RANCHING IN THE BRAZILIAN AMAZON IN A NATIONAL CONTEXT: ECONOMICS, POLICY, AND PRACTICE

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ABSTRACT

The ranching sector is dynamic in the Brazilian Amazon and the approaches and environments used to raise cattle are diverse. Ranching occurs in natural grasslands at the mouth of the Amazon River, flood plains along the Amazon River, and interfluvial (non-flooded) lands where forest has been cut and replaced by pasture. We compared ranching in these three settings and also considered Amazonian ranching within the context of the Brazilian national economy.

We found that traditional extensive-style approaches to ranching are lucrative in all three Amazonian settings. Moreover, returns on ranching investments improved when ranchers specialize in range fattening (upland areas) or calf production (natural grasslands). Returns on ranching also improved when weed-infested upland pastures were rejuvenated through tilling, planting better adapted forages, and fertilizing.

The Eastern Amazon offers several advantages over the traditional ranching regions in Central and South Brazil (e.g., more constant temperatures and rainfall, lower incidence of disease, and lower land prices). As land in the South is shifted from pasture use to crop land, it is likely that the Amazon cattle herd will continue to grow. We discuss concrete measures aimed at encouraging the intensification of ranching in Amazonia while discouraging further deforestation for pasture establishment.

INTRODUCTION

Cattle were introduced to the Brazilian Amazon three centuries ago, but until the 1950s cattle raising was restricted to the natural grasslands of Marajó Island and the flood plains (várzea) of the Amazon River. During the

1960's and 70's, there was an explosion of ranching activity in upland (terra firme) regions of eastern Amazonia prompted by improvements in regional infrastructure and tax breaks and attractive credit terms aimed at encouraging ranching (Teixeira, 1953; Hecht, 1985; Browder, 1988; Fearnside, 1989; Mahar, 1989).

Opinions regarding the viability of Amazon ranching in terra firme settings have varied considerably. During the 1970's, range management specialists and soil scientists presented evidence that ranching was possible (Falesi, 1976). During the 80's, social scientists and ecologists produced analyses revealing that ranching only made sense economically when viewed as a strategy to capture government credit or increase the exchange value of land (Fearnside, 1980; Browder, 1988; Hecht et al., 1988).

In the 1990s there is a growing appreciation for the dynamic nature of the ranching sector. Earlier analyses, while accurate for their time, need to be revised. For example, in a recent analysis of ranching in the environs of Paragominas along the Belém-Brasília Highway, Mattos and Uhl (1994) showed that ranching can be profitable. Here, we aim to go beyond that work to characterize ranching throughout the Eastern Amazon and in the context of Brazil as a whole.

We begin by observing that ranching activities are not homogeneous in Amazonia. Cattle are raised on both natural grasslands and planted pastures, in upland and seasonally flooded environments, and by both small and large landowners. Each locale has its own management schemes and economic and social characteristics. We present a comparative economic analysis of ranching in its various manisfestations in the Eastern Amazon. Then, we discuss the advantages and disadvantages of raising cattle in the Eastern Amazon as compared to the rest of Brazil. Finally, we discuss the impediments to the adoption of more intensive and productive ranching systems

in Amazonia along with suggestions for how these impediments might be overcome.

METHODS

We conducted our study in the state of Pará (1,218 thousand km^2). This state dominates the Eastern Amazon and contains two-thirds of the cattle herd of Brazilian Amazonia. We studied ranching activities in three subregions of this state that together accounted for more than 50% of the state's cattle herd in the 1980s (FIBGE 1985). These three regions (Fig. 1) contain the main ecosystems used for raising cattle in Amazonia: natural grassland savannas on poorly drained soils (Marajó Island), natural grasslands associated with river flood plains (Lower Amazon River), and planted pastures on upland or "terra firme" sites (southern Pará) (Serrão, 1986).

Economic data and characteristics of ranching systems were collected by interviewing ranchers in each of the three study regions from October, 1992, through July, 1993. Interviews were conducted by means of questionnaires concerning: i) the history of the ranch and rancher, ii) components of ranch infrastructure, iii) herd structure, iv) pasture management practices, and v) costs of infrastructure, herd acquisition, and ranch maintenance.

On Marajó Island we interviewed 20 ranchers in Soure County selected randomly from a list furnished by the National Institute of Colonization and Agrarian Reform (INCRA) and the Pará Ranchers Cooperative (SOCIPE). In the Lower Amazon River region, we interviewed 33 ranchers in Santarém County, also selected from a list provided by INCRA and the local syndicate. Interviews in the terra firme region of southern Pará were conducted along the principal highway, PA-150, and secondary roads between Xinguara and Santana do Araguaia (Fig. 1). In this region, we interviewed 66 ranchers

(Table 1).

The prices of products and services utilized by ranchers were determined by surveys of businesses in each locale. All values were corrected to the base month of July, 1993, using the Fundação Getúlio Vargas price index and converted to dollars using the official exchange rate for that same month (FGV/CEA, 1993). The prices of animals for slaughter for the period, 1990-93, were obtained from the stockyards of SOCIPE in Belém (Marajó study region), the Santarém Ranchers Syndicate (Lower Amazon River study region), and cattle marketing companies (southern Pará).

DESCRIPTION OF THE PHYSICAL ENVIRONMENT

The physical environment differed notably between the three study regions. Elevation, rainfall regime, and soil type influence ranch management strategy and pasture productivity.

Natural grasslands of Marajó Island

The total area of Marajó Island is approximately 50,000 km^2 (Fig. 1). The eastern half of this island consists of natural grasslands that cover 23,000 km^2. The main grasses are in the genera, *Axonopus*, *Paspalum*, and *Panicum*, and have low nutritive value (OEA,1974; EMBRAPA/CPATU, 1977). Gleying is common in the soil because of long-time poor aeration due to excess soil water. The cattle are generally crossbreeds of different "zebu" (*Bos indicus)* blood lines; water buffalo are also present.

The topography of this grassland region is almost flat with small elevational gradients that distinguish two areas: low grasslands--areas that remain inundated during six or more months each year, and higher areas that are not reached by annual flooding (Fig. 2a) (OEA, 1974). Flooding occurs between the months of January and May when up to 78% of the total annual

rainfall of 3,200 mm may fall (DNMET 1992). During the rest of the year rainfall is sparse. The extremes of high and low rainfall substantially lower the potential productivity of these grasslands.

Várzea grassland /terra firme pasture complex along the Lower Amazon River

"Várzea" refers to areas that are seasonally inundated by the Amazon River. The silt-laden flood waters carry particles of mineral and organic matter that are deposited with the falling flood waters, creating relatively fertile alluvial soils. Forests occupy some parts of the várzea but in the many areas (e.g., between várzea lakes, on sandbars, and along some river banks) natural grasses occur (Fig. 2b). The main grasses are in the genera, *Echinochloa*, *Hymenachne*, *Oryza* and *Paspalum*, which, in contrast to Marajó, possess high nutritive value (EMBRAPA/CPATU, 1977).

The cattle are generally crossbreeds of different "zebu" races; water buffalo are also raised. Each year when the river level rises, flooding the grasslands, there are two options for herd management. The traditional solution has been to maintain the cattle in floating corrals called "marombas". Rising waters during the flood season tear grass mats free from the varzea grasslands. Ranch hands rake these floating grass clusters into canoes and later transfer them to the cattle in the "marombas". By the early 1990s, it had become customary to move herds to terra firme areas with the onset of flooding. Terra firme pastures in this region are planted following slash-and-burn cropping of rice, corn, and cassava. The forage species planted are *Panicum maximum*, *Brachiaria humidicola*, and *Brachiaria brizantha*. Cattle remain in the terra firme sites for four to six months each year (i.e., until river waters recede and the natural pastures reappear).

Terra firme pastures of southern Pará

About one-quarter of Pará's cattle herd occurs in the southeastern part of the state. This region possess low-fertility, acidic latasols, that are common throughout much of Amazonia (EMBRAPA/CPATU, 1977). Pastures are planted following cutting and burning of the forest (Fig. 2c). Forest felling occurs at the beginning of the dry season to allow sufficient time for the slash to dry before it is burned. The first grass species introduced to this region were *Hyparrhenia rufa* and *Panicum maximum*. In the mid 1990s, other species, such as *Brachiaria brizantha* and *Andropogon gayanus*, were commonly planted.

