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Land-Use Practices in Ouro Preto do Oeste, Rondônia, Brazil

M. A. Pedlowski
V. H. Dale

Environmental Sciences Division
Publication No. 3850

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ENVIRONMENTAL SCIENCES DIVISION

LAND-USE PRACTICES IN OURO PRETO DO OESTE, RONDÔNIA, BRAZIL

M.A. PEDLOWSKI AND V.H. DALE

Environmental Sciences Division
Publication No. 3850

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ABSTRACT

Road development and colonization projects have brought about wide-scale deforestation in the Brazilian Amazon. The state of Rondônia, located in the western Amazon Basin, best exemplifies the problems related to land-use changes because it has the highest rates of deforestation in the Amazon Basin.

In order to identify the main land-use practices in Rondônia, interviews with local farmers were carried out in the central part of Rondônia, in the PIC (Integrated Colonization Project) Ouro Preto do Oeste. This is the oldest colonization project in the state. The governmental colonization programs attracted migrants to the area through the construction of roads and infrastructure necessary for the colonists to occupy the land for agricultural practices. The interviews were done on lots of the PIC Ouro Preto and in PAD Urupá to define the background of the colonists, their land-use practices, their economic situation, and their relationships with governmental institutions.

The results show that after 20 years, the colonists still face major obstacles to reaching a stable situation on the land. The only services available are elementary schools and health care, but both are provided only in a restricted way and leave the colonists under acute problems of lack of infrastructure.

Deforestation affected more than 50% of the area studied. Natural conditions (e.g., soils with low fertility, a strongly marked rainy season), the main land-use practices (e.g., "slash and burn agriculture," the absence of modern and appropriate techniques for the region), and the lack of governmental support (technical assistance, policy of storage and prices) caused a high turnover in the ownership of the land.

As a result, annual and perennial crops were replaced by pasture and cattle raising as the main source of income for the colonists in the region.

1. INTRODUCTION

The occupation of the Amazon Basin has been a goal of Brazilian governments since the 19th century. The region has the largest tract of tropical rain forest in the world [> than 3.3 million km^2 (Molofosky et al. 1986)], and a variety of mineral resources can be found there (Santos 1983). This combination of resources has led to the transformation of the region into the "last Brazilian frontier." During the 20th century the government has attempted to obtain a more complete control of the region and its resources (Machado 1991).

In 1970 the central government established the National Integration Program (PIN) as a result of economic tension in various regions of Brazil. The goal was to protect the western borders through the concentration of Brazilian citizens there. PIN was based on a new transportation system, the largest road of which is the Transamazon, to link the Atlantic coast to the Peruvian border. The goal of the project, which began in 1974, was to settle 100,000 families (500,000 people) in 5 years along the Transamazon Highway (Jordan 1987, Fearnside 1986). However, by 1978, 4 years after the plan was originated, less than 8% of the anticipated number were settled. Several factors contributed to the failure of the Transamazonian colonization. The main problems involved failure to provide land titles, lack of secure loans for agricultural provisions, inadequate governmental support (e.g., absence of storage facilities and technical assistance), poor maintenance of roads, and the inability of the underlying forest soils to sustain agriculture.

The Brazilian state of Rondônia in the western Amazon Basin best exemplifies problems related to land-use changes. Analysis of the images generated by the AVHRR satellite for Rondônia shows that in 1980 >8,000 km^2 of forest were eliminated, increasing to 28,000 km^2 by 1985, and the total reached 41,000 km^2 by 1987 (Malingreau and Tucker 1988, Stone et. al. 1991).

In contrast to the Transamazon development project, central Rondônia was situated on relatively good soils, and the plan included the establishment of some infrastructure. The colonization projects between 1970 and 1990 have successfully attracted migrants to the state through the construction of roads and infrastructure. The paving of BR-364 from Cuiabá to Porto Velho in 1984 played an important role in the

arrival of colonists in the region, because it served as a corridor for year-round immigration. An increase in the number of immigrants, coupled with an increase in the area of accessible forest, had a strong effect on the amount and rate of deforestation (Frohn et al. 1990).

A direct relationship exists between increases in the paved roads and deforestation caused by the land-use practices of colonists arriving in Rondônia (Fearnside 1983, Leite and Furley 1985). The colonists usually cut down the forest, practice "slash and burn" agriculture of annual crops for a few years, and then turn the land to pasture which is burned annually (Coy 1987). The land becomes so degraded by agricultural use that it will not sustain cattle ranching or any other type of farming (Millikan 1988). These land-use practices increased the area of deforestation and caused dramatic alteration in the biodiversity of the region.

To identify the main land-use practices in Rondônia, interviews with colonists were carried out in the central part of the state, in PIC Ouro Preto and in PAD Urupá. The interviews were conducted with four goals in mind:

1. To define the social characteristics of the colonists, the different kinds of land use, the crops planted, the fate of the production, and the relationships between the colonists and governmental institutions.
2. To determine the influence of such variables as distance to the market, characteristics of the road network, and soil quality on the success or failure of the colonists.
3. To determine trends in land-use practices and their effects on deforestation.
4. To estimate future trends of land-use based on economic activity related to agriculture and cattle raising.

2. METHODS

2.1 AREA OF STUDY

The PIC Ouro Preto and PAD Urupá are located in the central area of Rondônia (Fig. 1). The BR-364 is the only paved road in the region and connects Ouro Preto to cities in northern Rondônia as well as to Mato Grosso. The side roads are unpaved, which impedes passage during the rainy season. The topography in the region is dominated by low hills, averaging 340 m. The analysis of land suitability by the DNPM/RADAMBRASIL (1978) for annual and perennial crops and pasture includes fours categories: good, moderate, restricted and unsuitable. The general descriptions were given as follows:

Good— Conditions present no to light limitations for a large number of crops that are climatically adapted. Good yields are expected for a period of 20 years, when the yields start to decrease gradually.

