AGRICULTURAL-INDUSTRIAL INTEGRATION AND NEW APPLICATIONS OF NATURAL FIBRES: JUTE FLOODPLAIN CROPPING IN THE AMAZON REBORN?

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Abstract
Agricultural-industrial integration and new applications of natural fibres: jute floodplain cropping in the Amazon reborn?
In recent years natural fibre production has taken on considerable appeal because of new industrial applications in environmental friendly products and growing demand for fibres could contribute to social welfare of poor farmers in developing countries. The new uses of natural fibres are part of highly technical green solutions for problems in the industrial and consumption regions but it may be asked whether this demand really addresses social and ecological issues in regions of primary production. These issues are examined in the Brazilian Amazon where recently a composite fibre sheet factory was opened and fibre cropping is making a comeback after decades of economic stagnation. It is shown here that the expansion of the activity, while significant, has not yet reached the scale of the past, but the market is promising, particularly in the automotive industry, which could further stimulate jute and malva production in the region.

Key words
natural fibres, new industrial applications, agricultural-industrial integration, Amazon region, Brazil.

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1. Introduction

In ten years of research on floodplain agriculture in the Brazilian Amazon I have investigated the environmental, economic, social and political difficulties faced by traditional riverine farmers and how they actively search for new productive strategies which could integrate them into new regional dynamics (Bicalho 2003, 2009, Bicalho and Hoefle 2008a, 2008b, 2010). However, the historic riverine population seldom participates actively in new rural social and economic processes, such as the advance of the agrarian frontier in inter-fluvial areas and the rise of metropolitan agriculture associated to industrial expansion of Belém and Manaus (Bicalho and Hoefle 2008a, 2008b, Caldas *et. al.* 2007, Schmink and Wood 1992, Walker *et. al*. 2009). Riverine farmers are rarely articulated to national and export markets and the options open to them are restricted to supplying food to regional urban markets, which are limited by the region's low urban density so that most of these riverine farmers are poor and marginalised.

New demand for natural fibre today opens a potentially promising avenue for economic opportunity for riverine farmers, building on their past experience with jute (Corchorus capsularis L.) and malva (Urena lobata L., a kenaf type of native fibre of the Amazon), the last great commercial products of riverine Amazonia. In the late 20th Century, fibre crops almost disappeared from the region, but in the present decade are slowly making a comeback in response to demand in the emerging global eco-economy, of which new industrial applications of natural fibres in the plastics industry are important. This study evaluates whether the re-introduction of natural fibre and the rise of new relationships between agriculture and eco-industry in former production areas of the Amazon will benefit a very poor rural population. The key issue is to determine if fibre production significantly increases income as well as improves the quality of life of the local people and so contributes to economic and social sustainability, without which there can be no ecological sustainability.

The regional and global significance of the theme treated here is highlighted by the fact that the United Nations and the Food and Agriculture Organization declared 2009 as the International Year of Natural Fibres in order to call attention to the importance of a rural sector that once involved great commodity crops and today still produces about 30 million tonnes of natural fibres, worth about US$40 billion annually. Among the reasons cited by the FAO for targeting natural fibres is that they are produced by poor small farmers in developing countries and expanding demand helps fight hunger and rural poverty. A second major reason is that natural fibres are increasingly being incorporated into a rapidly expanding high-technological sector of the plastics industry, particularly with applications in automobile manufacturing. The investigation undertaken in the Brazilian Amazon can offer feedback concerning these issues in a region where natural fibres are cropped by poor small-scale family farmers and where production has been stimulated by the Brazilian vehicle manufacturing sector, which in turn is articulated to the expanding global eco-economy.

To some, the issue of small-scale farming in a country noted for agribusiness export commodity production may seem quixotic, but historically and increasingly in recent decades, Brazilian smallholders have been responsible for supplying most of the domestic market with more than 180 million consumers with foodstuffs and are important players supplying raw materials for agro-industry, which also exports

produce abroad (Martine 1990, MCT 2002, Sorj 1986, Silva 1978, 1996, Wilkinson 2008). In addition to this, buying fibre production from peasant farmers of riverine Amazonia can be important for Brazilian and foreign-owned manufacturing firms because they come under considerable national and international political pressure to be 'socially responsible'.