Ranches ranged from small (100 ha) to more than 100,000 ha. Small ranchers frequently specialized in dairy production. Animals used for dairy production did not represent a defined racial standard. Usually, they were a mixture of "zebu" and European races. Medium and large operations were managed for meat production. The predominant cattle on these ranches were of the the 'zebu' type.

RESULTS

Characteristics of ranching on natural grasslands of Marajó Island

Ranching is a traditional land use activity on Marajó Island. Properties here were acquired when Brazil was still a monarchy and tend to be large. Eighty percent of the study area was occupied by properties larger than 1,000 ha (FIBGE, 1985).

The 20 ranchers that we interviewed owned, in total, 25 ranches on the Island. Only two of these 25 were purchased by the current owners; the rest had been in the family for generations. All of the ranchers were natives to the state of Pará. The average size of holdings in our sample was 5,573 ha (n = 20 property holders; s.d. = 3,865). The mean herd size was 2,230 cattle

(s.d. = 1,586) and 432 water buffalo (s.d. = 641), resulting in a pasture grazing density of 0.48 animals/ha (Table 1).

Profitability of ranching on Marajó Island

Most (80%) of the ranchers that we interviewed had complete or self-reproducing herds (Fig. 3a). Livestock care in this system is rudimentary. Once a year, during the summer (dry season), the animals are separated, counted, branded, and vaccinated. During the rest of the year, animals are maintained together without much control. Provision of mineral supplements and vaccines is generally restricted to young animals. This is the 'traditional' herd management system throughout Amazonia.

Poor herd management, low quality forage, and poor animal care contribute to low system productivity--only 24 kg/ha/year (Table 2). Cattle are slaughtered after 50 months with a mean weight of only 347 kg (s.d. = 28 kg). Water buffalo are more productive, attaining a mean weight at slaughter of 402 kg (s.d. = 41 kg) after only 30 months.

The annual profitability of Marajó Island ranches, with a self-reproducing herd was low--$2/ha or $0.08/kg (Table 2). Three factors contributed to low profitability: i) low weight gains of adult cattle; ii) high mortality rates; and iii) low market prices (approximately 20% less than for animals fattened in terra firme regions ($0.55/kg versus $0.70/kg). Prices are lower because Marajo animals, although older, weigh less at slaughter than terra firme animals and, hence, the percentage of total live weight that is edible meat is lower. Nevertheless, total profits are approximately $9,300/ranch/year because ranches are relatively large and production costs are low due to the utilization of natural grasslands.

Some ranchers on Marajó have found that profits can be improved by specializing in calf breeding (Fig. 3b). In this system, male calves are

shunted from the Marajó grasslands to terra firme pastures on the mainland for fattening. Sometimes the rancher has terra firme holdings and simply transfers his animals there. Alternatively, the rancher may sell calves to terra firme ranchers. The costs of this calf breeding system are higher owing to the increased use of vaccines, mineral salts and acquisition of cows of better lineage and production increases only slightly, from 24 to 27 kg/ha/year. Nevertheless, the profits generated ($4/ha/yr or $21,300/ranch/yr) are two times greater than in the traditional system, because calves sell for more than mature animals ($0.70/kg live weight vs. $0.55/kg) (Table 2). Of the ranchers interviewed, 20% had already adopted this system and another 15% were intending to adopt it.

Specialization in range fattening (Fig. 3c), in which the rancher buys male, one-year-old calves, fattens them on the range, and sells them at slaughtering age, would not be advantageous on Marajó Island because of the low quality of the native forages grasses. Net profits would be negative $3/ha/yr in this system. Not surprisingly, Marajó ranchers do not practice this system.

Characteristics of ranching in the várzea grassland/terra firme pasture complex along the Lower Amazon River

The 33 ranchers that we interviewed along the Lower Amazon River in the vicinity of Santarém (Fig. 1) owned a total of 63 ranches including, 29 in várzea, 25 in terra firme, and 9 composed of both várzea and terra firme tracts. Generally, ranches in terra firme areas have legally defined boundaries. This is not the case in the várzea where natural grasslands represent a common resource among ranchers in a locale: families that have settled along the river have the right to graze their animals freely on the natural grasslands that extend away from the river's edge.

The average size of terra firme holdings for the ranchers in our sample was 1,022 ha (s.d. = 977), with 483 ha, on average, in planted pasture (s.d. = 548). Mean herd size was 473 cattle (s.d. = 648) and 267 water buffalo (s.d. = 421), resulting in a mean grazing density for planted terra firme pasture of 1.53 head/ha. This density, higher than the other regions studied, is possible because the animals rely on terra firme pasture for an average of only five months/yr. They spend the other seven months grazing on natural grasslands in the várzea. Hence, expressed on an annual basis, terra firme grazing densities fall to 0.64 head/ha.

Ranching was the sole source of income for only six (18%) of the ranchers we interviewed. The remaining 82% were also merchants (n = 22) or white-collar workers (n = 5). All of the interviewees were natives of Pará.

Profitability of ranching along the Lower Amazon River

In this region, cattle are slaughtered at about 34 months of age when they attain a weight of 353 kg (n = 23 interviews; s.d. = 37). Water buffalo are sold at about 27, weighing 420 kg (n = 16 interviews; s.d. = 60).

The economic performance of traditional-style ranching (i.e., self-reproducing herd; Fig. 3a) along the Lower Amazon River was better than on Marajó Island. Annual gross revenues were $27/ha, and costs were $24/ha, resulting in profits of $3/ha. Labor costs represented 30% of total costs of which temporary workers, contracted to clear pastures, accounted for 20%.

None of the ranchers that we interviewed utilized specialized systems of herd management. Simulations carried out using our data from the traditional system, show that specialization in range fattening could cause productivity to rise to 57 kg/ha/yr, generating gross annual revenues of $53/ha. However, costs would rise to $51/ha, yielding profits of only $2/ha, 40% less than the traditional system (Table 2).

If a traditional rancher along the Lower Amazon River were to specialize in calf production, profits might show an increase (from $3 to $4/ha/yr). However, the demand for calves was small in the study region and operations specializing in calf production were rare. It is likely, though, that the demand for calves will increase as ranching continues to expand to terra firme areas in proximity to várzea grasslands.

Characteristics of ranching in terra firme regions of southern Pará.

Of the three study areas, the terra firme region of southern Pará was the most important in terms of cattle production in the 1990s. Many ranches were created in this region during the 1970s and 80s and ranches of all sizes exist, from small properties with less than 100 ha to ranches a thousand times larger.

Most of the ranchers that we interviewed (n = 66) came from other states--Minas Gerais (29% of ranch owners), Goiás (28%), and São Paulo (18%). The majority purchased their land during the years 1976-81 (35%) and 1982-87 (26%). The average residence time for ranchers in 1993 (time of our survey) was 10.2 years (s.d. = 4) for small ranchers, 13.1 years (s.d.= 7) for medium-scale ranchers, 14.5 years (s.d. = 8) for large holders, and 17.3 years for the ranchers with very large holdings (Table 1).

Herd management systems are different in southern Pará from the Marajó grasslands and the Lower Amazon várzea in two respects: 1) animals receive better veterinary care (e.g., thorough use is made of vitamins, vaccinations, and anti-parasite medications); and 2) pastures are divided into relatively small paddocks so that herd movements can be monitored and managed. This more conscientious approach to management requires more capital. Ranchers in the south of Pará invest 65% more capital/ha in infrastructure, animal

purchase, and machines than ranchers along the Lower Amazon River ($205 to establish one ha of pasture vs. $124/ha) and 2.5 times more than those on Marajó Island. These increased expenditures lead to greater productivity (Table 2). Cattle generally reach slaughter weight (495 kg; s.d. = 32 kg) within 38 months.

Profitability of ranching in southern Pará

Small properties: A typical small ranch property was 253 ha in size (s.d. = 151), including 198 ha (s.d. = 137) of planted pasture. Mean herd size was 126 head, including cows (62 head), calves, and bulls. Mean grazing density was 0.64 head/ha (Table 1). Small ranchers provided milk to recently-established creameries. Average milk production was low because only half of the cows were lactating at any one time and the production per lactating cow was only 4 liters/day, on average. Nevertheless, these small dairy farmers realized an annual profit of $23/ha of pasture (Table 2). The selling of milk, alone, was sufficient to cover expenditures. Profit was provided by the sale of calves and old cows.