Moderate— Conditions present light to moderate limitations for a large number of crops that are climatically adapted. Good yields are expected for the first 10 years, and the yields are expected to decrease to a medium level during the following 10 years.

Restricted— Conditions present moderate to strong limitations for a large number of crops that are climatically adapted. Medium yields can be expected for the first few years, but they will decrease rapidly within a period of 10 years.

Unsuitable— Conditions present very strong limitations for farming a large number of crops that are climatically adapted, and yields are expected to be very low beginning in the first year of farming.

The study area is composed primarily of soils classified as good, but soils range from moderate to unsuitable for either annual or perennial crops and range from good to restricted for pasture.

The vegetation is characterized by dense tropical forest and the open tropical forest (DNPM/RADAMBRASIL 1978). Dense forest is stratified into basically four layers dominated by large trees with emergent canopies. The trees have luxurious

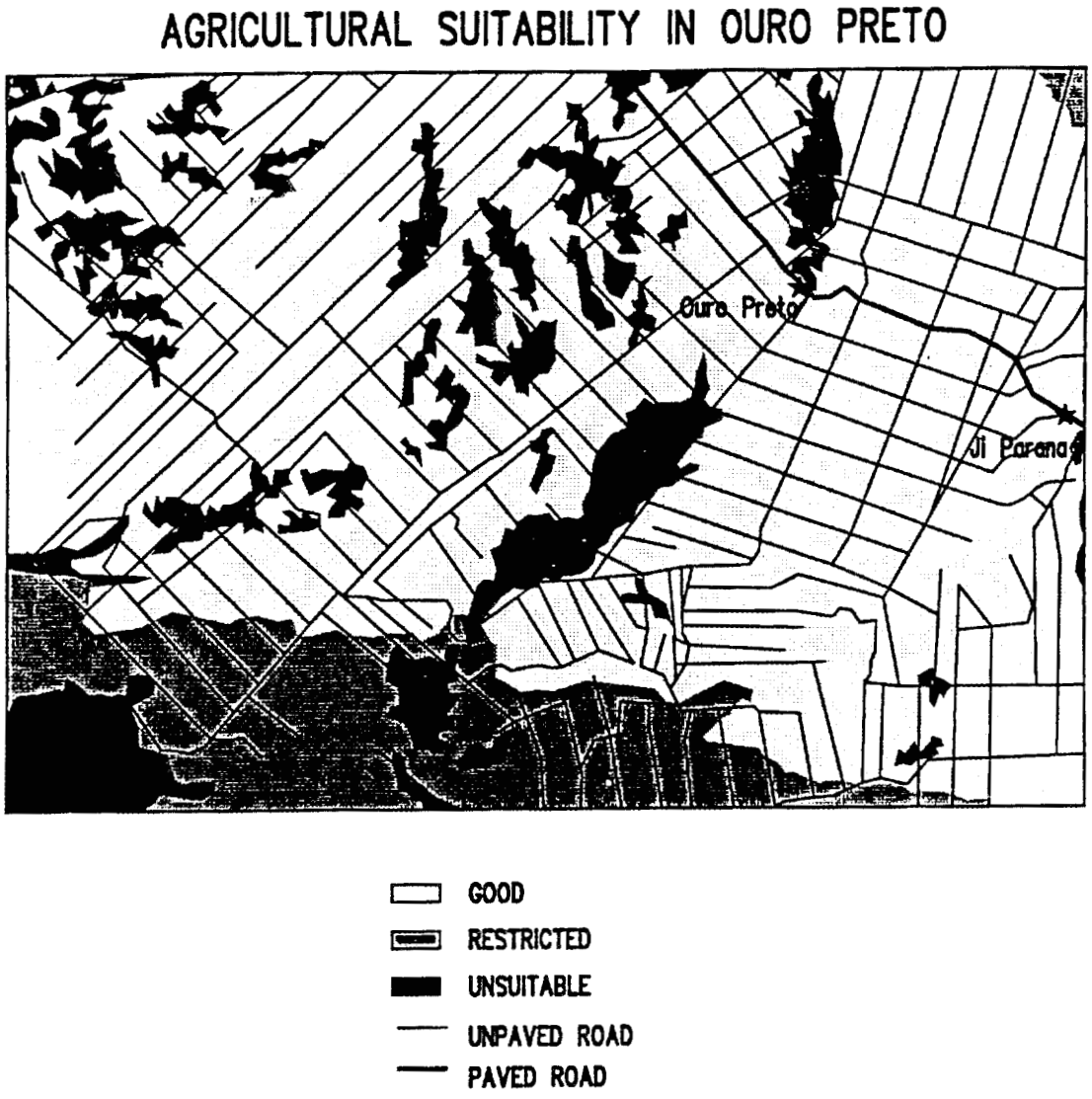

Fig. 1. Map showing the state of Rondônia, PIC Ouro Preto, PAD Urupá, and BR-364.

canopies and tall, straight stems. The open forest is characterized by a dense mixture of palms. The palms can be present in homogeneous groups but can also appear mixed with species from the dense forest.

The region has two marked seasons: the rainy period occurs from November to April, and the area is dry the rest of the year.

2.2 DATA GATHERING

Interviews with farmers were determined to be the most practical method to obtain information about social characteristics, land-use patterns, influences, and trends. In preparation for the interviews, a questionnaire was created to obtain specific information about land-use practices (see Appendix).

The farms from which the colonists were interviewed were chosen on the basis of two variables: soil quality and distance to market. With the use of a (1:250,000) map of agricultural and pasture suitability and roads network (Fig. 2), colonists were selected to represent all combinations of soil suitability and distance. Within this framework a random subset was chosen.

