An Economic Valuation of Managed Roundwood in the Region of Marajó, Brazilian Amazon, Estate of Pará

ANTÔNIO CORDEIRO DE SANTANA[1], MÁRIO MIGUEL AMIN[2], NILSON LUIZ COSTA[3], ÁDAMO LIMA DE SANTANA[4] and MARCOS ANTÔNIO SOUZA DOS SANTOS[5]
Environmental and Water Resources Institute
Federal Rural University of Amazon (UFRA)
Avenida Presidente Trancredo Neves Nº 2501, Montese, Belém/PA
BRAZIL
[1]acsantana@superig.com.br, [2]marioamin@gmail.com, [3]nilson.costa@ufsm.br, [4]adamo@ufpa.br
[5]marcos.marituba@gmail.com

Abstract: The aim of this study is to estimate the economic value and marketing margins of roundwood from managed areas. A positive economic value indicates economic viability of the activity. Besides generating a positive margin, in the case of this supply chain, the values are relatively higher than those generated by competing agricultural activities that are contributing to Amazonian deforestation. This result leads to the restructuring of the forest industry, by integrating the portfolios of decision makers and agencies. The results indicate that the average economic value of extraction and sale of standing timber, on the local market, is R$ 28.46/m3, which shows a minimum value of R$ 18.47/m3 for the species of the C4 category (white wood) and a maximum value of R$ 92.25/m3 for species of the C1 category (special wood). Thus, for a flow of 30 years and an extraction rate of 25 m3/ha, under the managed forest transition areas in the State of Pará, an average value of R$ 688.75/ha is expected. This result is relatively higher than the values obtained from extensive livestock farming (around R$ 180,00/ha) and grain crop cultivation (around R$ 420.00/ha), which are largely responsible for Amazonian deforestation. The results also show a higher profitability than for areas that have been reforested with paricá (Schizolobium amazonicum (Hber) Ducke), that generates a value of R$ 192.26/ha. The marketing margin shows that about 12.4% of the economic value generated from the timber's supply chain transition contracts is appropriated by society. Additionally, the mean rate of unfolding of 36.2% (2.76 m3 of logs for each 1.0 m3 of lumber) indicates poor technological advancements, which threatens enterprises' market competitiveness.

Key-Words: Price of roundwood, transition contracts, economic viability, Amazonian deforestation

1 Introduction

The forestry sector plays an important role in the State of Pará economic portfolio, responsible for the creation of employment and generation of income and foreign exchange earnings. In 2008, it contributed US$ 4.46 billion and generated 30,481 jobs, which represented 9.6% and 3.6% of the GDP and total employment, respectively. The domestic and international trade statistics showed a surplus of US$1.08 billion (Santana, 2012), that can significantly be attributed to illegal logging. With a more effective policy regulating forestry activity in the Brazilian Amazon, since 2004, deforestation and illegal logging have declined. The effects of the international economic crisis contributed towards a reduction of wood product market by 64.6%, between 2007 and 2009, in the Pará, thus, causing a significant economic impact on the regional timber industry and on the timber supply market.

To reduce the problem of supply, while contributing to the recovery of the timber industry, the Forestry Development Institute of Pará (IDEFLOR) implemented a policy for public forest management by means of transition contracts, which seeks to ensure that the extraction of timber products by the private sector is economically viable. (IDEFLOR, 2010).

To enable such contracts, the price of standing timber has been estimated to determine the amount that firms are required to pay for each contract, considering the maximum volume of timber for extraction that is allowed by their sustainable forest management plans.

The initial challenge has been to estimate the price of standing timber based on the market price of roundwood, the production cost and the profit margin. According to Santana (2012), Marajó's market for roundwood operates in perfect competition; and as such, the economic value of logging, determined from the equilibrium price in this market, reflects the opportunity cost of forest transition contracts.

Determining the economic value of managed forest and its comparison with alternative types of land use in the Amazon (e.g. extensive livestock farming and grain production) must provide results that support the hypothesis that sustainable extraction of forest is more profitable than the agricultural activities that require clear felling of the forest.

The economic viability of forest concessions can effectively contribute to combine a firm's objective for maximizing profit with the society's objective of making the minimal environmental impact for the land use in the State of Pará, more specifically in the region of Marajó, where the first transition contracts that are managed by IDEFLOR have been implemented.

The objective of this study is to use the results from previous researches by Santana et al. (2011a) and Santana (2012) to estimate the economic value of managed roundwood timber extraction in the transition contracts of Marajó, and to simultaneously determine the marketing margin of the supply chain, up to the lumber production.