Medium-size properties: Ranches considered to be medium-sized (n = 29) possessed a total area of 3,738 ha (s.d. = 2,256) with 2,140 ha (s.d. = 1,279) of this total in planted pasture (Table 1). Mean herd size was 1,590 head (s.d. = 991), resulting in a grazing density of 0.74 head/ha. The traditional herd management system (i.e., self-reproducing herd) was most common (65%), followed by herds assembled for range fattening (25%), and operations specializing in calf production (10%). Ranchers who utilized the traditional system achieved annual profits of $7/ha of pasture (Table 2). Ranchers specializing in range fattening could triple profits ($25/ha/yr; Table 2); whereas specialization in calf production resulted in a decrease in

profitability compared to the traditional approach.

Large properties: A typical large ranch possessed a total area of 21,570 ha (s.d. = 11,740), including 9,758 ha planted to pasture (s.d. = 2,686) (Table 1). In this size category, the self-reproducing herd system also predominated (60% of the ranches), while 25% specialized in calf production, and 15% in range fattening. Profits for a property of this size, using the traditional system, were $7/ha/yr and rose to $20/ha/yr in fattening operations (Table 2). Costs, gross revenues, profits, and productivities per hectare of large ranches are lower than those of medium-sized ranches because stocking densities are lower (0.65 vs. 0.74 head/ha).

Very large ranches: We conducted interviews at four ranches that possessed an average total area of 135,835 ha (s.d. = 69,462), with 37,375 ha (s.d. = 21,218) in planted pasture. Mean herd size was 24,000 head (s.d. = 10,520), resulting in a grazing density of 0.64 head/ha. The traditional self-reproducing herd system in this size class had annual gross revenues of $1,400,000 and mean net revenues of $275,000, equivalent to $7/ha (Table 2).

Overall, this analysis of ranching in terra firme regions of southern Pará reveals that specialization in range fattening generated higher profits than the traditional (self-reproducing herd) system (Table 2). Annual profits varied between $20/ha (large properties) and $25/ha (medium-sized properties), and were approximately triple those from complete herd management approaches. Although costs were higher in these range fattening operations (e.g., purchasing calves for fattening represented 59% of total costs), these additional costs were compensated for by productivity that increased from 60-70 kg/ha/yr to approximately 85-100 kg/ha/yr (Table 2). In addition, the price of male steers at slaughter was 15% higher than that of

the old cows that made up one-third of animal sales in the traditional system.

By contrast, a terra firme ranch that specializes in calf production, has annual profits of only $1 to $5/ha, considerably less than those of the traditional system (Table 2). Costs are higher and gross revenues are less. For this system to generate profits similar to those of the traditional system, the price received for a calf would have to rise to $175, but in mid-1990s, the calf price was holding steady at about $150. However, the use artificial insemination to produce genetically superior animals can lead to large increases in calf prices. Half of the ranchers specializing in calf production that we interviewed were already beginning to use artificial insemination. The offspring of these artificial crosses eventually serve as studs or brood cows and sell for $600 to $20,000 (bulls bring a higher price). The cost of artificial insemination is not high; one dose of semen can be purchased for $4 to $10, storage of semen is simple, and training in artificial insemination techniques is free.

Analysis of return on investment for different Amazonian ranching systems

By restricting our analysis to annual operating costs and returns, we have demonstrated that ranching can generate profits in a variety of Amazonian environments. However, this does not mean that the returns on ranching investments are attractive. In this section, we present an analysis of the Internal Rate of Return (IRR) and the Net Present Value (NPV) for Amazon ranching in each of the three study regions (Table 3). We use an interest rate of 6% and a time period of 15 years for this analysis.

In our base scenario (Table 3, left side), we consider the costs of all of the investments necessary to establish a ranch (land, herd, equipment,

infrastructure, etc.). In this case, returns on investment are not satisfactory. IRR is always less than 6% for the traditional system (i.e., self-reproducing herd). NPV for the traditional system varies from -$5/ha on Marajó Island to -$116/ha for very large ranches in southern Pará. NPV is only slightly positive in the case of dairy and range fattening operations in southern Pará and ranches specializing in calf production on Marajó Island.

In almost all cases, however, the costs of ranch establishment and ranch operation are lower than those assumed for the base scenario. For example, on Marajó Island, the majority of ranches were inherited and, thus, most of the ranchers whom we interviewed had no initial investment for land acquisition. Eliminating property purchase as a cost, IRR rises from 5% to 8% in the traditional herd management model (Table 3, right side).

The availability of government subsidies also reduced the cost of ranch establishment for some people. For example, some large land holders (e.g., 11 interviewees) in southern Pará had the option of investing in the region and remaining exempt from taxes on up to 75% of the value of their investments. Considering tax breaks and subsidies, IRR rises from 3% (base scenario) to 17-18% (Table 3).

Finally, even without the advantages of inheritance and incentives, it is possible to take measures to reduce the costs of pasture establishment and pasture maintenance. Also, land values have increased with time in the eastern Amazonia and this is not considered in the base scenario. In this way, a medium-sized ranching operation in southern Pará that cuts maintenance costs by using fire (instead of manual weeding), and whose land holdings increase in value at 6% per year, would have an IRR of 8% rather than the 5% calculated in the base scenario (Table 3). In the case of small-scale terra firme ranchers, costs can be even further reduced. At this small scale, all pastures are established following the clearing of the forest for the

cultivation of annual crops. If we consider an annual increase in land value of 6%, exclude the cost of forest clearing, and substitute the use of fire for manual weeding, small ranchers achieve an IRR of 16%.

The IRR in these various scenarios is not much different from the 10-15% returns that are common in Brazil's financial markets. However, investments in land and cattle are regarded as low-risk, secure investments--an important consideration given the instability of Brazil's macro-economy.

DISCUSSION

Now we would like to build on our analysis by: i) spotlighting recent trends in Amazon ranching, ii) evaluating the advantages of cattle raising in Amazonia in relation to other regions of Brazil, and iii) considering the economic and policy factors that influence the sustainability of Amazonian ranching.

Trends in Amazon Ranching

Based on our research, census data, and other studies (IDESP, 1990; Topall, 1991; McGrath et al., 1993), we note three trends in ranching in the Eastern Amazon. Each of these trends appears to be a logical response to economic conditions.

The first two trends are apparent on Marajó Island and along the Lower Amazon River. Here, we noted an increased emphasis on the integration of wetland and dryland cattle raising. In the case of Marajó, 30% of the ranchers that we interviewed had acquired areas of planted pasture along the Belém - Brasília Highway since 1970 to fatten calves born on Marajó Island. As we have demonstrated, a system of calf breeding on Marajó coupled with range fattening in terra firme regions is more profitable than the traditional system relying on a self-reproducing herd (Table 2).

A similar effort aimed at integrating traditional flood plain ranching with terra firme grazing was observed along the Lower Amazon River. Between 1970 and 1985 the area of pasture planted in terra firme in this region grew annually at the rate of 7.8% (FIBGE, 1970, 1985). This was, in part, a reflection of the growth of systems that rely on the várzea during the low water season and uplands during the flood period. Revenues are higher in these integrated systems because animals are not confined to floating rafts during the flood season. Maintaining animals on floating rafts during the flood season leads to loss of weight, animal deaths, and an increase in the age needed for slaughter and first calving (Costa et. al., 1987).

The second ranching trend in these seasonally flooded ecosystems is toward the increased representation of water buffalo in herds. Water buffalo are rugged animals and have lower death rates and higher birth rates than bovine cattle (Carvalho and Nascimento 1986). On Marajó, the total water buffalo herd grew at an annual rate of 7.4% from 1970 to 1985 (versus 0.08% for bovine cattle). In the várzea of the Lower Amazon River, the water buffalo herd was eight times bigger in 1985 than it was in 1970 (annual growth of 15% vs. 4.2% for bovine cattle) (FIBGE, 1970 and 1985).