The questionnaire includes colonists' demography, pattern of land use, productivity of the land, and the influence of official institutions of research and rural extension. Seven topic areas were included in the questionnaire:

1. Personal and family characteristics, their origin and prior occupations, the forms of land acquisition and reasons for choosing the specific lot, the number of lots previously occupied, and the main problems during the first occupancy of the lot.
2. Spatial characteristics of the lot, such as distance to the market, pavement characteristics of road network, and soil quality.
3. Rate of conversion from natural vegetation to crops or pasture, number of persons involved in clearing, the participation of different laborers (family and nonfamily) in this process, time spent, and kinds of tools used.
4. Information about the lot operation, such as mechanized and/or hand equipment, animals, teams of animals with operator, purchased seeds, fertilizers, insecticides, herbicides, labor, and structural.

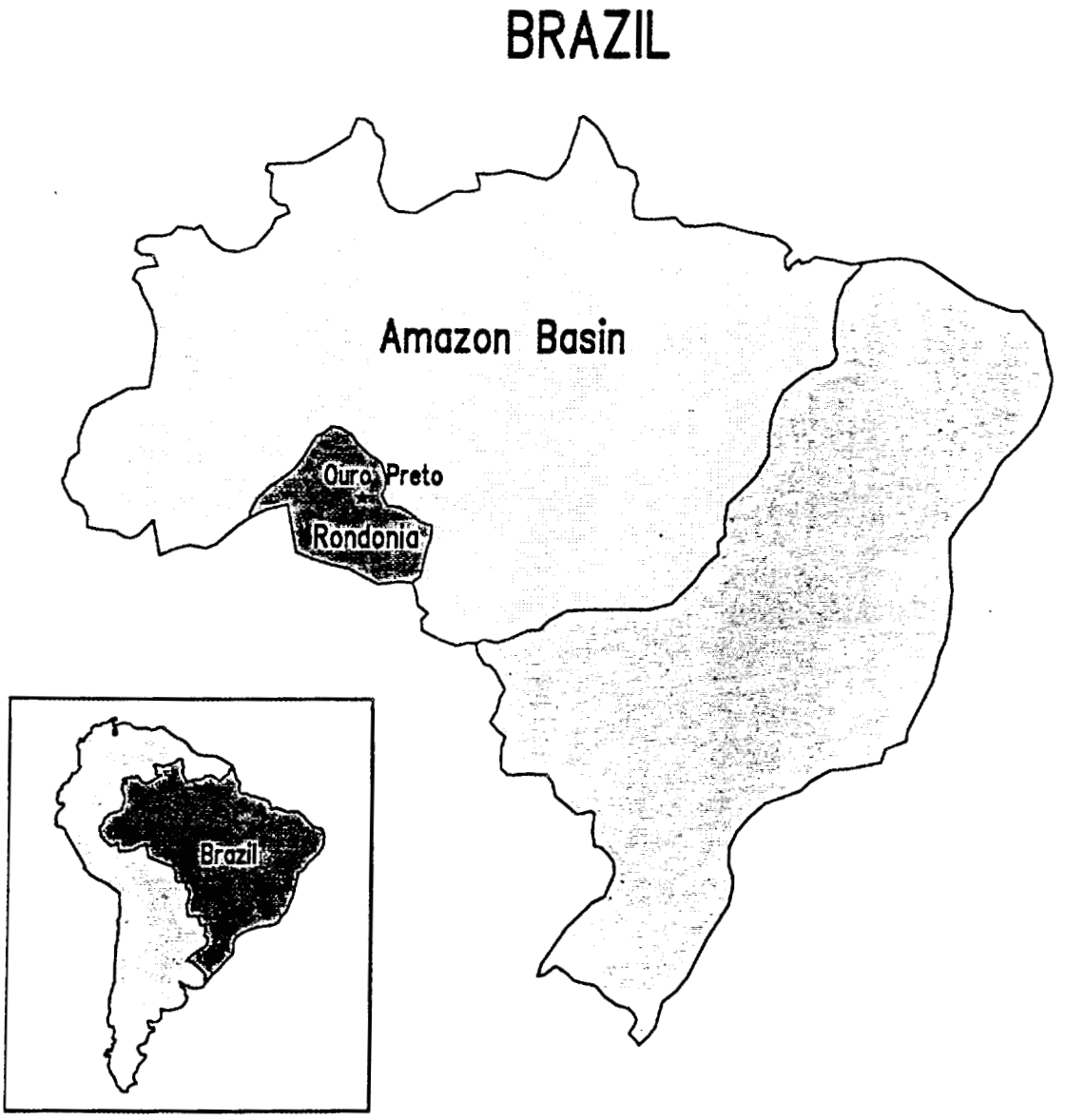

Fig. 2. Map of soil suitability (DNPM/RADAMBRASIL 1978) superimposed on the roads network for the study area.

5. Areas planted (annual, perennial, and pasture), cattle raising, goods and animal production, amount of commercialization, kinds of transport used.
6. Technical support by governmental institutions [i.e., Brazilian Enterprise of Agriculture and Cattle Raising Research (EMBRAPA), Brazilian Enterprise of Rural Extension (EMATER), Brazilian National Council for Cocoa Cropping Development (CEPLAC), Urban Nucleus of Rural Support (NUARs)] and the main necessities required to make their lots viable.

A total of 86 interviews were carried out from August 6 to August 21 and from November 22 to December 6, 1991. Information was obtained about 91 lots. The difference between the number of interviews and the number of lots occurs because three colonists had more than one lot in different locations. Fifty-five lots were sampled during the dry season and thirty-six during the wet season. Because milk production doubles during the wet season, the production values obtained during November and December were halved to provide a uniform comparison to dry-season milk production. The income found is expressed in U.S. dollars (U.S. $) for November 1990, and milk and expenses were calculated in July 1991.

3. RESULTS

3.1 CHARACTERISTICS OF COLONISTS AND CONFIGURATION OF LOTS.

The total area of the 91 lots is 7,855 ha. The average is 86 ha; the range is from 5 to 288 ha. This variation in lot size illustrates three common situations: the preservation of the original size (100 ha), aggregation of one or more adjacent lots, and fragmentation of a given lot into smaller lots.