2 Economic value of managed forest

The global forest industry is undergoing a restructuring process with different dynamics between producer and consumer countries of tropical timber, particularly in the Amazon, where all the efforts to control forest destruction converge. Therefore, the dimensions of economic and environmental sustainability are specifically included in transition contracts, also in response to greater market exposure and actions from specific interest groups. It must be pointed out, however, that the social benefits derived from collective participation and inclusion of traditionally local populations are in the initial stages.

This is explained by the fact that forest inventories do not identify the potential economic use of non-timber products; it also does not require for investors of transition areas to economically explore wood residues. At the same time, local populations surrounding public forests are not considered in the projects

The economic, environmental and social sustainability requirements are identified in the official documents of the Brazilian Institute of Environment and Natural Resources (IBAMA), Brazilian Forest Service (BFS) and IDEFLOR. Unfortunately, its effective implementation does not pay enough attention to the economic and environmental services of forests, neither incorporates local communities into the regional economic activities.

For the purpose of this study, the concept of economic value is associated to the wood industry value chain as outlined in Porter's (1999) theoretical approach. It is considered a set of competitive activities implemented by timber firms, which operate at the stages of forest harvesting (extraction and management) and roundwood processing (Santana, 2002; Santana et al., 2012; Santana, 2012). This stage is crucial for Para's timber industry to create and maintain its competitive advantage on the international market, as this initiative is being adopted by other countries producing tropical timber (ITTO, 2010, FAO 2010). Therefore, from a strategic policy perspective, the forest transition programs should serve as mechanisms for planning and developing the Amazon's timber industry.

Many firms that have survived the global economic crisis are incorporating technological innovations (Santana, 2012): (1) in the production of timber, through sustainable forest management and reforestation; (2) in the process of unfolding and processing of wood into lumber, veneer and plywood and in the furniture and artifacts industry, through incorporation of new designs; and (3) by using of waste such as briquettes, pellets, pieces of wood and differentiating final products. These actions have provided a comprehensive restructuring process in the Brazilian timber industry, particularly in the State of Pará, which is the largest producer and exporter of tropical timber from the Amazon and Brazil.

The estimated economic value, as discussed in Porter's value chain (1999), considers the results of various activities that differ in terms of technological, economic, environmental and social contributions developed along the firm's production and management processes. The cost to the firm at each stage of production and marketing is measured by the price that customers are willing to pay for the product; with the activity proving economically viable only when the value created by the firm is greater than the cost of developing the respective production activity.

The value chain has three components: (1) support activities; (2) primary activities; and (3) margins or economic value when result of the updated net flow is considered. The support activities include the implementation and management of the planned activities and the costs of extraction and infrastructure. Primary activities include operational logistics, marketing and sales, services for product certification and training for products manufactured for domestic and international markets. Finally, the margin component determines the difference between the unitary cost and the price customers pay for the product. This is transformed into net economic value when considering the flow of timber exploited in forest plantations.

Given the fact that the opportunity cost of wood is unknown, due to illegal logging, it has not been possible to determine the real market competitive position of firms, consequently, estimates as indicated by Santana et al. (2012) have overestimated the private benefits while underestimating the social benefits. In IDEFLOR's transition contracts, the price of standing timber is defined as the equilibrium price of roundwood on the local market, under the assumption that perfectly competitive markets exist (Santana et al., 2009; Santana et al., 2011b; Santana, 2012). Thus, by considering the extraction of managed timber, a determination of its economic value reveals not only the viability of the venture, but also serves as a basis to compare the value generated by the activities that are directly linked to deforestation in the Amazon.

The concept of economic valuation is applied only to the Marajó's supply chain of extracted timber. The marketing margins includes the links associated with the extraction and industrial processing of timber; a point at which the equivalent price of lumber species extracted are defined by firms with forest transition contracts in the Marajó's forests.

As the prices of standing timber reflect the opportunity cost of the managed forests activity, firms holding transition contracts may create some competitive advantage when compared to those without transition contracts and also to major competitors in the international tropical timber market. This perspective helps firms to expand the range of new tree species that may be introduced on the lumber market and at the same time may increase the supply for the products, since there is a large stock of natural resources in the areas considered under the state and federal concessions in the Amazon (Monteiro et al., 2011; Santana, 2012; Azevedo-Ramos et al., 2015).

