pp. 90-95 In: J.A. Parrotta and M. Kanashiro (eds.) Management and Rehabilitation of Degraded Lands and Secondary Forests in Amazonia. International Institute of Tropical Forestry, United States Department of Agriculture-Forest Service, Río Piedras, Puerto Rico, USA. 246 pp. (1995).

AGRICULTURAL MANAGEMENT OF CABOCLOS OF THE XINGU RIVER: A STARTING POINT FOR SUSTAINING POPULATIONS IN DEGRADED AREAS IN THE BRAZILIAN AMAZON

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ABSTRACT

We discuss here the system of agricultural management practiced by a caboclo population of the Brazilian Amazon and its impact on the forest ecosystem. The activities of the population were studied during a complete agricultural year. Information on management practices and agricultural yield were obtained through interviews with caboclos, direct observations and field collections. The caboclos obtained excellent agricultural yields compared with average values for northern Brazil, producing much more than necessary to meet their nutritional needs. Forest degradation associated with these agricultural activities was small in relation to that associated with other human activities in the region.

INTRODUCTION

Manv environmental impacts in the Amazon have resulted from the implantation of projects which didn't consider the ecological and cultural characteristics peculiar to the region. The agricultural colonies established in the Bragantine Region, employed a system of intensive agriculture with inadequate fallow periods which resulted in soil depletion, reduced agricultural yields (Ackermann 1966; Egler 1961; Sioli 1973, 1980; Fearnside 1986) and the desistence of most of the population (Penteado 1967).

The implantation of monocultures of rubber trees (*Hevea brasiliensis*) at Fordlandia and Belterra in the 30's by the Ford Motor Company had a similar destiny. The monocultures were attacked and decimated by a fungus (*Microcyclus ulei*), unheard of in native rubber tree plantations. Fordlandia was abandoned and Belterra was donated to the brazilian government (Sioli 1973).

The colonization program for the Transamazon Highway, located just 60 km from the study site, is another example of an unsuccessful development scheme. With the proclaimed objectives of reducing poverty in the Northeast, diminishing over population in large urban centers and opening frontiers for the export of agricultural products to neighboring regions and countries, the brazilian government supplied colonists with agricultural credit and technical assistance, and imagined that they would be successful. Like earlier development schemes, the Transamazon agricultural programs failed to produce the desired results. They provided neither excess grains for export nor solutions for Brazil's population problems (Moran 1981; Smith 1982; Fearnside 1986).

Until now, most large development programs initiated in the Amazon have failed. A re-evaluation of the guiding principals and directives of these projects provides some insight into the causes of these failures. For example, none of these projects considered the knowledge and experience of native amazonian populations (indians and caboclos) in their development plans. These populations have carried on agricultural activities in the Amazon forest for centuries. An understanding of their management practices could provide a basis for developing sustainable agriculture in degraded areas.

The objective of the present study was to investigate the system of agricultural management used by a caboclo population of the Xingu River and the effect of these practices on the local forest ecosystem.

STUDY AREA AND FIELD METHODS

The study was carried out between August of 1989 and August of 1990 at Arroz Cru, a settlement located on the left bank of the Xingu River (3°15'S, 52°W), within the municipal limits of Senador Jose Porfirio, approximately 50 km north of the city of Altamira in the brazilian state of Pará.

Structured interviews were used to obtain information on: the history of the population, choice of agricultural sites, thinning, cutting, burning, reburning, planting and harvesting. Fallow areas utilized by caboclos during the study year were characterized by the type and age of vegetation present at the time of cutting, varying between young (1-10 years) and mature (11-30 years) secondary forest. Several methods were used to estimate agricultural yields. To obtain corn production in plots that were topographically homogeneous, three 9 m^2 quadrats were chosen at random. In plots with large variations in topography, the above procedure was applied in each topographically distinct region. In each quadrat, all corn was collected, shucked and the grains were weighed on a 2 kg spring balance. Total production for each plot was obtained by multiplying the average production for all quadrats (kg/m^2) by the size of the plot, converting finally to metric tons per hectare.

To estimate manioc production, one 25 m^2 quadrat was chosen on each plot. All roots within the quadrat were collected in 50 kg sacks and weighed with a 90 kg spring balance. Since the manioc planted during the study period would only be harvested in the following year, production from the previous year's planting (1989) was measured. Production per m^2 in the 1989 plots was multiplied by plot sizes in 1990 to estimate production per plot, converting finally to metric tons per hectare.

The total production of beans and rice was obtained by accompanying the caboclos harvest. Since these crops were not planted uniformly over the plot, it was not possible to estimate production from subsamples. During the harvest period, beans and rice grains were collected in 50 kg nylon bags or in 16.5 kg cans to facilitate measurement. Rice and bean production corresponded to the total weight harvested in each plot.

Banana production was estimated by counting all plants above 1.5 m in height on each plot. As with manioc, banana trees require one year to produce fruit, and only produce a single large bunch per tree. Thus, the number of plants above 1.5 m represented the number of banana bunches produced in a year. The number of small bunches in a large banana bunch was estimated and the bananas in six small bunches were pealed and weighed to provide a basis for estimating the weight of large bunches and total plot production.