The results presented are based on fieldwork undertaken between 1999 and 2008 in the municipalities of Manacapuru, Maniquiri, Iranduba, Careiro da Várzea, Itacoatiara, Silves, Itapiranga, Parintins and Santarém, all of which once were important natural fibre producers located along the middle course of the Amazon River and where fibre cropping has been showing signs of recovery (Fig. 1). Primary data collection was undertaken through the interview of 51 former and current fibre farmers in addition to extension agents at the local and state levels as well as representatives of local industries processing natural fibre.

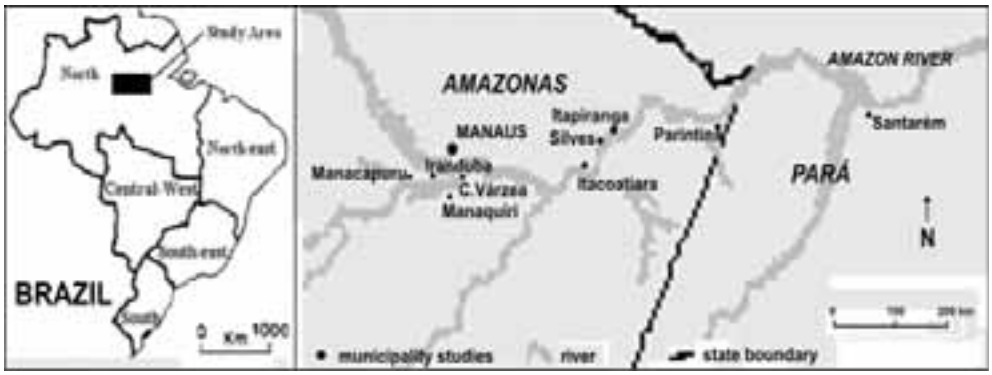

Fig. 1: The study area in the Brazilian Amazon.

This work is divided in four parts. First, there is a brief discussion of social inclusion and exclusion in Brazilian farming in relation to agricultural-industrial integration. Then, trends in international natural fibre production are outlined, followed by another part treating new industrial applications of natural fibre, before entering the evaluation of the regional significance of renewed fibre production in the Amazon. The conclusion highlights contradictions present in the global eco-economy due to the unequal relations between primary producers of natural fibre on the one hand and manufacturers on the other.

2. The social implications of dependency in agricultural-industrial integration

Brazil is characterised by great social polarisation in the countryside and between urban and rural areas as a result of the concentration of land ownership over the centuries. This was reinforced by agricultural modernisation and the growth of commodity production for international markets in the second half of the 20th Century (Martine 1990, Müller 1989, Pinazza and Alimandro 1999, Sorj 1986). Rural social polarisation has generated two distinct farm sectors in Brazil. One sector is attuned to the most dynamic part of the national economy and is composed of capital-intensive producers, who range in size from successful small farmers to agri-business firms supplying the large urban domestic market and manufacturing sectors with a variety of products as well as producing important

global commodities. Another sector consists of a large number of poor small farmers who face severe limitations in changing agriculture practices and crops in order to meet market demand.

The floodplains of the Amazon host a significant number of marginalized small-scale family farmers who lack commercial crops which could insert them in markets and are thus situated outside the dynamic farm sector of Brazil. The floodplain environment imposes serious restrictions for commercial production in terms of appropriate crops and technical practices. In the past, however this was not the case. Seasonal flooding on rich alluvial plains permitted the introduction of jute and later malva for fibre production in the mid-20th Century. The two became the first commercial crops to be extensively planted in the middle Amazon basin, which brought about significant regional change by causing considerable forest clearing of flood plain environments and consolidating agriculture as the mainstay of the local economy which previously had been based on collecting natural products of the forest. However, farmers became highly dependent on fibre middlemen who often practised abusive buying practices in their role as the link between farmers located in remote areas and the fibre industries. The dependency of farmers on middlemen in the Amazon region was similar to other situations of agricultural-industrial dependency found throughout Brazil. Historically, this kind of agricultural-industrial dependency rarely improved the life-style of small farmers and kept them subordinated to the productive and economic control of middlemen and the processing industries (Abramovay 1992, Guimarães 1978, Prado Jr. 1987, Sorj 1986).