3 Methodology

The research has been conducted with a focus on Marajó's timber pole, which has been recently approved by IDEFLOR; considered the leading region in implementing managed forest transition contracts. Questionnaires have been applied to 20 firms during the month of June 2011, as it is the period in which prices for logs and lumber are at their lower levels. Data on the prices of roundwood, production costs, management plans, and transportation costs of logs and the agents' profit margin have been collected.

The economic value is estimated for the forest species that are present in all the interviewed firms that have transition contracts. The data has been obtained from a pioneer study by Santana (2012), which estimates the price of standing timber in the Marajó's region and the southeastern region of Pará. Besides estimating prices and determining the economic value of forests in the transition contracts, the study also considers the interest groups that participate in the management of public forests in Pará. The formula used for calculating the economic value was (Pearce, 1990; Santana et al., 2012):

$$VE_t = \sum_{t=i}^{T} \left[\left(\frac{P_{it} - Cu_{it}}{(1+r)} \right) . Q_{it} \right] = (PLa_{it} . Q_{it}) \qquad (1)$$

Where EV_i is the economic value of forest specie *i*; PLa is the updated net price of forest specie *i* at time *t*, in R\$/m^3; P is the price of forest species in the *i* category, in the local market, in R\$/m^3 (Santana et al., 2011a); Cu is the unitary cost of production of forest specie *i*, in the local market, in R\$/m^3 (including management activities, extraction and transportation of roundwood); Q is the average volume of timber extracted by the interviewed firms, according to category and estimated at 25 m^3/h; r is the discount rate that represents the opportunity cost of forests managed for local markets (estimated at 8.5%); t is the time horizon (T=30 years) considered the market cycle for logging in forest concessions.

A positive value for EV indicates that the activity is economically viable; a value of zero indicates that the activity has no economic benefit and a negative value indicates that the activity is not viable.

To determine the marketing margin of the wood supply chain, it was necessary to calculate the equivalent price of roundwood, by multiplying the coefficient of unfolding by the price of lumber, as follows (Santana et al., 2012; Santana, 2012):

$$PEM_i = K_d PMS \tag{2}$$

Where:

PEMi is the equivalent price of wood for specie *i*;

PMSi is the price of lumber for specie *i*.

Using *PEMi* allowed to determine the marketing margin of roundwood, which indicates the proportion of the price paid for lumber that is appropriated by the marketing agents against that the established price for society, in this case represented by the government. The total marketing margin (TMM), as shown in Santana (2005), represents the remunerations from trading operations carried out through the product distribution channels (costs and profit margins). This is expressed mathematically as follows:

$$MCT_i = \left(\frac{PEM_i - PMP_i}{PEM_i}\right).100 \tag{3}$$

Where:

TMMi is the total marketing margin of wood for specie *i*;

PEMi is the equivalent price of wood for specie *i*;

PMPi is the price of standing timber.

The marketing margin can be divided into the middleman margin and the entrepreneurs margin. The marketing middleman margin is given by:

$$MCI_i = \left(\frac{PMT_i - PMP_i}{PEM_i}\right).100 \tag{4}$$

Similarly, the entrepreneurs margin is given by:

$$MCE_i = \left(\frac{PEM_i - PMT_i}{PEM_i}\right).100 \tag{5}$$

The social marketing margin (SM) represents the share of the price that is paid for lumber and that is appropriated by society. It is expressed by:

$$MCE_i = 100 - MC \tag{6}$$

4 Results and Discussion

Table 1 shows the results of the estimated quantities and the average economic values of forest species for categories C1 (two species), C2 (eight species), C3 (10 species) and C4 (14 species); including support activities, primary activities and the timber extraction margins from managed areas. The economic value (EV) is estimated per hectare and as m^3. The results for the forest species are presented in Table 1A (on Annex I), showing the economic viability of roundwood extraction in managed areas.

The results show a general average of 0.74 m^3/ha of extracted roundwood when all tree species are considered, thereby generating an average economic value of R$ 20.26 per hectare and R$ 27.55/m^3. When all the species are included in a model that considers an extraction rate of 25 m^3/ha, an economic period of 30 years for all managed areas of the transition contracts, and an economic value of R$ 688.75 per hectare, is obtained. This value is greater than that generated by economic activities that compete in the process of forests clearing, such as soybean (R$ 420.00 per hectare) and extensive livestock (R$180,00/ha) (Santana e Amin, 2002; Santana et al., 2009; Santana et al., 2012; Santana, 2012).

The results proved are very different from those presented by Karsenty et al. (2010), indicating that managed forests generate lower incomes than those that consider economic activities like agriculture, livestock and reforestation. In the Amazon, the value of the timber activity, under traditional systems of land use, is approximately zero.