The raising of water buffalo generates greater revenues than cattle. On Marajó, for example, water buffalo are 70% more productive than cattle (34 kg weight gain/ha/yr vs. 20 kg/ha/yr) even when considering their lower stocking density (0.3 vs. 0.5 head/ha). The difference in net profits is also large ($0.0/ha for a hypothetical herd composed only of cattle vs. $5/ha for a herd composed just of buffalo; Table 4). One big reason for this difference is capital costs; these costs are significantly greater for the hypothetical cattle operation because cattle require more than four years to reach slaughter weight, whereas buffalo are ready for slaughter in less than

three years and have a higher slaughter weight than cattle. The final result: a Marajó operation that only ran cattle would only make enough to pay off capital investments whereas a buffalo-only operation would realize a profit, even though the price paid for live buffalo is less ($0.45 vs. $0.55/kg live weight).

The third trend in Amazon ranching is the expansion of cattle raising among small holders in terra firme regions throughout the Eastern Amazon. Small-scale ranchers, those with less than 200 animals, as a group, possessed 28% of the total cattle herd in Pará in 1980. In 1985, their participation grew to 33%. The number of animals in this group grew twice as much as the states' herd in general (53% versus 27%) during the same period (FIBGE, 1980, 1985).

Ranching is economically attractive to small farmers. Annual profits for ranches specializing in dairy were $23/ha, three-times that of medium and large ranches raising cattle for slaughter (Table 2). Ranching also offers advantages over small-scale agriculture in Amazonia. The productivity of labor is generally higher than that in crop cultivation, the risk of product loss is low, transport and commercialization are simple, and the sale price of animals has generally accompanied inflation (Topall 1991, Hecht 1993).

Cattle could play an important role in the diversification of small-scale agriculture and in the development of sustainable family farms. In northeastern Pará we observed that small farmers often place temporary fencing around their abandoned farm fields. These farmers then place their small herds in these temporary enclosures in the evenings over a period of a month or two. Then, they turn the manure into the soil and plant corn, cassava and other annual crops. Given the right ratio of land, cattle, and farm fields, this approach results in healthy soils and high crop yields.

Another example of the integration of cattle raising and farming has

been observed in the Peruvian Amazon and described by Locker (1994). Shifting cultivators there, as elsewhere in much of the tropics, begin the cropping cycle by cutting down second-growth forest. They plant rice and corn for one year. At the same time, they plant pasture grasses and forage legumes. After the harvest of the crops, they place cattle in the new grass/legume pasture. No attempt is made weed out the trees and shrubs that eventually invade the pasture. After about six years, when the grasses and legumes are being shaded out by the regrowth forest, the cattle are shunted to another site. Meanwhile, the young forest is left to develop for three more years and on the tenth year it is cut and burned and the whole process is repeated. Following this approach, an area of 50 ha will support about 50 head of cattle and 4-5 ha in crop production at any one time (Locker, 1994).

Overall, it seems that small producers are well positioned to effectively manage cattle and take advantage of nutrient-rich cattle manure. These manures can be used to foster the growth of annual crops, as in the examples above, but we have also seen cases where the manure was collected and composted and then used as an amendment to fruit trees. In recognition of the important role that cattle could play in the diversification and intensification of Amazon family farms, the Brazilian government, in the mid-1990s, was, for the first time, offering credit to small producers for the purchase and maintenance of cattle.

Amazon ranching in a national context

The majority of the ranchers operating in eastern Amazonia, particularly the small and medium-scale operators, have not received any financial incentives (Browder, 1988; Hecht, 1993). Only four of the 47 medium and small ranchers that we interviewed had received fiscal incentives and/or subsidized credit. These people were ranching in this region because

they believed that it has distinct advantages over other regions of Brazil. In terms of climate, these ranchers observed that: 1) frosts do not occur like in the South; and 2) rainfall is more evenly distributed throughout the year increasing pasture productivity and reducing the risk of fire. Pará ranchers and technicians also concurred that diseases problems were infrequent--Pará was credited with a lower incidence of disease (e.g., hoof-and-mouth, brucelose) and ectoparasites than Central and South Brazil. Meanwhile, terra firme soils in eastern Amazonia are similar to those in the cattle raising zones (e.g., cerrados) of South-Central Brazil--latisols of low fertility and high acidity (Adámoli et.al., 1985). The soil pH in both regions is generally between 4 and 5; aluminum ranges from 0.7 to 1.8 milliequivalants/100g; and calcium and magnesium range from 0.2 to 2.0 milliequivalents/100g (Falesi, 1976, Fearnside, 1980; Adamoli et al., 1985; Buschbacher et al., 1988).

Another important factor making Amazon ranching an attractive alternative is the low price of land compared to traditional ranching regions in Brazil. In recent years, land prices have increased dramatically in Central and South Brazil due to the increased cultivation of agricultural crops for both export and domestic consumption (e.g., soy beans and corn, Schneider, 1992). The mean price for pasture land in the states of São Paulo, Minas Gerias, and Goiás (place of origin of the majority of ranchers), was 3.6 times greater than in Pará in the early 1990s ($1,541 vs. $427; mean for 1992/93). In response to this situation some ranchers from South and Central Brazil have been inclined to sell their land and use the money to establish larger ranches in southern Pará (Schneider, 1992). Our survey revealed that 44% of the small ranchers and 28% of the medium-scale ranchers had sold their ranches in other states to invest in ranching in Pará. Moreover, 48% of the medium-scale ranchers and 53% of the large ranchers still have ranchers in

their states of origin.

In southern Pará most cattle are sold on the hoof to wholesalers who buy cattle at the ranch and truck them to markets in Central and Northeast Brazil. The price of live, slaughter-ready cattle in southern Pará is about $0.05/kg lower than the price received in Central and Northeast Brazil because of the cost of transportation from Amazonia to markets. Low land prices and, therefore, lower costs of capital explain, in large part, why eastern Amazonia ranchers can compete in the national cattle market, even though they are far from consumers.

Prospects for a sustainable cattle sector in Amazonia

When one considers the potential for sustainable ranching in Amazonia, the primary factor that needs to be examined is the capacity of pastures, both natural and planted, to maintain productivity. Natural grasslands on Marajó Island and in the Amazon várzea have been in use for hundreds of years (Teixeira, 1953; Lins, 1991). Hence, it would seem that the sustainability of ranching in these areas has already been demonstrated and should continue provided overgrazing is avoided. However, the expansion of the buffalo herd should be carefully monitored. Buffalo, by virtue of their greater weight and less selective eating habits, are more damaging to seasonally flooded environments. Also, because buffalo frequently move in single file, they open up new channels and might affect regional hydrology and drainage patterns. We know of no research that examines the environmental impacts of buffalo but such work is badly needed.

The possibility for sustainable ranching in terra firme areas is also difficult to evaluate. The first attempts at terra firme ranching were not very successful. Pastures became weed infested and the levels of available phosphorus in the soil dropped from 4-10 ppm to sub-adequate < 1 ppm within

five years of pasture establishment (Hecht, 1985). Some forages were also heavily attacked by insects (e.g., spittle bug attacks on *Brachiaria humidicola*), and these so called "first generation pastures" were also often subjected to overgrazing.

Starting in the 1980s conscientious ranchers began to rejuvenate their degraded pastures. Pasture rejuvenation consisted of removing the tree stumps and residual debris from the pre-existing forest, tilling the area with tractors, planting improved forages, and sometimes fertilizing. The total cost in the early 1990s was $260/ha (Mattos and Uhl, 1994). After pasture rejuvenation, the application of phosphate fertilizer will probably be necessary in some areas at, perhaps, five-year intervals to maintain pasture vigor. Rejuvenated or improved pastures are capable of supporting higher grazing densities (1 head/ha) and animals might attain slaughter weight six months earlier than normal due to higher pasture productivity (Mattos and Uhl, 1994). The long-term maintenance of productivity of these pastures will depend on the economic viability of, first, rejuvenating the weed-infested first generation pastures and then maintaining the improved pastures in a productive state.

At the time of our interviews in southern Pará we observed that 61% of the small ranchers and 79% or the medium-scale ranchers were rejuvenating their pastures. Fertilization was generally not used in the restoration process. In no instance did we observe these ranchers clearing primary forest to establish pastures. In the case of the ranchers with large holdings (Table 1), 58% were rejuvenating pastures and 22% were converting primary forest to pasture.