Thirty one farm plots were investigated, including 10 plots adjacent to the Arroz Cru settlement where corn and manioc production were estimated to improve the data base for these crops. Of these, 12 plots were derived from young secondary forest (1-10 years), 7 from mature secondary forest (11-30 years) and 12 from virgin forest (forest uncut by caboclos in recent decades but possibly utilized for slash and burn agriculture by indians in previous centuries).

HISTORY OF THE POPULATION AND AGRICULTURAL MANAGEMENT

The population of Arroz Cru is composed of descendants of portuguese and indians who were born in the state of Para and their descendants. Ninety eight percent of the second generation population lived within the study area or near it.

Prior to 1970, the families which today occupy Arroz Cru lived on islands in the Xingu River. In these days the families survived primarily by the collection of latex from rubber trees (*Hevea brasiliensis*) and brasil nuts (*Bertholletia excelsa*), complimenting these activities with the cultivation of manioc, hunting and fishing.

In the decade of the seventies, with the implantation of the National Integration Program (PIN), the Nacional Institute of Agrarian Reform (INCRA) stimulated these families to move from the islands to the adjacent terra firme. Each family received a plot of land which averaged around 100 ha. In the new settlement, agriculture became the principal activity and primary means of survival for the population (for more information see Silva 1991).

Actually, the caboclos at Arroz Cru use the slash and burn form of agriculture common to much of the Amazon (Clark and Uhl 1983). A consortium of crops, including rice, beans, corn, manioc and banana, are generally planted on the plots. Between July and November the plots are prepared by thinning, cutting, burning and reburning. Between the periods of preparation and planting, species with short growth cycles such as watermelon (*Citrulus vulgares*) and maxixe (*Cucmis anguria*) are cultivated. Rice and corn are planted in December or January, depending on the beginning of the rainy season. Manioc can be planted together with rice and corn or after these crops are harvested. The plots are normally weeded before the first planting and again in March or April. Between April and May, rice is harvested, corn stalks are broken, and the plots are cleaned for planting beans. Banana trees can be planted in several different periods: in October and November after preparing the plot, in the dry season, in January after the planting of corn and rice, or together with beans. Manioc is harvested throughout the year and beans between July and August. After this, another agricultural cycle is begun. A caboclo rarely repeats an agricultural cycle in the same area after manioc is harvested. The used plots are normally left to fallow for at least 4 years.

In the consortium planting method used here, beans are planted around corn stalks after these have been broken and turned down to serve as supports. Corn ears are still collected after the stalks have been broken. However most ears are harvested while the corn is still green, before it is broken. The bean varieties most used by the caboclos are known locally as canarinho, carioquinha and jaulinha.

The population has a broad knowledge of the local ecosystem. They recognize five different categories of soil: black dirt, red clay, white clay, red dirt and areusca (a mixture of sand and clay). When the caboclos lived on the islands and possessed large tracts of land on which to plant, a soil's quality was identified by the plant species which grew on it. The plants jurema (*Pityrocarpa Pteroclada*), muiraximbe (*Emmotum tagifollum*), pau preto (*Diospyros reticulata*), tipi (*Petiveria tetranda*), and xichá (*Sterrculia pruriens*) were indicators of good planting soil while acapu (*Vouacapoua americana*), jambo (*Eugenia melaccensis*) and tabuqui (*Olyra cardifolia*) indicated poor soils.

In spite of the change in life style which occurred in the seventies, the caboclos have maintained their former knowledge of the ecosystem.

Consortium planting is utilized by the majority of the Amazon's agricultural populations, although the mixture of species used varies. Indian populations, for example the kamayuras, jivaros, kayapó, sirono and waiwai tribes, practiced consortium planting before making contact with the portuguese colonists (Meggers 1987). After contact with the colonists, the indians introduced new varieties into their consortiums, as did the population of Arroz cru after contact with newer colonists. After the move to the mainland in the seventies, the Arroz Cru caboclos broadened the diversity of plants grown in consortium. The new transamazon colonists, coming primarily from outside the Amazon Region, also planted in consortium (Fearnside 1986). The strategy of planting a little of each species is an efficient way of utilizing a variable terrain and guaranteeing food production even in bad years and in spite of insect plagues and diseases. If one species doesn't produce, there are always others that will.

The choice of agricultural plots at Arroz Cru depended on several variables which influenced production, available time and man-power. For terra firme plots, the most important variables were: 1) distance from the river (each caboclo had to carry his manioc roots to the river to prepare manioc flour), 2) the age of the vegetation closest to the caboclos house, respecting the normal fallow period, and 3) the minimum distance from the house necessary to protect crops from domestic animals.

AGRICULTURAL PRODUCTION

Among the cultivated species, manioc had the highest production (Table 1). The total production of fresh manioc roots for the population of Arroz Cru was 614 metric tons, with an average production of 40.3 tons/ha, accounting for 89.5 % of the population's available calories.