Table 1. Quantity of extracted wood and economic values ooundwood in the transition contracts in Marajó, State of Pará, 2010.

Average value	Number of spicies	Quantity Q (m^3/ha)	EVa[1] (R$/ha)	EVb[2] (R$/m^3)
C1 Category	2	0.25	20.40	81.59
C2 Category	8	1.30	48.59	37.38
C3 Category	10	0.62	14.26	23.00
C4 Category	14	0.56	9.85	17.46
Average	**34**	**0.74**	**20.26**	**27,55**

[1] Economic Value EVa = value/ha; [2] Economic Value EVb = value/m^3.
Source: Field research.

Under the current systems of land use in the Amazon, the revenue from selling trees that have a greater commercial value to logging entrepreneurs was generally used to pay out for forest clearing, implementation of agricultural activities and grazing for livestock production (Santana, 2002). This practice confirms the results found by Santana (2008) and Santana (2012), which indicate that traditional agriculture and extensive livestock production in the Amazon have been implemented at the expense of natural resources and informal local labor exploitation.

Forest extraction regulated under the system of transition contracts may also present a higher profitability than reforestation. As example, a reforestation project with paricá, developed in the municipality of Paragominas, with a 28 years flow, productivity of 200 m^3/ha and a price of R$70.00 per m^3, generated an economic value of R$192.26 per hectare (VALE, 2010). Therefore, management of public forests by means of transition contracts represents an economically viable alternative that should be integrated into the production systems and plans, hence diversifying economic activities in the State of Pará.

Furhermore, results in Table 1 show that even where managed forests consists only of white wood (C4 category), the estimated total economic value would be R$436.50 per hectare, a value greater than that generated by the agriculture production alternatives. The reason for this greater profitability is due to low production costs, as the use of modern inputs during the logging period is very low.

Timber extraction in transition areas has become an important economical enterprise since all species listed in the four categories are found throughout the Amazon. This situation indicates an important opportunity for potential firms and development agencies to invest in this sector.

The C1 category, which includes the special cedar and ipe woods presents, as a result of the prevalent large demand, a higher average EV of production per m^3 (R$81.59), assuring a higher value for tropical timber markets. On the other hand, due to the scarcity of these species in managed forests areas (average production of 0.25 m^3/ha), as a result of the long periods of illegal logging, it presents an EV of R$20.40/ha.

In the C2 and C3 categories woods are grouped in terms of quality, in response to demands for rural and urban construction, and from the furniture and artifacts industries on domestic and international markets. The species in the C2 category shows the highest average production of 1.30 m^3/ha and an average economic value of R$ 48.59/ha.

The C4 category that group all species classified as white wood, has a lower commercial value, although widely used in the production of laminates, plywood and wooden artifacts. As a result of the global economic and financial crisis, laminate and plywood markets have been severely affected, thus providing a greater opportunity for the lumber industry to supply housing, furniture and artifacts industries. As a consequence, the C4 category represents the second largest average quantity produced in managed areas (0.56 m^3/ha), generating an average EV of R$ 9.85/ha per species. The average EV of R$ 17.46/ m^3 is higher than the price of R$ 10.00/ m^3 that is paid for special or noble wood, illegally harvested from unmanaged forests.

Moreover, this underestimated economic value also reflects a further limitation by restricting an equitable distribution of income across local communities, since the value of residues from the logging process has not been computed. The residues are generally used to produce additional products, such as firewood and charcoal, and non-timber products, which can be considered as profitable marketing options for traditional populations in the area and for local development.

5 Marketing Margins of Roundwood

Table 2 summarizes the results for the marketing margins and for the coefficient of unfolding wood, used to estimate the equivalent price of lumber. This coefficient is an important indicator of the technological level of the logging firms interviewed. The higher the Kd, greater the use of roundwood and, as a consequence, lower is the volume of waste produced. The results for the forest species considered are summarized in Table 1A.

Table 2. Marketing margins and coefficient of unfolding of roundwood in Marajó, State of Pará, 2010.

Mean Value	Kd	TMM	MMM	MME	SM
Category C1 average	39.7%	79.1%	45.9%	33.1%	20.9%
Category C2 average	35.2%	81.9%	45.7%	36.1%	18.1%
Category C3 average	38.4%	87.5%	43.9%	43.6%	12.5%
Category C4 average	36.4%	92.2%	47.1%	45.1%	7.8 %
Average	**36.9%**	**87.6%**	**45.7%**	**41.9%**	**12.4%**

Where: Kd is the coefficient of unfolding of roundwood), TMM is the total marketing margin, MMM is the marketing margin of middleman; MME is the marketing margin of the entrepreneur, and SM is the social margin.
Source: Compiled from field research.