The likelihood of pasture rejuvenation and pasture maintenance in the future will depend largely on the relative prices of four elements: farm machinery, fertilizer, cattle, and land. Prices for farm machinery and

fertilizer are important because they represent 83% of the cost of pasture rejuvenation. Farm machinery prices have increased somewhat in Brazil in recent years while the costs of fertilizers have declined steadily (Fig. 4). Meanwhile, returns on cattle sales represent the main source of revenue resulting from pasture rejuvenation investments. The price of cattle was relatively constant, in real terms, in the early 1990s, after a period of decline in the late 1980s (Fig. 4). According to Oliveira (1991), low consumer buying power coupled with the sluggish growth in the Brazilian economy and the expansion of poultry raising, reversed the trend of elevated cattle prices that was seen in the 1980s. If beef prices were to dip lower and fertilizer and farm machinery prices were to rise, pasture rejuvenation would not be feasible. Conversely, a rise in beef prices and/or declines in fertilizer and machinery prices would create an even more favorable environment for pasture restoration and maintenance.

Independent of these factors, the availability and price of land in the Eastern Amazon will also affect the likelihood of intensification of ranching practices. The value of both forest and pgsture land increased by 40-80% from the mid-1980s to the mid-1990s ($292 to $427 for pasture land and $94 to $180 for forest land, in real 1993 dollars) (Fig. 4). As infrastructure improves in old Amazonian frontier areas and land becomes more scarce, it is likely that land will continue to increase in value. And in the absence of dramatic changes in the prices of beef, fertilizer, and farm machinery, increasing land values will be the driving force in the shift to more intensive ranching practices.

Two visions for ranching development in Amazonia

The Default model

Ranching is profitable under a variety of circumstances in Amazonia.

Indeed, ranching, even in its extensive form, can generate profits. Thus, the conversion of primary forest to pasture is likely to continue. In the region of São Felix do Xingu, for example (Fig. 1), loggers in search of mahogany, have built approximately 3,000 km of roads. Some of the lands bordering these roads are now being converted to ranches (Veríssimo et al., 1995). Another zone of expansion is the Tapajos River Basin. This is a major gold mining region. Many of the more successful miners are using their profits to establish cattle ranches in the Tapajos basin.

The introduction of cash crops can also affect ranching. In the mid-1990s, a government project was initiated to promote soybean production in southern Pará (Diário do Pará, 1994). If soybean cultivation is successful in the Eastern Amazon, ranching may be pushed to even more peripheral areas toward the center of the Basin.

The growth of the Brazilian economy (projected at 7%/yr for the period 1995-2005; Veja, 1994) could provoke an increase in the demand for and price of beef which in turn could stimulate more conversion of Amazon forest to pasture, particularly if land in Amazonian frontiers remains, essentially, available for the taking. The result of these various forces acting together will likely be a continuation of the disorderly occupation of Amazonian lands (Fig. 5).

Alternative model

There is an alternatie to this default model. To appreciate this alternative, it is necessary to consider the value of the ecosystem that is being removed to make room for pastures--namely the value of standing Amazonian forest. As knowledge of Amazonian forests improves, the appreciation of the values of these ecosystems grows. Some forest values are obvious. For example, the forest contains enormous stocks of valuable

hardwoods. As Asian timber supplies are depleted, Amazonia is well positioned to supply global hardwood needs, provided these forests aren't converted to pastures. The Amazon forest is also coming to be valued for the non-timber forest products (ntfps) that it contains. The plant species that inhabit the forest offer an array of fibers, oils, dyes, resins and foods, not to mention medicinals. Efforts to identify these potential products and to develop sustainable production and marketing strategies are underway and hold potential. Finally, intact forests are coming to be valued for the services that they provide. For example, forests store carbon and the cutting and burning of these forests to establish pastures results in carbon emissions which in turn could contribute to global warming. The value of this atmospheric buffering service can be expressed in monetary terms. Schneider (1993) has recommended that the North consider paying Amazonia countries to preserve their forests because these forests serve as global carbon sinks.

Twenty years ago none of these values were attributed to Amazonian forest to any significant degree. Advancing that the forest be valued for its biodiversity or for its climate buffering capacity would have been regarded as fanciful. Even as recently as the early 1980s Amazonian forests were being converted to pastures with no attempt to salvage the hardwoods they contained. It is clear that we are still in our infancy in terms of understanding and appreciating the value of these forests. Hence, we cannot effectively judge the wisdom of forest conversion to pasture because the forests that are being replaced are not fully valued by landholders, the government, and society at large. Although we are incapable of fully valuing these ecosystems, it does seem that their value will increase in the foreseeable future, as what they possess and the services they provide are more fully appreciated.

Recognizing that Amazonian forests have not been fully valued, of

course, is not a reason for banishing ranching from Amazonia. We have shown that ranching can be profitable and that the intensification of ranching is possible. Indeed, if all the land that has been cleared for ranching but is now abandoned could be rejuvenated, the carrying capacity of the state's pasture lands could easily double from five to ten million animals. We believe that it is possible, then, to take measures to maintain forest cover and biodiversity while also creating conditions that allow ranching to flourish.

The first point in developing an alternative model for land occupation and resource management in Pará is that forested land is probably too valuable to be converted to pasture, but that the ranching sector could continue to grow, indeed double, simply by intensifying ranching practices on lands that have already been cleared.

In addition to investments in pasture restoration, two additional types of capital inputs would be helpful in promoting the intensification of ranching. The first is for investments in infrastructure, particularly roads. The need is for an intensive network of farm to market roads (Schneider, 1994). Such intensive road webs decrease transport costs and improve services. Meanwhile, improved infrastructure, in the form of dense road networks should increase land value and thereby promote intensification.

Investments are also needed for measures that increase the diversification of ranching products. There are two product lines that should be encouraged--dairy products and leather products. Currently, even with a large herd in relation to human population in Pará, approximately 80% of the milk consumed in Belém (capital city of the state) is in powdered form and is imported from other regions of Brazil or even other countries (BASA/CECON, 1994). Meanwhile, there is no leather products industry in the state. A large portion of the cattle for slaughter are transported live to

other states for processing. Leather generated in Pará is of good quality due to the low incidence of ectoparasites. With appropriate incentives, artisans and shoe and hat industries might be attracted to the region.

In tandem with measures to promote the intensification of ranching, intensify road networks, and promote the diversification of ranch products, a viable alternative to the haphazard occupation of Pará depicted in the default model (Fig. 5) should give attention to the stewardship of the majority of the state where no claims to land have been registered. In the absence of any state or federal-level vision for this land, much of it will be simply taken over by private interests. As an alternative, the state could exert authority over these non-titled lands and they could be transformed into state forests, extractive reserves, and conservation units. This would, in effect, make land more scarce in Pará and be a further impetus for intensification of land use on private holdings (Fig. 5).

Finally, on private, public lands, and Indian Lands, there is a general need for monitoring land use and enforcing legislation designed to control deforestation. This is best done by demarcating and geo-referencing property lines, reserves, and parks and then placing this information into a GIS (Geographic Information System) together with satellite images that show land use (Almeida and Uhl, 1995). With a system of this type, it is possible to accompany actual land use, enforce laws and policies, and collect taxes, property by property, as well as to detect instances of invasion of parks and reserves.

Overall, then, through the control of access to new areas, the intensification of ranching, the improvement of roads, and the promotion of diversification of ranch products, ranching could become a catalyst of development in the region generating more employment and revenue for the state. The end result: sustainable development of natural resources,

improved quality of life, and maintenance of biodiversity (Fig. 5).

End Note:

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Table 1. Characteristics of ranching in three Amazonian environments, Pará, Brazil.

	RANCHING ENVIRONMENTS IN THE EASTERN AMAZON					
	Natural Grasslands (Marajo)	**Floodplain/upland complex** (Lower Amazon)	**Upland Planted Pastures** (Southern Pará State)			
			Small	Medium	Large	Very large
Nº of interviews	20	33	18	29	15	4
Mean area/ranch (ha)	5,573	1,022 [1]	253	3,738	21,570	135,835
Mean area of ranch in pasture (ha)	5,573	483	198	2,140	9,758	37,375
Mean stocking density (head/ha)	0.48	0.64	0.64	0.74	0.65	0.64

[1] Referring only to upland areas.

