



STABILISING THE AMAZON FRONTIER: TECHNOLOGY, INSTITUTIONS AND POLICIES

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'The one thing that can be stated about the frontier with certainty is that it displays enormous variety in all its aspects' (Almeida, 1992)

Although the extent of deforestation by colonist farmers is sometimes overstated, stabilisation of the Amazon frontier remains a major conservation priority at the international level. One of the main characteristics of colonisation is the high rate of turnover of land holdings. The main environmental challenge is how to reduce this, and thus subsequent incursion into primary forest areas. Few would dispute that appropriate technology development has a vital role to play in this process, but our understanding of the socio-economic and policy determinants of technology adoption and its impact on colonist stability remains incomplete.

POLICY CONCLUSION

- The key to stabilisation lies in assisting colonists to accumulate capital other than land. Infrastructure support that reduces risk, and support to credit and marketing are likely to have a greater impact than technology development alone.
- Research and extension should focus more on increasing the returns to labour and capital than to land.
- Government support to second-wave colonists has contributed to pioneer colonists abandonment and further encroachment.
- Appropriate decentralised institutional support for colonists farmers is critical, especially during the early stage of colonisation, when support through rural labour unions and NGOs is likely to be most effective.
- Colonisation zones require a new configuration of institutions involving public/private partnerships at local, provincial and national levels, so that policy, institutional and technology development initiatives can complement rather than contradict each other.
- Policies and donor support should also focus on reducing 'push' factors through social investment in the colonists areas of origin.

Introduction

Colonisation is the spontaneous or sponsored settlement of areas of largely unoccupied land, and comprises three basic types: 'official' or government managed colonisation, 'directed' or government sponsored but privately managed colonisation, and 'spontaneous' colonisation. Of these the latter has been most important in numbers - for example two million colonists settled along the Belem-Brasilia highway in less than a decade.

The term 'frontier' is best defined not in a fixed spatial sense, but as a 'transitional process whereby specific new territory is incorporated into an economy' (Almeida, 1992). Such processes include the area covered by official and directed colonisation programme⁵ in Brazil in the 1970s. Here the term is used in a more generic sense to refer to the forest margin areas of colonisation zones, usually characterised by the presence of pioneer or small-farmer colonists.

There are currently some half million colonist farmers practising slash and burn agriculture in the Brazilian Amazon, many of whom see the frontier as an escape from poverty. Rates of colonisation are certainly sensitive to macro-economic and demographic change: colonisation pressures in Brazil have fallen recently, mainly due to urbanisation and an aging population. Deforestation is characterised by a sequential dynamic: ranchers rarely enter an area before subsistence-oriented colonists, due to the high costs of primary forest clearance away from social and market infrastructure. Stabilisation of the frontier would thus reduce the spread of ranching and land speculation.

The colonisation policy of the 1970s was based on the idea of 'bringing men without land to land without people.' In the 1970s alone, the frontier 'absorbed' about three million people. However, there was a reverse flow in the late 1970s as most of the private colonisation schemes, which were driven by land speculation, collapsed following the withdrawal of government support due to low colonist productivity and macro-economic pressures. By the mid 1980s many of these areas were resettled under INCRA, the Brazilian agrarian reform institute.

Large-scale spontaneous colonisation has resulted from both pull and push factors. The pull factors include road building, fiscal incentives for larger-scale enterprises, and development programmes like the Tucuruí Dam and the Grande Carajás mining project in Para State. Push factors include agricultural mechanisation and labour displacement in the south, land poverty in the north, inflation and urban unemployment. Schmink and Wood (1992) argue that colonisation policies reproduced the urban ecology of metropolitan Brazil at the frontier - integration into the cash economy was rapid, and by the 1980s many colonisation areas were on the path of urbanisation, land concentration and social differentiation. Surviving colonists turned into businessmen, while those who failed returned to the cities, worked as hired labourers or moved to the next frontier.

In some of the official programmes like Altamira in eastern Para colonist production proved competitive and led to investment in permanent crops, diversification, and accumulation of capital. However, the best soils were claimed by the end of the 1970s. The Ministry of Agrarian Reform was created in 1984 to redistribute some land to new colonists, but with inadequate political support, was abolished in 1989. Violent land conflicts ensued as colonists squatted on unoccupied better quality soils, and formed rural labour unions against those who had previously claimed land but left it largely unutilised.

There have been substantial changes in policy and politics since the mid-1980s with the rise of rubber tapper unions, the ending of ranching incentives, and the curbing of multilateral funded dams and roads. More political channels are now open to grassroots movements, with new forms of political organisation and alliances within and outside Brazil, especially among environmental and indigenous rights groups. Despite these changes, the policy has largely remained one of frontier expansion.