The results confirm that the TMM has an inverse ratio with respect to the EV of woods presented in Table 1: higher TMM values are obtained for C4 species, reflecting lower economic values; and lower TMM values are obtained for C1 species, which have higher economic values. This can be explained, not only by the result of the processing costs, but also by the risks involved in shipments to new markets.

The marketing margin of middlemen (MMM), is attributed to those producers who sell logs on the local market and to those extractors who seek wood from local communities and from managed areas (known as "toreiros"), but that do not perform the unfolding of wood. In general, they take the higher share of marketing margins, since they bear the costs of wood extraction and transportation from the producing areas to the shipment ports. For these agents, species falling into categories C2 and C3 have lower marketing margins, while those in C1 and C4 have are more profitable. The species in the C1 categories are characterized by higher costs of extraction and transportation, high taxes and a relatively higher price for roundwood; on the other hand, species in the C4 category have costs and profit margins that are relatively higher due to the risk involved in the price formation of the roundwood market.

The entrepreneurs marketing margin (EMM) is less than the margin of the middlemen, since it only adds the wood transportation and deployment costs to the price of roundwood. In this case, the margin shows a positive ratio as to the TMM, with lower margin for woods in the C1 category and higher margin for woods in the C4 category. On the other hand, vertically integrated firms that perform all steps, from extraction to industrial processing, appropriate the entire marketing margin. Thus, timber firms seek to balance their profit by trading timber that have a higher diversity and abundance of species, and are of lower economic value. This result explains why entrepreneurs, who have transitional contracts, seek for a reduction in the price of wood that has a low commercial value.

The social margin (SM) or the margin appropriated by the rural producer goes in the opposite direction of the TMM, thus showing a greater participation in high quality timber ventures.

An average Kd value of 36.9% indicates that it takes 2.71 m^3 of timber to produce 1.0 m^3 of lumber. This is due to the low technological levels of firms, as well as to several defects including cracks and knots, which generally affect log quality.

A TMM of 87.6% indicates that for every R$1,000.00 customers spend to purchase lumber, R$876.00 are appropriated by marketing agents; the middleman and entrepreneurs get R$457.00 and R$419.00, respectively, while R$ 124.00 goes to producers. In other words, society appropriates 12.4% of the total value of timber produced under the transition contracts from forests in Marajó.

The field research revealed that a considerable number of forest species under the "white wood" categories are unknown in the wood market among firms in the areas of furniture and artifacts production, and of civil construction. These forest species are currently gaining important market share because of their durability and other physical attributes, like color. Thus, this new market scenario is giving firms an opportunity to improve their competitive advantage from new emerging international markets and, especially, from the dynamics of a new Brazilian environmental policy.

6 Conclusions

The exploitation of timber from public forests in the State of Pará, made possible by transition contracts managed by IDEFLOR, allows to value standing forests and transform the managed forest extraction into an economically viable alternative.

The average economic value of timber extracted from managed areas is R$ 27.55/ m^3, with a minimum value of R$ 17.46/ m^3 for the species in the C4 category and a maximum value of R$ 81.59/m^3 for the species in the C1 category. Thus, for a timber extraction rate of 25 m^3/ha in areas under managed forest transition contracts, with an economic flow of 30 years, an economic value of R$688.74 per hectare or R$22.96/ ha/year can be generated. This result is higher than what could be obtained from extensive livestock farming, which yields approximately R$ 180.00 per hectare or R$6.00 per ha/year. The same holds for grain crop production, yielding approximately R$420.00/ha or R$14.00/ha/year. In addition to their low income, these two alternatives types of land use are highly responsible for deforestation in the Amazon.

It can be concluded, therefore, that timber extracted from managed forest transition areas, unlike what was expected, shows a higher economic value than traditional crop production and extensive livestock farming, demonstrating the economic viability of the managed public forests in the Amazon.

Timber producers, along with local community, control 12.4% of the economic value of the timber business, while logging companies own the remaining 87.6%. In the case of areas under transition contracts, society appropriates 12.4% of the timber business. Thus, for every R$ 1,000.00 spent on the purchase of lumber, R$ 124.00 is transmitted to society through government taxes, while R$ 876.00 goes to middlemen and forestry entrepreneurs.