Table 2. Annual gross revenues, costs, profits, and productivity for different ranching systems in three Amazonian environments, Pará, Brazil.[1]

Locale/ System	INDICES OF COMPARISON[2] Gross revenue/ha/yr (Gross revenue/kg)	Costs/ha/yr (Costs/kg)	Profits/ha/yr (Profits/kg)	Productivity (Kg live/ha/yr)
Grasslands of Marajó:				
-Self-reproducing herd	$12 ($0.50)	$10 ($0.42)	$2 ($0.08)	24
-Calf production	$16 ($0.60)	$12 ($0.45)	$4 ($0.15)	27
-Range fattening	$26 ($1.08)	$29 ($1.21)	-$3 (-$0.13)	24
Várzea/terra firme complex of Lower Amaz:				
-Self-reproducing herd	$27 ($0.54)	$24 ($0.48)	$3 ($0.06)	50
-Calf production	$29 ($0.62)	$25 ($0.53)	$4 ($0.09)	47
-Range fattening	$53 ($0.93)	$51 ($0.89)	$2 ($0.04)	57
Terra firme pastures of southern Pará:				
Small properties:				
-Dairy farming	$65	$42	$23	46
Medium-sized properties:				
-Self-reproducing herd	$44 ($0.64)	$37 ($0.54)	$7 ($0.10)	68
-Calf production	$41 ($0.68)	$38 ($0.63)	$3 ($0.05)	60
-Range fattening	$125 ($1.24)	$100 ($0.99)	$25 ($0.25)	101
Large properties:				
-Self-reproducing herd	$39 ($0.66)	$32 ($0.54)	$7 ($0.12)	59
-Calf production	$35 ($0.69)	$34 ($0.67)	$1 ($0.02)	52
-Range fattening	$110 ($1.26)	$90 ($1.03)	$20 ($0.23)	87
Very large properties:				
-Self-reproducing herd	$38 ($0.65)	$31 ($0.53)	$7 ($0.12)	58
-Calf production	$35 ($0.67)	$30 ($0.57)	$5 ($0.10)	52
-Range fattening	$108 ($1.27)	$86 ($1.01)	$22 ($0.26)	85

table 2, cont.

[1] Detailed data regarding the costs and production of each system may be obtained from the first author.

[2] Values in June, 1993, dollars.

Table 3. Net Present Value at 6% and Internal Rate of Return for different ranching systems in three Amazonian environments, Pará, Brazil.

Locale/ System	Total Investments [1]		Partial Investments	
	Net Present Value/ha	Internal Rate of Return	Net Present Value/ha	Internal Rate of Return
Grasslands of Marajó:				
-Self-reproducing herd	-$5	5%	$20 [2]	8%
-Calf production	$15	8%	$35 [2]	9%
Várzea/terra firme complex of Lower Amaz:				
-Self-reproducing herd	-$40	4%	$66 [3]	10%
Terra firme pastures of southern of Pará:				
Small properties:				
-Dairy farming	$90	9%	$317 [4]	16%
Medium-sized properties:				
-Self-reproducing herd	-$53	5%	$104 [5]	8%
-Calf production	-$100	3%	$60 [5]	7%
-Range fattening	$24	7%	$184 [5]	10%
Large properties:				
-Self-reproducing herd	-$101	3%	$190 [6]	18%
Very large properties:				
-Self-reproducing herd	-$116	3%	$202 [6]	17%

[1] Investments include purchase of land ($26-$55/ha), animals ($68-$158/ha), planting of pasture ($78-$89/ha), construction of infrastructure ($7-$84/ha), and acquisition of motors and machines ($0-$30/ha).

[2] Considering a property in the grasslands of Marajó where the owner inherits the land.

tabela 3, cont.

3 Considering a medium-sized property in the region of the Lower Amazon River with a self-reproducing herd where: 1) half of the pastures were planted by small farmers (i.e., no pasture land clearing and pasture establishment cost for the rancher); 2) fire is used instead of manual weeding of pastures (i.e., reduced pasture maintenace cost); and 3) land values increase at 6%/year. The numbers per hectare are corrected considering the period of utilization of terra firme pastures during the year.

4 Considering a small dairy farm where pastures were cleared and planted without cost and where land prices increase at 6% per year.

5 Considering a medium-sized property where fire is used instead of manual weeding to maintain pastures free of weeds and where land values increase at 6%/year.

6 Considering a large property where 75% of the initial investments were covered by fiscal incentives.

Table 4. Comparison of productivity, costs, and profits between cattle and water buffalo raised in the traditional system (self-reproducing herd) on the natural grasslands of Marajó Island, Pará, Brazil

	CATTLE	WATER BUFFALO
Productivity (kg live/ha/yr)	20	34
Gross revenue (US$/ha/yr)	$11	$15
Total costs (US$/ha/yr)	$11	$10
Net revenues (US$/ha/yr)	$0	$5

FIGURE LEGENDS

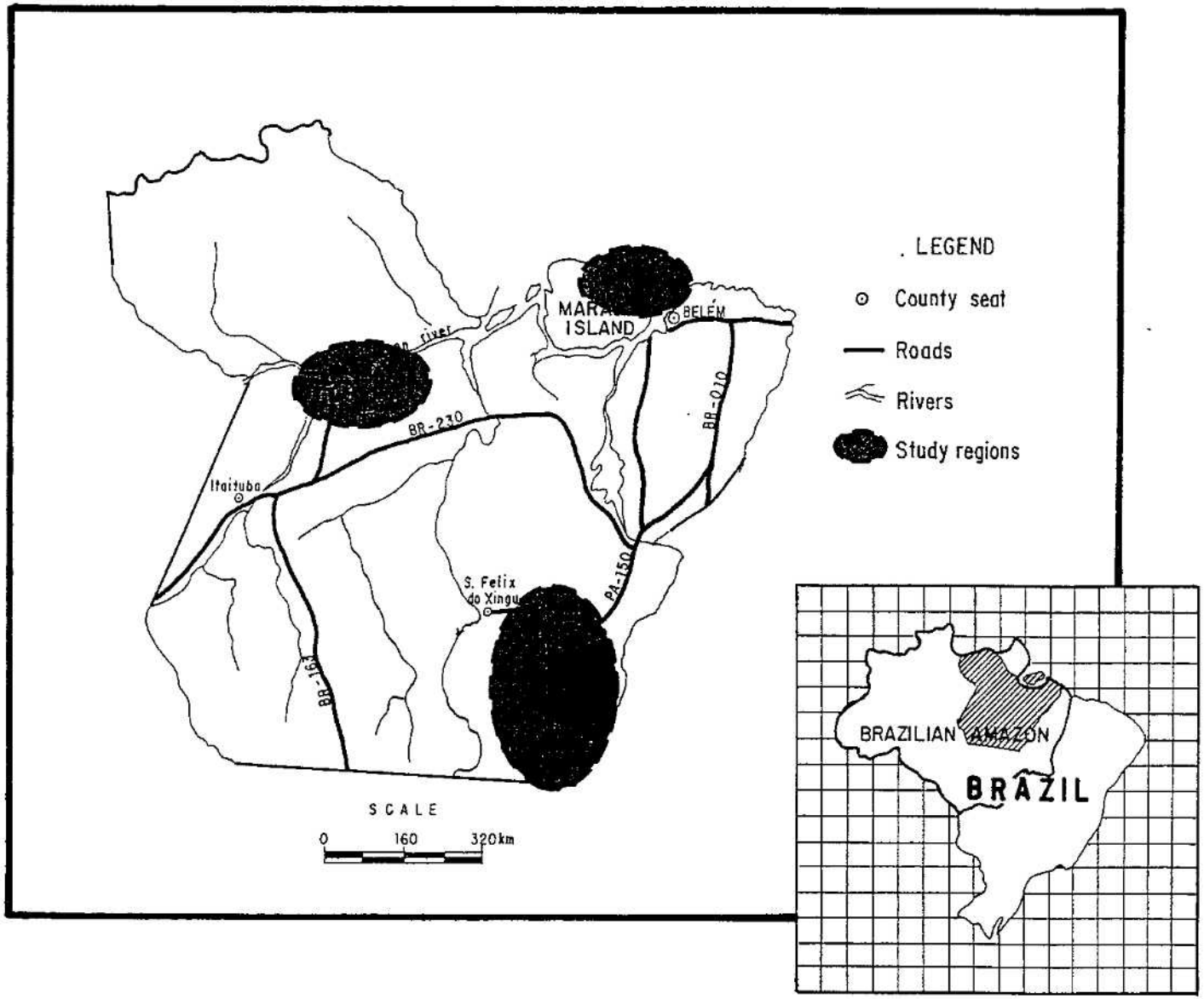
Figure 1. Location of the state of Pará and the three study regions in the Brazilian Amazon.