The causes of colonist instability

The first observation from the many documented case studies of colonisation is the wide diversity of situations and pressures. There are the obvious differences between official/directed and spontaneous colonisation, which often occurred sequentially in the same area. However, the dynamics of colonisation zone development exhibit a consistency, summarised in Table and discussed below.

The three main stages of colonisation

In most situations, low-resource colonists come to an undeveloped frontier where land is cheap and abundant, usually following road construction - the 'early pioneer stage' in Table 1. At this stage there is often little interest in formalising land rights.

However, over time, social infrastructure and market opportunities gradually improve, government arrives, tenure becomes formalised and land price increase, stimulating a second, 'emerging market economy', stage. As institutions land and labour markets, credit, property rights, market infrastructure - develop, a further wave of capitalist-type colonists are attracted. This is the stage (typically five to 15 years after the frontier is opened) when most land abandonment occurs.

A final, 'closing frontier', stage occurs when there is little or no land left to colonise, and the frontier has become distant. Land use systems are dominated by ranching. Land is more expensive due to a stronger speculative element and a more developed infrastructure. Land concentration, social differentiation and urbanisation are well-advanced.

Table 1. Colonisation zone conditions associated with high instability

	Early pioneer stage	Emerging market economy	Closing frontier
Colonists characteristics	Individualist, speculative attitudes; pre-colonisation itinerancy cultures of NE Brazil; wide differences in initial financial and human capital: brokers and clients; very risk averse; small family/young children.	Lack of literacy proves handicap in land claims; slow to adapt to new market and institutional opportunities; lack of prior entrepreneurial experience in emerging market economy conditions.	Colonists unable to make socio-cultural adaptation to capitalist frontier economy; become landless labourers, migrate to frontier or return to cities.
Land tenure and distribution	Not usually an important issue since land abundant, but there may	Government defends land claims of pioneers or second-	Increasing concentration of land in hands of second-wave

	be land claims from earlier abandoned directed colonisation.	wave colonists - land conflicts; second-wave colonists do not have to occupy land to secure tenure.	colonists.
Role of land value and speculation	Cheap land encourages land-extensive farming regardless of soil quality; colonists aim to maximise return to scarce family labour and capital; and value can be tripled by conversion to pasture.	Rising land values and market economy institutions: second speculative wave arrives; increasing indebtedness, tenure insecurity and rising land prices encourage sale by pioneers.	Higher land values encourage more intensive and commercial farming systems by survivors - mainly capitalist colonists.
Government/other institutional interventions	In directed/official colonisation: support services do not reach resource-poor farmers; incentives/credit tied to cash crop mono-cultures; negative invisible institution problems; absence of NGOs or labour unions slow to develop.	In increasing indebtedness due to induced emphasis on inappropriate cash crop mono-cultures; government agricultural support to second wave colonists; weak NGO/labour union support for pioneers.	Formal government withdraws and local institutions/NGOs take over but land concentration and social differentiation well advanced.
Credit	Mainly non-monetary mercantile credit with high interest rates - indebtedness forces labour/subsistence crisis.	Formal credit arrives but depends on land title, and tied to inappropriate cash crop monoculture induces indebtedness.	Credit tied to unsustainable land use management.
Off-farm income	Lack of opportunities for off-farm income to provide alternative means of accumulating capital, or ease capital constraints.	Increasing off-farm wage opportunities can accelerate conversion and abandonment if speculative element dominant.	Developed labour market: client colonists absorbed as hired labourers, other factors encourage land abandonment.
Farming systems	Subsistence crops, manual farming methods and destumping by family labour, fire as key management tool.	Increasing clearance for pasture, market orientation, use of hired labour and some external inputs.	Dominated by pasture, reliance on hired labour, occasional mechanisation.

Socio-economic differentiation and land tenure

Moran (1981) divided pioneer colonists into two main types: 'broker' and 'client' farmers. Brokers arrived with some capital, and were more market/cash-oriented. Subsistence oriented client farmers rapidly came to depend on the brokers for credit and other services.

There is also a key difference between pioneer colonists and second-wave settlers. The latter, often termed capitalist colonists, came with strong urban connections: they often held political or civil service positions, owned urban real estate, and ran small businesses. They were essentially speculators with only a secondary interest in farming.

There is an important interaction between social differences and land security. Illiteracy has seriously handicapped early colonists in pressing their land claims. Furthermore, urban-based officials have less cultural affinity with them than with ranchers or land speculators. Early informal tenure is precarious, usually involves some cost to the colonist, and does not provide access to bank credit.

As the frontier matures, formal government enters and takes over land rights adjudication - usually coming to the defence of the absentee 'landowners' and second-wave colonists. The latter can often reserve forested land until its market access and value has improved, without facing the costs and risks of clearing and farming it.