In the last two decades there was an exponential increase in the number of processing plants for a variety of farm products in Brazil, giving rise to a more competitive agro-industrial sector and a more balanced relationship between farmers and industry. But in the absence of competition at the local level as well as with recent trans-national acquisitions and mergers of the largest Brazilian firms at the national and global levels, problems with monopolistic practices and the subordination of farmers still remain, so that three situations can be encountered in Brazil today:

1. social exclusion resulting from the dominance of agribusiness farms producing monoculture commodities with extreme land ownership concentration and elimination of small farmers taking place;
2. disguised social exclusion resulting from the dominance of the processing industries which dictate low prices and maintain small farmers completely subordinated so that they remain in poverty and
3. social inclusion resulting from a relationship of interdependence with industry in which produce prices are favourable and farmers achieve social upward mobility to the point of becoming a rural middle class.

Hence, in the case of the return of fibre crops in the Amazon, we have to ask if a balanced relationship will arise between fibre farmers and the new industries or if the past relationships of dependency and over exploitation will be reproduced once again, maintaining farmers in poverty. As fibre production is related to the automobile industry, one of the strongest and most powerful economic sectors in Brazil and in the world, producing goods with high aggregated value, the question is whether poor small farmers furnishing raw material for components will benefit. Behind the rhetoric for eco-initiatives incorporating natural fibres into industrial processes and claims about social responsibility, lurk classic considerations of cost

and profit, which motivate industries to look for cheap materials and can have serious consequences for poor, powerless farmers.

3. International Production of Natural Fibre and New Industrial Applications

The production of natural fibre for the manufacture of twine, rope, food-grade sacks and bulk wrapping materials was once of great importance in international markets. Of the principal fibres which produce natural strand and line the most important is jute, followed by kenaf, coir, flax and agave-sisal (Table 1).

Tab. 1: International production of natural fibre.

Fibre	Main Countries	World Production (t)
Jute	India, Bangladesh	2,861,000
Kenaf	India, China	970,000
Coir	India, Vietnam, Sri Lanka	931,000
Flax	China, Europe	830,000
Agave& Sisal	Brazil, Columbia, Cuba, Mexico, Tanzania, Kenya	424,000
Ramie	China	249,000
Hemp	China, Europe	214,000
Abaca	Philippines, Ecuador	98,000

Source: Suddell (2009).

From the 1970s onward, petroleum-based fibres replaced natural fibre so that, worldwide, the cropping of natural fibres entered into steep decline, causing economic stagnation in the producer regions. In addition to the competition with synthetic fibres, innovation in transport facilities also contributed to the decline of natural fibres, particularly the advent of commodity bulk handling facilities in long distance trade, which eliminated the use of food-grade sacks altogether. Jute has always been the most important natural fibre but it too suffered long decline. In 1990, 2.1 million hectares were planted in jute, which fell to 1.6 million in 2000 and is projected to slump to 1.2 million hectares by 2010, a retraction of about 3% a year. During the same period, production also fell from 3.3 million tons to 2.6 million tons and is projected to diminish to 2.3 million tons by 2010. During this period jute consumed in the developed countries fell by 40% and that consumed in developing countries by 10% (FAO 2003).

Given these trends, considerable debate exists concerning the future of natural fibres. According to the negative viewpoint, the world market for natural fibre will continue to fall due to the strong competition of petroleum-based fibre (FAO 2003). On the other hand, the position of FAO is not entirely negative as it allows for the possibility of the development of new materials and the diversification of products utilising natural fibre. Suddell (2009) takes the more positive and optimistic view that new applications have arisen for natural fibre in the so-called eco-economy where they are used to substitute or in combination with synthetic fibre. Indeed, the use of natural fibre in composite materials in new industrial products is part of a new conception of environmental governance called product-oriented environmental management (Jan 2009, Medina 2005, Williams 2009).

Despite having fallen to a low proportion of world trade today, natural fibre production is labour-intensive and provides work so that it is still socially important for many farmers of the world, particularly in poor-parts of Asia, the main producer region. Proposals for maintaining traditional natural fibre production usually target

such social considerations because of the large number of small farmers engaged in this sector. Many of the proposals revolve around traditional uses for local consumption or readapting production to crafts for decoration and for the tourist market or the occasional use by the Western fashion industry when it incorporates exotic motifs from other regions of the world. However, these markets are quite restricted and short-lived in the case of fashion so that this limited demand will never boost fibre production to its former scale. New industrial applications of natural fibres involve products with greater continuous demand and so could represent a firmer basis for expanding natural fibre production in the world.