Figure 2. Characterization of the three environments used for ranching in the state of Pará in the Brazilian Amazon.

Figure 3. Herd management systems in the state of Pará in the Brazilian Amazon.

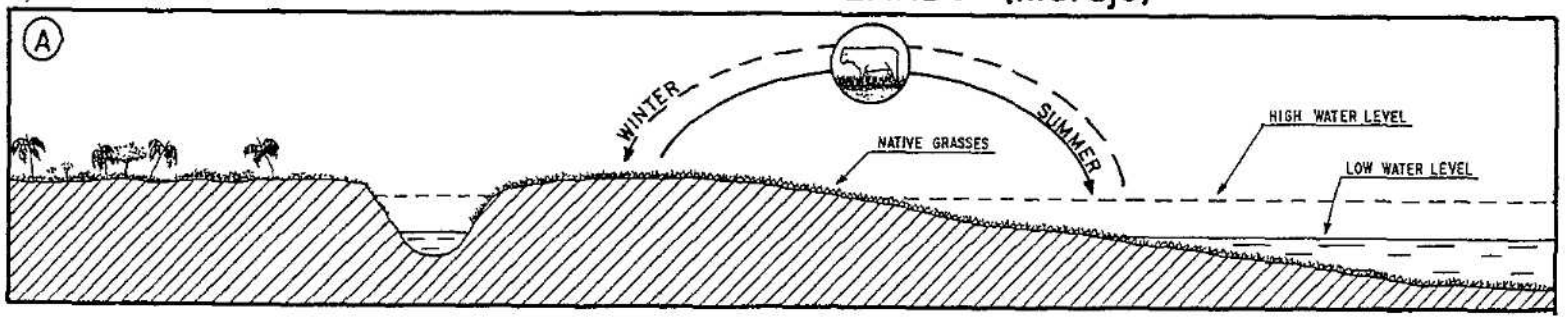
Figure 4. Changes in the prices of land, cattle, fertilizer, and farm machinery in Brazil (FGV/CEA, 1984-1993).

Figure 5. Two models for the development of ranching in the Eastern Amazon state of Pará. Top: the default model--the absence of state control and the abundance of resources leads to the mining of resources and biological impoverishment. Bottom: the alternative model--the valuation of forests and the active participation of the government in the control of resource use leads to the sustainable development of natural resources and the maintence of biological diversity.

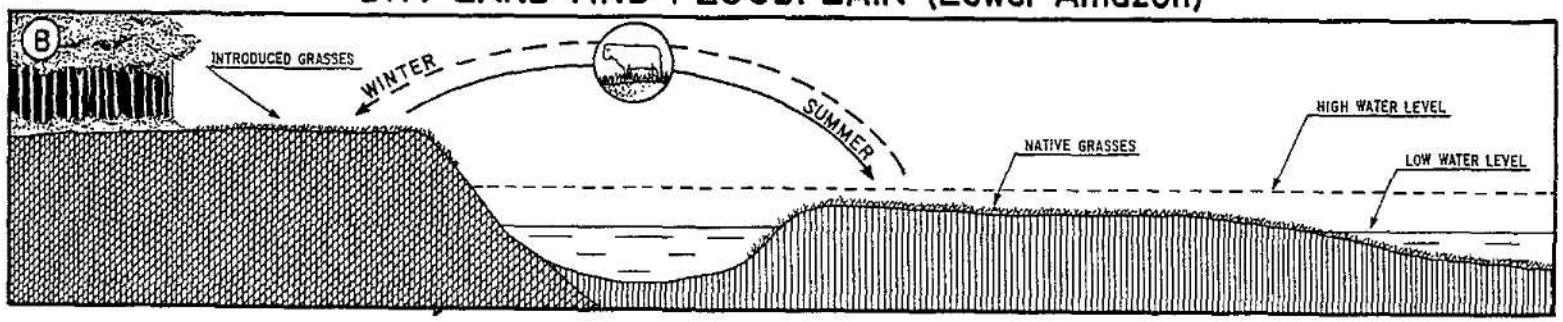


Aurina / UNC

NATURAL GRASSLANDS (Marajo)



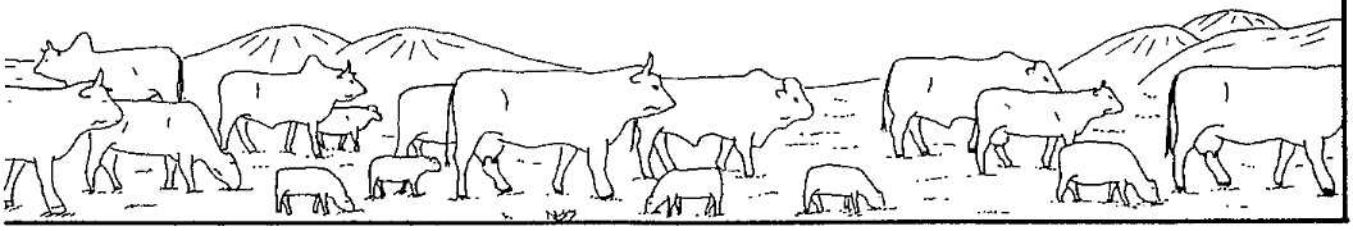
DRY LAND AND FLOODPLAIN (Lower Amazon)



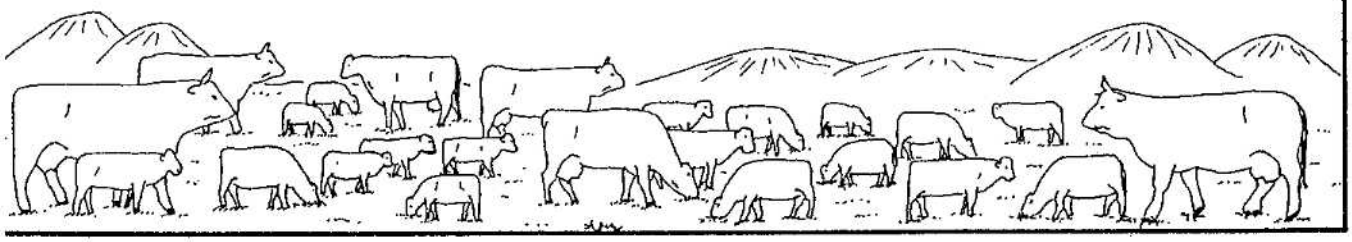
DRY LAND (Southern Para)