Coy (1987) observed that aggregation and fragmentation result from different reasons. Aggregation reflects either colonists who have done well on their original lots or the arrival of migrants with capital to buy a set of lots. Fragmentation is caused by a farmer's need to sell part of his lots to make the remaining viable. In contrast with the official planning, the region is currently undergoing extensive aggregation, especially adjacent to the BR-364, where some colonists are buying as many as 20 lots to use as

pasture. However, this process is difficult to measure because the owners are not living on the lots.

The first colonists arrived in 1971 shortly after the establishment of the PIC and the paving of the road. During the 1970s, 58% of the colonists arrived, primarily during the first half of the decade.

As shown in Table 1, the average age of the interviewed colonists, who ranged in age from 19 to 73 years, is 48.8 years. A total of 699 persons live on the 91 sample lots, including the colonists' families and sharecroppers.

Table 1. Age of the colonists and population on the lots sampled

	Age	Men	Women	Children
Total		245	196	258
Average	48.8	3	2	3
Maximum	73.0	7	8	15
Minimum	19.0	0	0	0

Most of the colonists immigrated from southern and southeastern Brazil: 23% were from the middle west, and only 4% were from the north or northeast (Table 2). The last place inhabited is not necessarily the colonist's birthplace because the person may have moved several times before arriving in Rondônia. The high percentage from the middle west had moved often because that area was recently settled and continues to have a high turnover rate. Only two colonists were originally from Rondônia.

Table 2. Last location before arriving in Rondônia

Region	Relative frequency (%)
South	23
Southeast	50
North	2
Northeast	2
Middle West	23

The colonists' previous occupations can be divided into seven categories (Table 3). The distinction between share renter and fixed renter is based on the percentage of production given to the owner (50% in the first case) and the time spent on a certain area, which is longer for the second case. Most colonists were sharecroppers because the programs of the Brazilian government in the 1970s did not allow for the large number of landless farmers in other regions such as the south and southeast.

Land was acquired in two main ways. One-third (34%) of the colonists received land from governmental programs in Ouro Preto, 64% bought the lot from other colonists, 1% changed lots to acquire a larger area, and 1% rented. Only 11% of the colonists were interested in selling their lots. Only 17% of the colonists had previously owned other lots in Rondônia. The low percentage of renters reflects a disinterest in renting land or having sharecroppers.

The length of time the colonists had been on the lots ranged from 0 to 20 years; the average time was 10 years. Browder (1990) found the same average for an area in the south of Rondônia. In the case of Ouro Preto, such results show that despite high turnover and soil degradation, the area is attractive to people searching for land.

Table 3. Previous occupations of the colonists

Occupation	Relative frequency. (%)
Owner	36
Share renter	39
Fixed renter	2
Urban or town worker	14
Rural worker	1
Professional	2
Other	6

3.2 LAND-USE HISTORY

Table 4 shows deforestation during the first year on the land, the amount currently deforested, the annual average of days used to cut the vegetation, and the number of people involved in clearing (divided into family and nonfamily members). Current deforestation is 52% of the region (4,060.5 ha); an annual average of 3.1 ha is cut per lot. A total of 18 colonists never cut the natural vegetation, which reflects either a low level of activity or receipt of the lot totally cut up to the legal limit of 50%.

Table 4. Area of deforestation (ha), days spent to clear the land, and kinds of labor available

	Cleared first year (ha)	Days to clear	Family workers (no./farm)	Non-family workers (no./farm)	Current clearing (ha)	Area cleared per year (ha/yr)
Total	423.4	2245	178	113	4060.5	282.8
Average	4.6	25	2	1	45	3.1
Maximum	24	115	10	10	180	15.4
Minimum	0	0	0	0	4	0

The time of clearing averaged 24 days, ranging from 0 to 115 days. The wide range of days necessary is explained by the number of laborers, tools available, and the types of natural vegetation. Most laborers are family members (61%).

Chain saws decreased the time spent in clearing and the number of people involved. Currently 74% of the farmers use chain saws plus other tools, and of this total 54% are chain-saw owners. The other farmers used only machetes and/or sickles.

The farmers estimate that a decrease in productivity has occurred on 57% of the lots. However, this decrease may be underestimated because of the colonists' lack of knowledge about land fertility. Specific crops (e.g., rice, corn, coffee, and cocoa) are in decline after some years of agricultural use.

Slash-and-burn agriculture is practiced every year by 62% of the colonists, and only 1% (1 colonist) declared that he had never burned. The remaining 37% burn less frequently. Small trees, vines, and understory are cut at the beginning of the dry season. Then the farmers wait until the slash is as dry as possible to ensure a complete burning. Burning provides ash to fertilize the land and eliminates large amounts of material that impede planting (Jordan 1987).

There are limited land preparation practices. Only 7% of the farmers —basically cocoa planters who received financial support from CEPLAC— fertilize with manure. Liming is not practiced because the colonists are not aware of this kind of land preparation. On the other hand, 63% of them annually rotate crops. The type of rotation commonly used is very rustic (first they plant rice and corn; afterward they plant beans), but the practice does reduce soil degradation. Unfortunately, an increasing trend is to substitute a more damaging rotation that consists of rice during one year and pasture in the following years.

The combination of soil limitations, land preparation, and availability of tools for clearing represents a crucial problem for the control of deforestation. As Frohn et al. (1990) pointed out, the potential for deforestation is greater than what has actually occurred, and the present results reinforce that conclusion.

3.3 AREA PLANTED

Table 5 shows the area planted, divided into annual crops, perennial crops, and pasture. Pasture covers 72% of the area; 12% is in annuals, and 16% is in perennials.