Natural fibres are increasingly being used not only for making conventional petroleum-based composite products more environmentally responsible but also to endow them with superior structural qualities, particularly when long natural fibres are used to produce greater strength and toughness to moulded thermal plastics. The most important new applications of natural fibres occur in the automotive and construction industries but there are many other applications in a number of sectors, such as furniture making, shoe manufacturing, textiles and in the substitution of fibre glass. Natural fibres have several advantages vis-à-vis conventional plastic, such as being from 10% to 30% cheaper; having lower density, superior thermal properties and low embodied energy; involving lower tool wear in the moulding process; producing better acoustic proprieties and reducing irritation to the skin and respiratory system (Suddell 2009). Natural fibres have assumed considerable environmental importance in function of being produced with renewable energy sources, consuming less energy to produce and being biodegradable and recyclable (Santos *et. al*. 2009).

European car manufacturers, and in particular German firms, use natural fibres more extensively than their North American and Asian counterparts. Overall lighter vehicle weights reduce fuel consumption and diminish carbon emissions. Fibres are used extensively in bumpers, seating and internal panels to increase impact resistance. Used as insulation, the materials enhance heating and cooling efficiency and reduce noise. The second greatest new use of natural fibres is in building construction and in this case the most important country is the United States. Fibres are used to produce lighter structural walls, as insulation, in floor and wall coverings, thatched roofing and as a composite in roof tiles and building blocks. Another important application is geo-textile used to control erosion on slopes and in road construction (Suddell 2009).

Ironically, a number of the perceived advantages of natural fibres in composite polymers were cited in the past as disadvantages which led to the substitution of natural fibre by synthetics. Natural fibres were said to be inferior because they were not water resistant, were porous and breathable, were biodegradable and were not adaptable to automatic sack filling. The water resistance problem has been overcome by using fibres in composites with resins which have this property. Breathability is now seen to be an advantage in reducing heat and impregnated bad odour, particularly in textiles. Similarly, bio-degradability is highly desirable today as well as the characteristic of being recyclable. All of these characteristics now perceived to be desirable have stimulated a good deal of research into finding other industrial applications which could cause fibre production to expand even further.

4. Regional Significance of Renewed Fibre Production in Brazilian Amazon

4.1 - Historical importance of jute and malva in the Amazon

Jute and malva cropping was once an important farming activity in an extensive area along the middle Amazon River. This part of the Amazon has extensive floodplains in which jute was planted in low-lying areas and malva in higher parts. From the 1950s onward, the planted area, production and number of floodplain farmers growing fibre expanded rapidly until 1980. At the peak, nearly 54,000 farmer families were involved in planting over 95,000 hectares of fibre, almost all of them being smallholders with an average of 1.75 hectares in fibre (Tab. 2).

Tab. 2: Change in number of farmers engaged in fibre production in the Brazilian Amazon.

Year	Farmers	% Change
1975	50,376	-
1980	53,942	7
1985	36,603	- 32
1990	15,022	- 59
1996	1,338	- 91
2000	3,568	+ 167
2007	9,282	+ 160

Source of data: IBGE (1975-2007).

There were almost thirty processing factories along the Amazon River, particularly in production areas. The most important factories were located in Manacapuru, Manaus, Parintins, Santarém and Belém. The factory in Santarém was one of the largest and was specialised in making burlap sacks for exporting Brazilian farm commodities so that Amazonian fibres were once indirectly linked to global markets.

Following a world-wide trend, demand for fibres in Brazil declined rapidly after 1980 due to the competition of petroleum-based fibres and particularly after 1985 with the introduction of bulk grain shipping facilities which eliminated the need for sacking Brazilian commodities. The fall over a relatively short period was dramatic, from 53,942 farmers planting jute and malva in 1980 to a mere 1,338 in 1996. A number of these farmers were interviewed in field research. Some of them still plant fibre crops and those who had progressively abandoned jute and malva cropping between 1982 and 1996 expressed regret about no longer being able to grow what had been their main cash crops. The collapse of fibre production occurred without crop substitution taking place so that the region experienced economic stagnation and farmers reverted to subsistence and semi-subsistence production of basic food crops, which command low prices.

In recent years, however, the agricultural-industrial chain using natural fibre is expanding and fibre production is increasing again, particularly in Amazonas state. Fibre cropping is starting to spread further up and down the Amazon River and the number of farmers involved has passed 9,000. Prices received by farmers have also improved, from R$0.51 per kilogramme of fibre in 2000 to R$0.73 in 2002 and R$1.11 in 2006 (R$1=US$0.47 in 2006). Further expansion is a distinct possibility because the market for natural fibre has great potential for national and global growth and different levels of government in Brazil, especially within the region, have been keen on stimulating the production of natural fibres for new industrial applications.