Land 'speculation' and farm economics

Many colonists sell frontier land to buy plots closer to the market and better served by health and education infrastructure. Second-wave colonists have even stronger land speculation motives - land inflation is especially rapid where there are large-scale development projects and/or valuable natural resources are present - as in southern Para.

Most analysts consider the price of land as the most fundamental influence on colonist technology choice. Whatever the underlying income potential, as defined by soil quality, if land is cheap, the rational response is land extensive technology (slash and burn, and pasture development) and early land abandonment. However, as the frontier closes, land values rise with improving social, institutional and market infrastructure, giving more incentive to intensify land use.

Paradoxically, when the economic incentive to intensify is highest, the capacity of the land for intensification is at its lowest. Declining productivity is compensated, wherever possible, by bringing new land into production, and the cycle begins again.

Intensification in the closing frontier stage therefore implies improving the productivity of open or degraded areas. Both larger and smaller ranchers in the Paragominas area of Para State have been prepared to reinvest about \$260 per ha to achieve a three to fourfold increase in animal liveweight production per hectare with a 13-16% return on investment (Mattos et al., 1992). The prevailing scarcity and cost of land underpin this: ranchers needing more land have been unable to find it at a price less than the equivalent cost of pasture rehabilitation.

But technology change in the Amazon cannot be reduced to relative factor and product prices. Other influences include the varying period of adjustment by colonists. Also the quality of institutional support, and how rapidly colonists respond to it, varies widely.

The role of Government and institutional factors

Most accounts of colonisation emphasise a range of institutional problems. For example, the early risk-avoiding priorities of poorer colonist farmers were for: market access for a range of crops, health infrastructure, schools, and, adaptive agricultural research and extension (Moran, 1980). But official colonisation agencies along the Transamazon highway responded more to the national priority of maximising staple food production than to colonists' needs.

The technology underpinning national priorities was rarely consistent with colonists' needs. It emphasised land, not labour, productivity, centralised research, the transfer of 'model' technologies, and market orientation. The main policy instrument of INCRA was to tie credit, tenure and support services to rice production, a crop inappropriate for most of the region's soils. Shorter fallow periods and declining yields resulted in indebtedness and sale or abandonment.

Government agencies have rarely provided services promised to settlers. Extension workers sent to the region tended not to work effectively with those of a lower social status. Information feedback from the field was poor, and the institutions showed little inclination to identify and meet the needs of the colonists, who found it difficult to obtain timely advice, inputs and credit.

Box 1: PESACRE - A case study of appropriate institutional response

The Acre Agroforestry Research and Extension Group (PESACRE) evolved as a 'political ecology' response to the problems of colonist farmers. Since 1986, the Universities of Acre and Florida have been working towards 'a coherent institutional strategy within which technical, social and political issues can be addressed over the long-term' (Schmink, 1992). PESACRE has the active participation of both federal and State organisations like EMBRAPA/CPATU (the federal agricultural research agency), FUNTAC (a parastatal rural development agency, the universities, the State extension agency, and a range of NGOs and private sector groups, including the National Rubber Tappers' Council. PESACRE has been primarily funded by USAID and Ford Foundation.

Key reasons for the success of PESACRE (now an NGO) have included a strong emphasis on training in participatory research methods (especially in agroforestry), the use of 'issue-oriented' and interdisciplinary working groups, information networking, and support from the Acre State governor. Schmink (1992) emphasises the importance of informal connections as several PESACRE staff moved into key positions in the State: sharing a common vision was more important than formal linkages. However, replication of PESACRE may not be easy. It was pioneered by a group of scientists with good links to external funding, and sound knowledge of the local area and institutions.

The government's role has critically influenced the processes of capital accumulation, land abandonment and social differentiation. There are three main ways that colonists can accumulate capital - through farming, off-farm income activities and the land market. Government policies have largely restricted colonists to farming and the land market as a means of capital accumulation, obliging them to occupy and farm the land in order to defend their land rights, whilst tenure support to second-wave colonists has permitted them to focus on off-farm income activities.

Increasing indebtedness attributable in part to high input monocultures coincides with increased purchasing power among the second-wave colonists, generating pressure on the first wave to sell.

Risk, markets and political economy

Risk dominates the lives of colonist farmers: malaria and other health threats, challenges to land rights, crop pests and diseases, fluctuating input and output prices, and other risks are rarely far away. Physical isolation encourages short-term cash crop farming and clearance for cattle, since this combination makes it easiest for colonists to respond to a crisis - typically of sickness. Rural labour unions or NGOs have often provided social and physical support and so assisted stabilisation.