Table 5. Area planted with pasture, annual crops, and perennial crops

	Relative frequency(%)	Area planted (ha)
Total	100	3,889.9
Annual	12	464.0
Perennial	16	620.6
Pasture	72	2,805.2

3.3.1 The Annual Crops

The most common annual crops are rice, beans, corn, and manioc (Table 6). Percentiles total more than 100% because of the crop rotation used in the region. Beans are planted after rice and corn are harvested. The manioc is commonly planted among corn and beans, and the amount is difficult to determine because the colonists plant it in an uncontrolled way.

Table 6. Area planted and average, maximum, and minimum per lot for annual crops

	Total (ha)	Number of lots[a]	Average (ha)	Maximum (ha)	Minimum (ha)
Rice	213.8	68	3.1	16.8	0.5
Beans	226.4	62	3.6	16.8	0.2
Manioc	43.5	35	1.2	4.8	0.2
Corn	325.3	74	4.4	24.0	0.5

[a] From a total of 91

Corn is presently planted more than other traditional food crops, and the persistence of this trend is linked with the increase in the area covered with pasture. To illustrate this situation, the current results can be compared with those of a study done by INCRA (1982) for the PIC Ouro Preto in which the areas planted to rice, beans, manioc, and corn were, respectively, 3.81, 4.30, 0.40, and 3.90 ha. The values found in the 1991 interviews for the same crops are 2.3, 2.4, 0.4 and 3.6. Rice and beans are declining for different reasons.

Rice requires areas recently deforested, which are becoming rarer as a result of the legal restrictions. Beans are declining because they have been affected by diseases.

3.3.2 The Perennial Crops

The colonists were encouraged by financial programs to plant perennial crops, especially cocoa, rubber, and banana. However, the amount of coffee also increased in the region because the colonists came from coffee-growing areas.

Coffee is the most common perennial crop (Table 7) because cocoa and banana have been unproductive in recent years mainly as result of decreases in soil fertility, diseases, fungal outbreaks, and insects. Also, such crops as sugarcane and fruits have not been traditional, and colonists show little interest in planting them. Some colonists indicated that even coffee is decreasing in productivity. Currently, there is a tendency to eradicate perennial crops from many areas.

Table 7. Area planted and average, maximum, and minimum per lot for perennial crops

	Total (ha)	Number of lots	Average (ha)	Maximum (ha)	Minimum (ha)
Cocoa	168.9	25	6.8	19.9	0.6
Fruits	6.3	05	1.2	2.4	0.5
Coffee	361.3	59	6.1	24.0	0.1
Rubber	55.2	07	7.9	12.0	1.2
Banana	36.6	12	3.0	7.2	1.2
Sugarcane	19.9	01	19.9	19.9	0.0

3.4 PASTURE AND ANIMAL RAISING

3.4.1 The Area with Pasture and Secondary Vegetation

Pasture or secondary vegetation is absent from only 4.3% of the lots studied (Table 8). One reason is that land consolidation occurs through the transition from crops to cattle. This transition is caused by the decrease in crop productivity, by the problems in the storage or transport of the crops, and by the lack of a national policy of prices which makes income from crops very unstable. Thus, cattle raising and pasture represent a safer return on the money spent by farmers.

A second reason is that pasture is considered an improvement in land conditions and thus increases the price of the property. As a result, having pasture can be helpful for those farmers wishing to sell the land. Planting pasture does not necessarily indicate interest in or even plans to have cows; 15% of the lots with pasture do not have any cows.

The conversion to pasture is happening at a rapid pace. Surveys in the earlier 1980s found that land in pasture ranged from 40% to 49% in the lots of Ouro Preto (Leite and Furley 1985; Lena 1982; Coy 1987). The 1991 estimate of pasture area was 72% but included some secondary vegetation because farmers tended to lump the two categories. The area of pasture and secondary vegetation can be even higher because in the areas where aggregation has occurred, pasture is often the only land use. Thus, the trend toward pasture's attaining a complete dominance in the area will be reversed only if valuable and stable sources of income for the colonists are identified.

Table 8. Total area, average, maximum, and minimum size per lot for pasture (which may include some secondary vegetation)

	Hectares
Total area	2,805.2
Average	32.2
Maximum	163.2
Minimum	0.6
Number of lots	87

3.4.2 The Animals Being Raised

Table 9 presents the most important animals on the lots sampled. The commercial importance of cattle is evidenced by a total of 3,739 head, which represents an average of 41 head per lot. Even considering the high variance caused by different resources among the farmers, cattle are very significant to the region's future. About 68% of the cows are beef cows, and the remaining 32% are milk cows, which provide daily incomes from milk production.

Pigs are of secondary commercial importance, and chickens are raised more for subsistence than for sale. The pigs raised in the region belong to an inferior species with high fat content.

Table 9. Total number of animals and average, maximum, and minimum for lots sampled

	Total	Average	Maximum	Minimum
Milk cows	1,200	13	120	0
Beef cows	2,539	28	172	0
Pigs	908	10	50	0
Chickens	7,565	83	400	0
Sheep/goats	94	2	58	0
Ducks	12	0.1	10	0

Sheep and goats are still raised by a few farmers but may be important in the future because they easily adapt to the region. Ducks were found in only two lots and are not important even as a source of food.

3.5. PRODUCTION AND COMMERCIALIZATION

3.5.1. Annual Crops

Table 10 shows the area planted with annual crops, their production, and sale. Compared with INCRA (1982), all crops experienced a decrease. Rice decreased 27%; beans, 10%; manioc, 32%; and corn, 16%. Only beans are largely commercialized (56%), whereas rice (30%), corn (20%), and manioc (0%) are mainly used for subsistence.