4.2 - New Industrial Applications of Amazonian Natural Fibre

The demand for natural fibre in the Amazon today is related to new manufacturing applications, which induced the rise of a sophisticated agricultural-industrial sector in the region. Recently, a new composite-fibre factory was set up in the riverine city of Santarém, which is part of an industrial chain utilising new applications of fibres. This factory represents part of a larger process, in which Brazilian industry has accompanied the global eco-economy of incorporating natural fibres into the production of composite polymers and a number of these polymer factories have been set up in industrial areas of Brazil. This industrial chemical sector has had the greatest number of applications in automobile manufacturing undertaken by subsidiaries of European firms.

There are two factories located in the Brazilian Amazon, which supply fibre materials to Brazilian automobile factories for upholstery, acoustic and thermal insulation, bumpers, etc. The POEMA factory located in the Belém metropolitan area was set up in 1992 by Daimler-Benz and was one of the first composite fibre factories in the world. The second factory, PEMATEC TRIANGLE, started producing fibre sheets in 2004 to supply the Volkswagen plants in São Paulo but soon included a number of different Brazilian car manufacturers, such as Mercedes Benz, Audi, GM-Opal, Toyota and Volvo, as customers and expanded into other industrial sectors, such as mattress and shoe manufacturing as well as in construction materials. Sheets are produced in high temperature presses and three fibres are blended with polymer materials in a proportion of 50% jute and malva, 10% curauá and 40% recycled fibres.

In contrast to the POEMA factory, which uses coconut fibre, important in coastal areas, PEMATEC uses jute and malva fibre, which was historically important in inland riverine areas of the Amazon, particularly in the middle part of the basin. In this part of the Amazon, where there are extensive wetlands and floodplains, the possibility of commercial agriculture is very restricted, so that the re-introduction of natural fibre farming could represent a good opportunity for re-dynamising the regional economy.

4.3 Questionable Social Benefits

But what is the social significance of renewed fibre production? Will the scale of production reach the point that a large number of peasant farmers will be integrated in such a way as to improve their income and quality of life? There are already 9,282 family farmers planting jute and malva, which is a significant number, but still well below the historic figure. The number of farmers involved has increased and they were drawn to the possibility of earning an income, but is it a dignified income?

Compared to basic food production in riverine areas, fibre cropping generates more income and involves less work. Basic food crops grown are beans, maize and manioc and only manioc in the form of meal has a market but requires a large labour input and the price is comparatively low. Fibre is highly adaptive to floodplain environments and is also cheap to produce because it does not require agro-chemical inputs so that this kind of cropping is accessible to poor farmers and does not cause soil and water pollution. Fibre farmers have increased their annual income in recent years, from R$3,872 on average in 2000 to R$5,219 in 2002 and

to an estimated income of R$7,863 in 2006 as opposed to R$1,766 for basic food producers in 2002 (R$1=US$0.47 in 2006).

The new source of income for riverine farmers is welcome but is still too low and quality of life poor. Housing is rudimentary, furniture consists of a wooden bench and hammocks, no electricity or treated water are available and house appliances may consist of a radio or manual sewing machine.

Poor working conditions represent another problem for renewing fibre production and work ecology constitutes an important dimension of environmental sustainability. A common complaint among interviewed farmers was the long hours spent in the water harvesting jute and malva. A good deal of the work, which is almost all manual, is undertaken in the water. During harvest the stalks are cut, bundled and placed in the sun for six to eight days to dry. Then, the bundles are soaked in clean, running water for 15 to 20 days. After this, fibre is manually removed from the stalk and again placed in the water and manually beaten and shaken to clean the fibre. Finally, the fibre is put to dry on lines and re-bundled for classification and sale.