Isolation from markets is also a major constraint on colonist stability. So, too, is access to credit. Almeida (1992) emphasises

the importance of traditional mercantile non cash forms of credit imported into Para State by north easterners. Credit, which is only provided for cash crops like rice, is in the form of food, inputs and other necessary goods; payment and interest is through advance purchase of the harvest. Plot abandonment can be due to a labour, rather than land, crisis, when there is insufficient labour to meet both repayment and subsistence needs, and off-farm employment opportunities are limited.

Finally there is a widely held view that the failure of small-farm colonisation is predetermined by vested national interests, and the pressure of the international market. If colonist farming were to succeed, it would reduce access by elites to new frontier land. This, it is argued, is one reason why technological, rather than policy or institutional options are more commonly supported: an agroforestry programme is unlikely to affect the underlying incentives which favour those with capital and influence.

Implications for colonist technology development

Technology and labour

Technological response must be compatible with the micro economic determinants of colonist land use, relieving labour and capital constraints in the earlier stages of colonisation, then land constraints as forest cover is reduced and land values increase.

Most attempts at colonist technology development have focused on land use intensification through, for example, fallow enrichment, inter-cropping or multiple cropping. These are vital aspects of colonist stability, but have focused technology development on land productivity at a time when land is abundant and cheap. Colonists' emphasis has remained on maximising returns to scarce capital and labour through slash and burn farming, and conversion to pasture. Repayments under the mercantile credit system increase the demands on labour productivity. Also Maxwell's (1979) pioneering analysis in the Bolivian Amazon points to labour crises as a primary cause of land abandonment: shorter fallow periods increased the labour cost of weed control. Farmers without the capital to hire labour or use herbicides would often face abandonment.

Burning is a labour-efficient means of controlling weeds and releasing nutrients, but is a major constraint to land intensification (e.g. through the introduction of perennials). Technologies with the potential to increase returns to labour and capital, as well as land, are few, but include green manures and cover crops combined with minimum tillage, which have been widely adopted in Central America and more recently in Bolivian colonisation areas.

Technology and capital

Colonists adopt more land-intensive technology only when land values are rising (as the frontier matures and closes). This implies that raising productivity and incomes, or providing credit, could encourage deforestation and accelerate abandonment, as the increased working capital facilitates the process of land clearance for pasture. The powerful incentives to keep cattle include: high returns to labour; ease of marketing; flexibility - cattle can be sold in a crisis. Cattle also provide a hedge against inflation, and permit occupation of large areas and so establish tenure and gain access to credit. In Rondonia State, which has the highest level of recent deforestation in Amazonia, cattle numbers expanded by 3,000% between 1970 and 1988.

A more optimistic picture comes from those who see institutional, human capital and market incentives as the major constraints to technology adoption. They argue that accumulation is less for purposes of land speculation and more for investments which enable them to stay on the plot in cattle, trucks and buildings. Technology facilitating this strategy is more likely to be adopted where colonists live in communities with high social cohesion and where the proportion of older colonists - who are less keen to move on - is high. Close consultation between research and extension services and farmers is essential if there are to be good prospects of technology adoption. Yet this has rarely been the case in the Amazon.

Institutions and methodology

Vosti (1993) calls for a new type of institutional basis capable of adopting a systems approach in which the interactions of technological, policy and institutional issues can be assessed together. The PESACRE programme (Box 1) may provide useful lessons: it involves a policy and technology partnership between local, national and international interest. PESACRE has long emphasised training in participatory research and extension methods.

The potential for natural forest management

For pioneer colonist farmers, it is during the early colonisation stage that support for appropriate technology development is most crucial, while there is still considerable forest cover on the plot. One approach with the potential to increase returns to capital and labour, and retain the forest cover, is natural forest management (NFM). There are now several embryonic attempts to pioneer timber-based NFM among colonists, for example in the Maraba, Altamira and Chore (Bolivia) colonisation areas. However the social, economic and institutional complexities will necessitate considerable support for community-based NFM to become established. It would appear to have most potential where social cohesion is highest, as in some communities in the early frontier stage.

Conclusions

This review finds that incentives linked to policies and institutional factors are more important than soil quality or appropriate technology in frontier stabilisation. If the pull and push factors driving colonisation are to be addressed, incentives towards land concentration and social differentiation in the 'second wave' need to be reduced; incentives to encourage colonists to remain on their existing plots increased; and assistance for grassroots and support institutions like NGOs and rural labour unions be increased, especially in the early stages of colonisation. These help to develop greater social cohesion, secure external support, improve marketing margins and resist opposing land claims. Government support for social and market infrastructure, especially health facilities, schools and roads, is essential. Policy, technology and institutional interventions need to complement rather than contradict each other, and a planning frame in each colonisation area needs to be set up to ensure this. Technology development inconsistent with policy and institutional conditions is as likely to exacerbate the problems as ameliorate them, and given the wide heterogeneity of conditions on the Amazon frontier, the danger of this remains high.

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