Table 10. Area planted with annual crops, production, and commercialization

Crop	Area planted (ha)	Production	Sale
Rice (60 kg bags)	213.8	3,660	1,099
Beans (60 kg bags)	226.4	1,792	1,003
Manioc (kg)	43.5	211,000	0
Corn (60 kg bags)	325.3	6,955	1,179

3.5.2 Perennial Crops

Table 11 shows the area planted with perennial crops, their production, and sale. The main ones are cocoa and coffee. The official financial support (provided by CEPLAC) gave more support for cocoa than coffee, but the colonists followed their traditions, and coffee is currently more important than the other perennial crops. Banana, rubber, fruits, and sugarcane cover only 19% of the area planted, and there is no indication that this pattern will change, because there is a lack of financial support, technical support, and the price policies required to improve such crops as fruits, rubber, and banana. Perennial crops are more commercialized than annual crops because the colonists cannot use these crops as food. The exception is bananas, which are food for both humans and animals. Sugarcane is used to produce white rum.

Twenty-four lots (26% of the sample) sell neither perennial nor annual crops. Furthermore, these lots have no bananas, cocoa, fruits, or rubber. Although there is no commercial production, crops produced and used on the lot contribute 8% of the total production of corn (n=510 bags), 9% of the total production of rice (n=365 bags), 2%

of the total production of beans (n=32 bags), and 0.2% of the total production of coffee (n=20 bags). One colonist said he produced 90,000 kg of manioc (43% of the total production declared). Other farmers undoubtedly grew manioc but did not have an estimate of the amount grown. The low level of activity in these 24 lots is related to the economical failure of farmers on soils of low fertility and to the expansion of cattle raising (half of the 24 lots have profits from animal sales).

Table 11. Area planted, production, and sale of perennial crops

Crop	Area planted (ha)	Production	Sale
Cocoa (kg)	168.9	33,600	33,600
Banana (bunches)	36.6	7,310	4,710
Fruits (boxes)	6.2	165	165
Coffee (40 kg bags)	361.3	8,291	7,628
Rubber (kg)	55.2	6,272	6,272
Sugarcane (kg)	19.9	1,000	0

3.5.3 Animal Production

Table 12 shows the production and sale of milk during the dry season. Of the lots sampled, 70% are producing milk, and 80% of the milk is sold to factories in Ji-Paraná and Ouro Preto. The remaining milk is for the production of cheese or for subsistence. The boom in milk production has caused improvements in the infrastructure, exemplified by the construction of a cheese factory and a second milk factory.

Despite the high number of lots covered with pasture, only a few colonists obtain a high return from animal production. Twenty-one percent of the lots are responsible for 62% of the production and 77% of the sale of the animals.

Table 12. Production and commercialization of milk during the dry season

	Number of lots	Total (liters/day)
Milk produced	64	2,211
Milk sold	46	1,766

In fact, 33% of the lots do not have any kind of income from animal production (n=33), and 23% of the lots (n=21) produce milk but do not sell it. The commercialization of other animals is shown in Table 13. The most important source of income is the revenue from beef cows, but only 30% of the lots benefit. Pigs were sold on 12% of the lots and chickens on 16% of the lots.

Table 13. Commercialization of cows, pigs, and chickens in 1990

	Number of lots	Total
Cows	28	238
Pigs	11	117
Chickens	15	806

3.5.4 Lots Without Any Commercialization in 1990/1991

Twelve lots had no income from either crops or animal production. These nonproductive lots are disastrous for the colonists who depend on the lot for survival. The lots either are in areas with poor soils or are far from the main road.

3.5.5 Distance and Markets Where The Production is Sold

Table 14 shows the distance to the main markets in the region. Ouro Preto is the closest market, and most colonists must travel unpaved roads to reach it. Mobility is greatly reduced during the rainy season, especially on tertiary roads. The average distance from the lots to Ji-Paraná is two times higher, and the distance along unpaved roads is almost the same. Transportation is clearly a main obstacle for the absorption of production by Ji-Paraná.

Table 14. Distance from the lots to Ouro Preto and Ji-Paraná by paved and unpaved roads

Distance	Ji-Paraná		Ouro Preto	
	Paved	Unpaved	Paved	Unpaved
Average	33	36	4	34
Maximum	60	113	22	84
Minimum	0	0	0	0

The NUARs (Urban Nucleus of Rural Support) are the second important market. The different levels of economic success found among the different NUARs occur because only some of them receive produce from the surrounding farms. Rondoninas and Vale do Paraiso, for example are centers of milk production which is trucked directly to factories in Ouro Preto and Ji-Paraná. Ji-Paraná, Jarú, Alvorada do Oeste, and Porto Velho are secondary markets; most of the goods are sold in Ouro Preto before they are transferred to the larger cities.

For some goods the primary market is outside Rondônia. In those cases truckers come from other regions of the country and buy produce directly on the lots.

Table 15. Markets where the production is commercialized

Market	Sale of animal production	Sale of crops
Ouro Preto	44	49
Nuar	9	17
Ji-Paraná	10	6
Jarú	1	2
Alvorada do Oeste	1	0
Porto Velho	0	1
Lot	8	6

3.5.6 The Transportation

Table 16 shows the main forms of transportation in the area. An important aspect is the lack of vehicles among the colonists, because only 3% of the colonists interviewed (n=3) own a truck. The colonists pay freight costs for having milk picked up daily from their lots. The expense amounts to 22% of the production. Thus, besides the low price paid for milk, the factories make money by transporting the milk in the factories' milk trucks.

Table 16. Forms of production transportation

Vehicle	Milk	Crops
Truck belonging to other person	29	40
Bus	0	4
Truck belonging to a colonist	1	3
Other	8	2

3.6. INCOME AND EXPENSES

3.6.1 Income from Perennial and Annual Crops

Table 17 shows the income from perennial and annual crops and the number of colonists benefitting from the sale of each crop. Coffee is the most important source of income and represents 64% of the total crop income. Beans are second in importance (9% of the income), but the number of colonists selling beans is lower. Cocoa represents 7% of the total income. Other crops (rice, corn, fruits, banana, and rubber,) represent 11% of income and are sold by only a few colonists. The sale of white rum and honey provides the remaining income from crops.