5. Economic and Social Dilemmas of the Global Eco-economy

At the primary production end of the natural fibre eco-economy, a good deal more social responsibility is called for than merely thinking in economic terms of production because farmers still earn low income, face bad working conditions and have a poor quality of life in general. The result of new agricultural-industrial integration to date looks more like disguised exclusion involving dependency. When compared to the aggregated value of the final industrial products of the agricultural-industrial chain we can think of raw material production as involving over-exploitation rather than social inclusion and upward social mobility. The best indicator of this relationship is the gulf which exists between the meagre benefits received by fibre farmers in the Amazon and those enjoyed by the industrial and consumer sectors. The gulf in lifestyle is best exemplified by contrasting the way of life of a fibre farm with that of the buyer of a car in Europe, North America or even in industrialised Brazil. New crop methods attuned to better working conditions must be introduced and income and quality of life must be improved or else the firms touting the environmental friendliness and social responsibility of their products are just engaging marketing tactics to sell to green consumers at the same time that farmers remain in poverty.

6. Summary

New industrial applications of natural fibres have been hailed as important alternative environmental friendly products. As many fibre producing regions of the world involve poor small farmers, increasing demand for fibre could also contribute to social welfare. The new uses of natural fibres are part of highly technical green solutions for problems in the industrial and consumption regions but does this demand really address social issues in regions of primary production? These issues were examined in the Brazilian Amazon where recently a natural fibre sheet factory was opened and fibre cropping is making a comeback after decades of economic stagnation. In response to increased demand for new industrial uses in Brazilian automobile manufacturing for products sold in national and export markets, fibre

production and the number of farmers cropping jute and malva were shown to have increased significantly but still have not reached the scale of the past.

Furthermore, even if a new source of income is welcome in a part of the Amazon characterised by poverty, the revival of fibre crops should not be seen merely in economic terms of increased production and some additional income for the local population but also should be related to introducing new crop methods attuned to better working conditions and quality of life so that social responsibility and environmental benefits can accrue to the whole chain of production, including the primary producers. To date, the social benefits for fibre farmers of the Amazon have been meagre. Markets prices may have increased recently but farmer income is still very low, working conditions poor and quality of life low. If the new applications of natural fibre in manufacturing are to be sustainable, issues of social responsibility must be addressed in addition to the environmental concerns, because extreme poverty is still the typical situation for fibre producers throughout the world.

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Summary

This paper will examine the possible role for jute cropping in revitalising stagnated floodplain farming in the Brazilian Amazon. Jute cropping was once the most important farming activity in an extensive area along the Amazon River but disappeared in the second half of the 20th Century due to global competition with synthetic fibres, so depressing floodplain farming for decades. A natural fibre sheet factory was opened in Santarém in 2003 and jute cropping is making a comeback. This development might open the way for new rural agricultural and industrial work with the prospect of earning higher income and attaining a better standard of living.
For decades floodplain farmers have been poorly integrated in processes of regional development. Economic incentives to increase production have been limited to local initiatives undertaken by the farmers themselves, often times limited to supplying urban markets with vegetables in areas close to large cities, such as Manaus and Belém, and to a lesser extent to medium cities, such as Santarém. The vast majority of floodplain farmers do not have this opportunity due to problems with logistics and lack other high-value products appropriate to their environment which could be sold in regional urban markets or in national and international markets. The demand for all of the historic commercial crops of the floodplains declined rapidly after 1970 so that these areas experienced economic stagnation and farmers reverted to semi-subsistence and subsistence production. The most important negative impact was the long decline of natural fibre cropping of jute and mallow, culminating in the closing of the last processing factories in the end of the 1990s.
With the recent installation of a factory in Santarém in western Pará state for producing fibre sheets with industrial applications in the production of vehicles and mattresses in the national market, jute cropping has been reintroduced, together with another highly resistant native fibre, *curauá* (A*nanas sativus*). These fibres are mixed with polyester and recycled fibres brought in from the industrial Southeast in a proportion of 60% natural fibre and 40% synthetic fibre. The factory is a subsidiary of a firm from São Paulo, located in the Southeast, where 90% of the product is used by manufacturers and the remaining 10% is exported to Argentina. The factory is located 12 kilometres to the east of Santarém and draws and trains its workers from the local rural area, paying higher salaries than earned in the farm sector.

The main issues for the future perspectives of jute cropping in the Amazon is whether the industrial capacity will expand further and if other manufacturing concerns will be attracted to the region, generating increasing demand for jute so that the activity will spread further up river and return to previous levels of production or whether jute cropping will remain restricted to supplying only one factory in Santarém. Another important issue is whether the articulation of floodplain farmers to this new agro-industrial sector will result in significant income and superior quality of life and not reproduce the exploitive subordination of farmers common in the past.