ARIMA T. 1.
Fig. 2

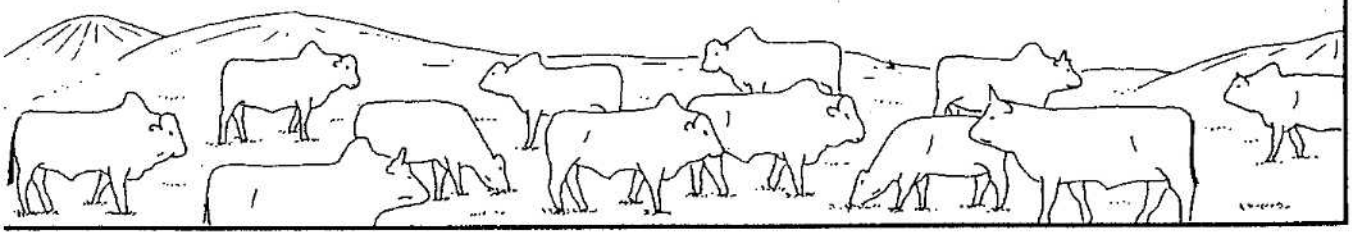
(A) - BREEDING, RAISING AND FATTENING



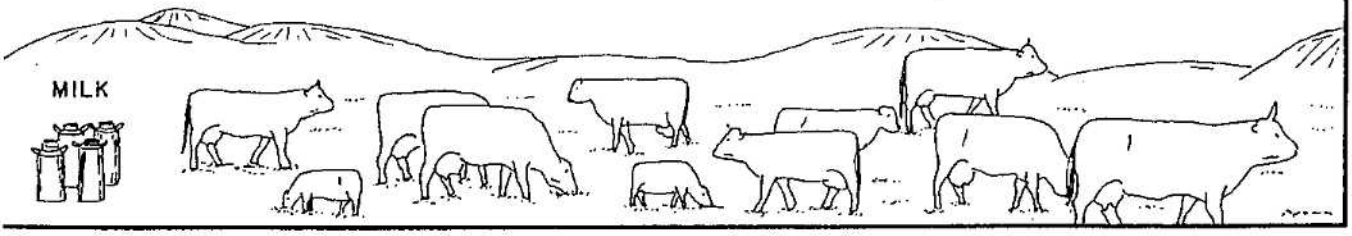
(B) - BREEDING

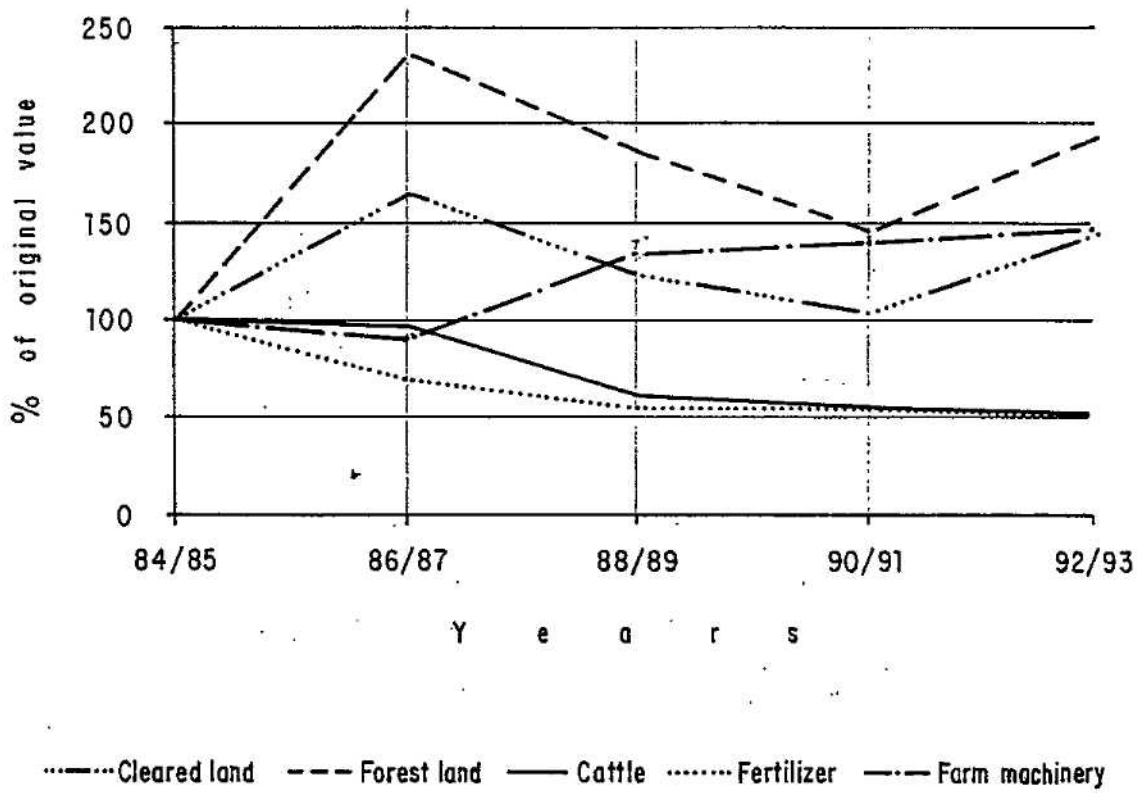


(C) - RAISING AND FATTENING



(D) - DAIRY





ARIMA / UHC

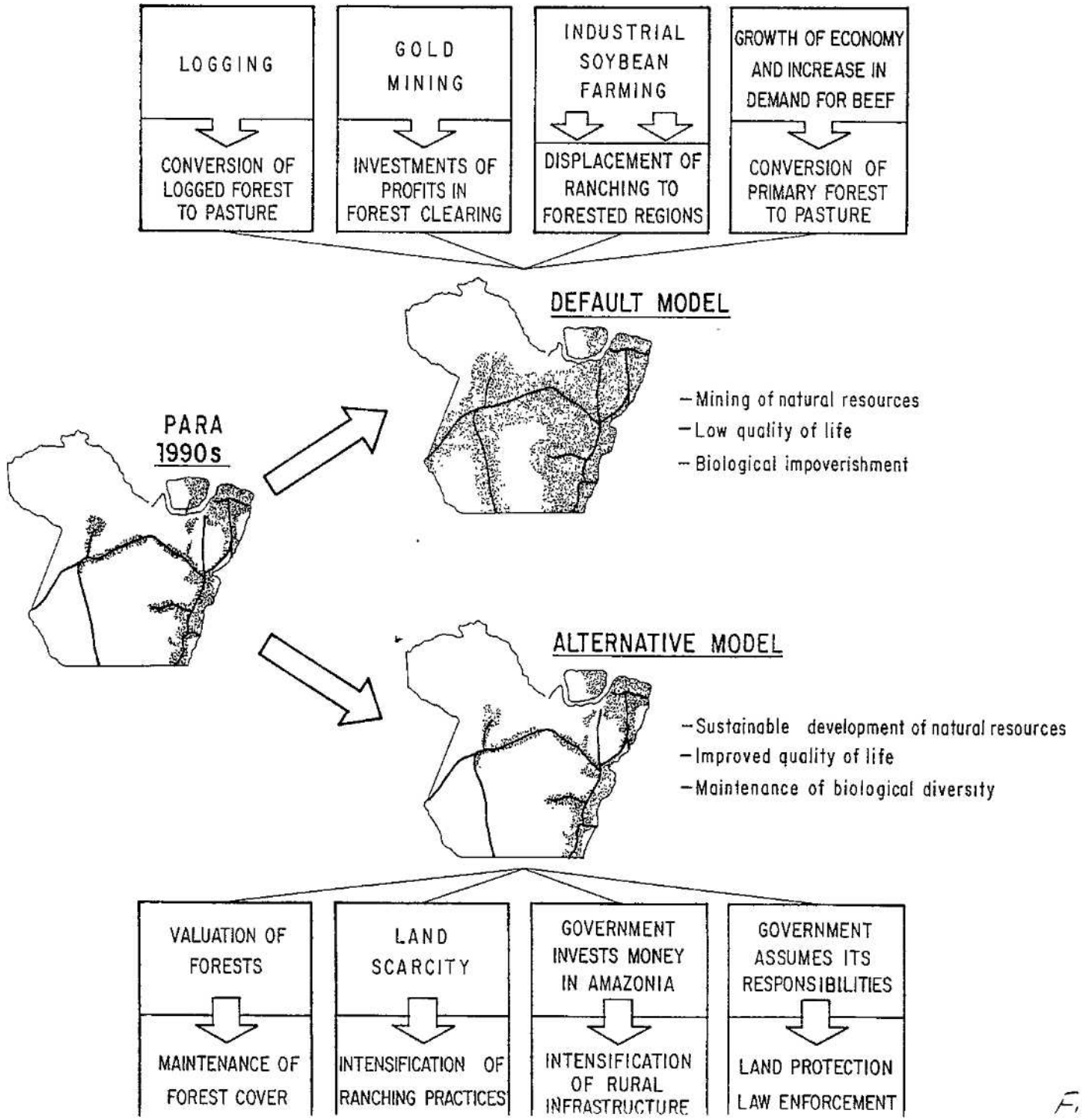


Fig. 5