Despite efforts carried out by governmental institutions to introduce perennial crops in the region, presently only three crops constitute 80% of the total income. In addition, all these crops suffer problems at different scales (e.g., loss of soil quality and diseases at the local scale and low prices at the national scale).

Table 17. Income (U.S.$) in 1990 from perennial and annual crops in terms of total, average, maximum, and minimum incomes, and number of colonists selling each crop

	Total	Average	Maximum	Minimum	Number of colonists
Rice	10,957	577	2193	120	19
Beans	22,898	739	2625	68	31
Corn	6,532	502	1662	22	13
Fruits	69	34	50	19	2
Coffee	154,595	3,435	20,923	80	45
Banana	4,993	624	1,060	159	8
Rubber	4,617	1,154	4,335	23	4
Cocoa	17,136	857	3,060	10	20
Others	19,077	4,769	11,898	874	4

3.6.2 Animal Production

The results demonstrate the importance of milk production as a source of income for the colonists (Table 18). The daily income averages $2 (U.S.) during the dry season and decreases to around 50-70% thereafter. When this value is extrapolated for annual production, the total income from milk is second only to the sale of cows. Income from milk and beef are both less than the income provided by coffee. This helps explain the trend in substituting annual and perennial crops with animal production as the main source of income.

The sale of beef cows is of increasing importance for the local economy. It is the second most important source of income, and many colonists are interested in planting pasture. However, the number of colonists benefitting is restricted because only 31% sold cows during the past year. Only a few colonists obtain income from pigs or chickens.

Table 18. Annual income (U.S. $) in 1990 from animal production in terms of total, average, maximum, and minimum income, and number of colonists

	Milk production	Cows sold	Pigs sold	Chickens sold
Total	66,758	109,554	3,591	1,814
Average	734	3,913	326	121
Maximum	6,327	11,508	921	405
Minimum	38	460	31	14
Number of colonists	46	28	11	15

3.6.3 Expenses

Operational expenses include land preparation (e.g., tools, labor), planting and weeding (e.g., seeds, herbicides, insecticides), vehicles (trucks, tractors), animals (e.g., cows, pigs, chickens), and improvements in infrastructure (e.g., houses, stables, fences) (Table 19). Obtaining these values was difficult because the colonists do not keep records.

The main form of expenses is the acquisition of animals, declared by 77% of the colonists to have reached a total of $447,848 (U.S.). Most of this money was used to buy cows. Only 24% of the colonists were responsible for 70% of the expenses related to animals, which indicate a high concentration of capital among a few colonists.

Improvement in infrastructure is the second most important expense; with 82% of the colonists spending a total of $361,688 (U.S.) on materials to build stables, fences, and houses and to buy motor pumps and chain saws.

The acquisition of vehicles is the third most important expense. However, only 20% of the colonists owned a motorized vehicle (tractor, truck, or car), and only 27% had a cart.

Table 19. Expenses (U.S. dollars in July 1991) used to make the lot operational

	Total	Average	Maximum	Minimum	Number of colonists
Motorized vehicle[a]	136,476	7,183	34,624	120	19
Animal vehicle[a]	10,229	409	903	213	25
Animals[a]	447,848	6,398	83,098	34	70
Manual tools	4,576	53	112	5	86
Purchased seeds[a]	6,517	310	1,199	3	21
Laborers (per year)[a]	36,874	838	6,408	27	44
Fertilizers	1,581	790	1,395	186	2
Infrastructure[a]	361,688	5,089	68,944	93	75
Agricultural defensive[a]	95,705	1,450	15,141	40	66

[a] Estimated over the time the farmer has been on the lot.

A significant number of colonists (n=66) spent money on herbicides, insecticides, or medication for cows. The relative lack of money spent on fertilizers and purchased seeds shows that there is low interest in improving the land preparation quality. Only 2% of the colonists (n=2) acquired fertilizers, and 11% bought seeds. Most of the colonists (95%) spent money to acquire manual tools.

Contracted laborers were hired by 48% of the farmers for land preparation and periodic clearing. The ranchers have a more stable staff to handle their cattle and tend to establish a more stable labor market.

3.7 THE COLONISTS AND THE GOVERNMENTAL SUPPORT

3.7.1 Institutions of Research and Technical Support

Few of the colonists received any scientific contribution from EMBRAPA (91% of the colonists) or CEPLAC (67% of the colonists) (Table 20). CEPLAC assistance is higher because of the strong incentives to establish cocoa in Rondônia. But this role has decreased in recent years because of the national economic crisis and problems with international markets.

In contrast, half of the colonists received rural extension services from EMATER (the rural extension service) at least one time. In many cases, the staff of EMATER consists of poorly trained personal. Thus, prevailing agricultural practices are based on the empirical knowledge of the colonists. This contributes to the problems with land degradation because the colonists are largely from regions where a very different ecological situation exists.

Table 20. Scientific and rural extension received by the colonists from governmental institutions

	EMBRAPA	CEPLAC	EMATER
Never	78	58	43
Once	5	5	3
More than once	3	18	40

3.7.2.- Public Services

Public services are very limited. The colonists do not have electricity, water supply, or sewerage facilities. The road network is limited and basically unusable during the rainy season. The colonists received only limited health and school services. The most important health services are provided only in Ouro Preto or in Ji-Paraná; only elementary school is available elsewhere.

A good example of the failure in official support is the NUARs. The NUARs were planned to provide easier access to technical assistance, schools, health posts,

commercial districts, recreation facilities, police, telephone lines and postal agencies (World Bank 1981). However, after 20 years the assistance is extremely restricted, and only 44% of the colonists use the NUAR, primarily to sell their production or to buy food supplies or medication. In actuality, the NUARs became a location for people who were waiting for a piece of land, who were unemployed, or who had failed on their lots.

