the remaining forests.

5. References

- Branstromm, C. (2000). "Coffee labor regimes and deforestation on a Brazilian frontier, 1915-1965", *Economic Geography* 76(4):326-46.
- Fundação SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais e Instituto Socioambiental (1998). *Atlas da evolução dos remanescentes florestais e ecossistemas associados no domínio da mata atlântica no período 1990-1995*. São Paulo: SOS Mata Atlântica.
- Lessa, C. (2000). *O Rio de todos os Brasis: uma reflexão em busca de auto-estima*. Rio de Janeiro: Record.
- Mahar, D. and Schneider, R. (1994) "Incentives for tropical deforestation: some examples from Latin America", in: K. Brown and D.W. Pearce (eds), *The causes of tropical deforestation*. London: University College London Press.
- Reis, E.J. and Guzmán, R. (1994) "An econometric model of Amazon deforestation", in: K. Brown and D.W. Pearce (eds), *The causes of tropical deforestation*. London: University College London Press.
- Young, C.E.F. (2001). "Public policies and deforestation in the Brazilian Amazon", in: Seroa da Motta, R. (ed) *Environmental economics and policy making in developing countries*. Cheltenham: Edward Elgar.