Manioc production above 100 tons/ha has been reported in some regions of Brazil, for example in northern Parana (150 tons/ha after 34 months on red dirt, Albuquerque and Cardoso 1969). However 75% of the world's production of manioc is derived from pl ant at i ons wi t h product i on varyi ng between 10-15 tons/ha (Albuquerque and Cardoso 1969). Albuquerque and Cardoso qualified manioc production in the following manner: low = less than 15 tons/ha, regular = 15 to 20 tons/ha, good = 20 to 35 tons/ha and excellent = above 35 tons/ha.

Average annual manioc production in the Amazon varies between poor to regular, reaching good production in a few cases. The average production in the region was 13 tons/ha in 1965 (Albuquerque

TABLE 1. Agricultural production and calories derived from different crops grown by the population of Arroz CRU/Altamira/Pará in 1990.

Crop	Total prod. (tons)*	Prod./ha (tons/ha)**	Total calories (10^6 kcal)	% calories
Manioc	616	40.3	1113.7	89.6
Corn	28.1	1.8	101.8	8.2
Rice	1.1	-	4.1	0.3
Beans	1.4	-	4.8	0.4
Bananas	18.4	-	19.3	1.5
Total	633.1	-	1243.7	100.0

*Total production estimated for the 21 farm plots cultivated by the population of Arroz Cru.

**(-) crop yield not estimated on an areal basis, see text.

and Cardoso 1969), 20 tons/ha in 1980 (Albuquerque 1980) and 13 tons/ha in 1990 (IBGE 1991). In the upper Amazon floodplain, a production of 15 tons/ha in six months was considered very good by Albuquerque and Cardoso (1969). In Tabatinga (upper Amazon River), an exceptional production of 35 tons/ha in just four months was obtained on relatively dry glei soil (Albuquerque and Cardoso 1969). The manioc production of the caboclos at Arroz Cru was excellent, according to Albuquerque and Cardoso's scale, and two times greater than the highest average production reported for the region. Since the climate and soil characteristics in this area are similar to those found over most of the Amazon region, the higher production, in this case, must be due to the efficient system of agricultural management employed by this population.

Corn had the second highest production with a total yield for the population of 28.2 tons per year and an average of 1.8 tons/ha. Average corn production for this same period in all of Brazil was 1.9 tons/ha, in the Amazon Region was 1.4 tons/ha, in the Northeast was 0.3 tons/ha and in the South was 2.5 tons/ha (IBGE 1991). Thus, the corn production of the study population was better than the average for the region and close to the average for Brazil. It should be noted that the caboclos used little corn in their diet. The bulk of the production was used to feed domestic animals.

The total production of bananas for the population was 18.4 tons which represented 1.5% of the calories available to the population. The lowest production was obtained with rice and beans which, together, yielded a total of 2.5 tons, representing 0.7% of the available calories of the population.

The total agricultural production for the population, excluding forest products and fruit besides banana, was 633.1 tons, the equivalent of 1,243.7 X 106 kcal. Thus the 134 inhabitants of Arroz Cru had 25,400 kcal available per person per day, much greater than the maximum daily caloric requirement of 3600 Kcal estimated for men between the ages of 20 and 35 from data presented by Vanucchi *et al.* (1990). An evaluation of food production derived from hunting and fishing (Silva 1991) showed that each member of the study population had 103.6 grams of animal protein available per day, also much higher than the maximum daily requirement of protein estimated for men from data presented by

Vanucchi *et al.* (1990). Thus, the population was self sufficient with respect to food, producing more than the regional average, and enough to exceed its nutritional requirement.

IMPACT ON THE FOREST ECOSYSTEM

The principal impact of these agricultural activities on the forest ecosystem was the cutting of the forest for planting crops. About 0.7 ha was cleared per family for the 1990 harvest. The average family size was five persons. Thus approximately 0.14 ha of forest was cut to sustain each person. Of the 31 plots studied, 19 (61%) were derived from the cutting of secondary forest and 12 (39%) from virgin forest. Corn production increased with the age of the original secondary forest and the production on plots derived from secondary forest was higher than that on plots derived from virgin forest (Silva-Forsberg and Fearnside, in press).

Thus the caboclos of Arroz Cru sustain themselves utilizing primarily secondary forest, obtaining excellent agricultural yields with only a minimal per capita impact to the forest ecosystem, when compared, for instance, to cattle ranching.

CONCLUSIONS

1) The agricultural production of caboclos along the Xingu River was higher than the regional average.

2) The agricultural system employed supplied the nutritional needs of the local population with a much lower per capita impact on the forest e cosystem than with other types of human development.

3) These traditional methods provide a basis for developing strategies for human occupation in degraded areas.

ACKNOWLEDGEMENTS

The authors acknowledge the FBB (Fundação Banco do Brasil) and the Pew Scholar Program in Conservation and the Environment for financial assistance. CAPES for a graduate fellowship for the first author and B. R. Forsberg for the English translation.

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