4. SUMMARY AND CONCLUSION

After 20 years, the PIC Ouro Preto has a distinct spatial differentiation of lot sizes determined by the economic success of lots closest to the BR-364. Three components of changing ownership distribution occur in the area: maintenance of the original size, aggregation, and fragmentation of the lots. Lots adjacent to the BR-364 generally are aggregated into large pastures. This aggregation has occurred because these lots have been more profitable since transportation costs are reduced. Also these lots were among the first settled in the area and may represent the long-term trend.

The area of the PAD Urupá, which was only recently occupied, already presents the same trends. The colonists in Ouro Preto came basically from the south and southeastern regions of Brazil, many of them after several moves. Most of the colonists are applying their previous land-use practices, which include slash-and-burn agriculture without land preparation or management. As a result, 53% of the area has been deforested.

The governmental infrastructure either has collapsed or was never put into place, and there is not effective technical assistance. Most of the secondary and tertiary roads are impassable during the rainy season. The commercialization and storage of goods are not adequately provided. The NUARs are basically used for the acquisition of food supplies and medication.

The combination of the poor soil, inappropriate agricultural techniques, and lack of governmental support caused a high turnover in the land ownership and the abandonment of annual and perennial crops. Pasture with annual burnings has become the main form of land use (72% of the area cleared). Currently, colonists spend most of their money acquiring animals and improving the infrastructure (e.g., stables, fences).

The low economical return from crops reinforces the expansion of pasture. The increase of pasture (40-49% in the 1980s, 72% in 1991) shows that it may become the only form of land use in the region. Pasture also contributes to the aggregation of land because the poor colonists are obligated to sell their land. The necessity of obtaining larger areas for pasture and the availability of chain saws increase the potential for deforestation if alternative land-use practices are not promoted and employed.

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APPENDIX

INTERVIEW FORM

Tenant's Name_____ Date of interview_____

Tenant's Age_____ Family: # men____ #women____ #Children_____

Arrival in Rondônia (yr)___ Arrival on lot (yr)___ Share-Cropper___ or owner____

Lot size (ha)_____ Lot location_____ Position_____

Table 1. What is the distance from your house to the market (km)?

Market	Total	Paved Road	Good dirt road	Bad dirt road
Ji Parana				
Ouro Preto				
Other				

What financing was used to acquire lot: cash( ), bank financing( ), other( )

What was your previous occupation?

FARMER: Owner/operator( ), Share-renter( ), or Fixed renter( )

URBAN OR TOWN WORKER( ), UNEMPLOYED( )

RURAL NON-AGRICULTURAL WORKER( ), LAND-LESS FARMER/LABORER( ), OTHER( )

Where did you previously live?
Rondônia( ), NE Brazil( ), SE Brazil( ), Other( ),

State_____

How many lots did you live on in Rondônia before this lot?_____

Any soils information? Source?

Tenant's Name_____ Date of interview_____

Table 2. Land use history (by alqueires or %)

Year on lot	Time to clear lot (days)	Number of people helping to clear the lot		Amount Cleared		Dense Forest	Savannah		Open forest	
		Family	Non-family	Being Used						
				Al	%	Al %	Al	%	Al	%
First										
2nd										
Current (___)										

What kinds of tools do you use to clear the lot?

Axes( ), Chain-saw( ), Shovels( ), Other( )

How do you acquire the equipment?

Own( ), Rent( ), Borrow( ), Barter( )

Has any decline in productivity of annual crops been observed?

Tenant's name_____ Date of interview_____

Table 3. Land preparation

Frequency	Slash and Burn	Manure	Lime	Rotate Crops	Other (specify)
First yr.					
One yr. (other than 1st)					
Every yr.					
Two yrs. or more					
Never					

[3]Give years each portion is used.

Table 4. What costs are incurred in operating this lot?

ITEM	Estimated costs-rented items	Estimated Costs- purchased items
Mechanized equipment		
Hand equipment		
Animals		
Team of animals with operator		
Purchased seed		
Labor		
Fertilizer		
Insecticide/pesticide		
other		

Table 5. Tenure information

ITEM	Rent	Land	Share	Land	Input Costs
Owner/operator					
Renter					

Tenant's name_____ Date of interview_____

Table 6. Revenue per unit of product during previous year.

Product	Alqueires	Total yield (bags)	Amount sold (bags)	Where sold[a]	Method of transport[b]	
All annuals						
Vegetables						
Rice						
Beans						
Manioc						
All perennials						
Cocoa						
Banana						
Fruits						
Coffee						
All Pasture						Number of animals
Milk cows		liters/ day				
Beef cows		heads				
Poultry		heads eggs				
Pigs		heads				

[a] Ji Parana, Ouro Preto (if sold at front door, indicate location of buyer)

[b] Symbols: B = bus, OT = own truck, T = truck belonging to someone else, W = walked and carried, BC = bicycle, O = other

List other major crops:

List other animals raised:

Tenant's name_____ Date of interview_____

Sociological questions

Table 7. Technical assistance

Frequency	EMBRAPA	EMATER	Other
Never			
Once			
More than once			

Services available (Y or N)

Water supply( ) Electricity( ) School( )
Telephone( ) Health Center( ) (distance - _____km)

Main problems to make coditions better (rank, 1=most imp.):

Roads( ) Transportation( ) Health( )
Education( ) Technical support( ) Other( )

Do you use the NUAR? _____ How?

Are you planning to leave your lot? _____ Why?

Where?

Why did you decide to buy this particular lot? (or settle if sharecropper)

What major problems occured during the installation period?

illness( ) transportation( )
lack of technical assistance( ) other( )

What kinds of illness occured in your family?

Malaria( ) Leishmanioses( ) erysipelas( )
cholera( ) other( ) specify _____

How many days were you or members of your family out of work during the past year?

1-15( ) 16-30( ) 31-60( ) 61-90( ) 91-120( )
121-180( ) 181-250( ) 251-300( ) 301-365( )

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