References:

[1] COPELAND, T.; KOLLER, T.; MURRIN, J. *Avaliação de empresas - valuation: calculando e gerenciando o valor das empresas*, Makron Books, 2002.

[2] FAO. Food and Agriculture Organization of the United Nations. *Evaluación de los recursos forestales mundiales, 2010*. http://www.fao.org/forestry/fra2020.

[3] IDEFLOR. Instituto de Desenvolvimento Florestal do Estado do Pará. *Orientação de Pagamento – Contratos de Transição*, 2010. www.ideflor.pa.gov.br.

[4] ITTO. International Tropical Timber Organization. *Annual review and assessment of the world timber situation*, 2008. http://www.itto.org.jp/.

[5] KARSENTY, A.; DRIGO, I.G.; PIKETTY, M. G.; SINGER, B. Regulating industrial forest concessions in Central Africa and South America. *Forest ecology and Management*, v. 256, p.1498-1508, 2008. www.elsevier.com/locale/foreco.

[6] MONTEIRO, L. C., SANTANA, A. C., ROCHA, G. M., MITSCHEIN, T. A., MENDES, F. A. T. Análise crítica e proposições para a gestão sustentável dos contratos de concessão de florestas públicas no Pará. *Amazônia: Tecnologia & Desenvolvimento*, v.7, p.129 - 145, 2011.

[7] PEARCE, D. W. Environmental sustainability and cost benefit analysis. *Environment and planning*, v.22, n.1, p.97-112, 1990.

[8] PORTER, M. E. *Vantagem competitiva.*, Campus, 1999.

[9] PORTER, M. E.; MILLAR, V. E. Como a informação proporciona vantagem competitiva. In: PORTER, M. E. *Competição (on competition): estratégias competitivas essenciais*, Campus, 1999. p.83-106.

[10] SANTANA, A. C. *A competitividade sistêmica das empresas de madeira da Região Norte*, FCAP, 2002.

[11] SANTANA, A. C. de; AMIN, M. M. *Cadeias produtivas e oportunidades de negócio na Amazônia*, Unama, 2002.

[12] SANTANA, A. C. Cadeias produtivas setoriais e o curso do desenvolvimento local na Amazônia In: ALBUQUERQUE, A. C. S.; SILVA, A. G. (Ed.) *Agricultura Tropical: quatro décadas de inovações tecnológicas, institucionais e políticas*. Embrapa, 2008, v.2, p. 275-291.

[13] SANTANA, A. C.; SILVA, I. M.; SILVA, R.C.; OLIVEIRA, C. M.; BARRETO, A. G. T. A sustentabilidade do desempenho competitivo das madeireiras da região Mamuru-Arapiuns, estado do Pará. *Teoria e Evidencia Econômica*, v.15, p.9 - 36, 2009.

[14] SANTANA, A. C.; SILVA, I. M.; SILVA, R.C.; OLIVEIRA, C. M.; BARRETO, A. G. T. A sustentabilidade do desempenho competitivo das madeireiras da região Mamuru-Arapiuns, estado do Pará. **Teoria e Evidencia Econômica**, v.15, p.9 - 36, 2009.

[15] SANTANA, AC; SANTANA, A. L.; SANTOS, M. A. S. Influência do desmatamento no mercado de madeira em tora da região Mamuru-Arapiuns, Sudoeste do Pará. *Revista de Ciências Agrárias*, v.54, n.1, p.44-53, 2011.

[16] SANTANA, A. C.; SANTANA, A. L.; SANTOS, M. A. S.; YARED, J. A. G. Determinação dos preços da madeira em pé para as áreas de florestas públicas da região do Baixo Amazonas, no estado do Pará. *Revista de Estudos Sociais*, v.13, p.40 - 51, 2011b.

[17] SANTANA, A. C.; SANTOS, M. A. S.; SALOMÃO, R. P.; OLIVEIRA, C. M. Estimação dos preços da madeira em pé para as áreas de florestas públicas da região do Marajó, no estado do Pará. *Amazônia: tecnologia & desenvolvimento*, v.6, p.7 - 19, 2011a.

[18] SANTANA, A. C.; SANTOS, M. A. S.; SANTANA, A. L.; YARED, J. A. G. O valor econômico da extração manejada de madeira no Baixo Amazonas, estado do Pará. *Revista Árvore*, v.36, n.3, p.527-536, 2012.

[19] AZEVEDO-RAMOS, C.; SILVA, J. N. M.; MERRY, F. The extinction of deforestation in the Brazilian Amazon: Is it possible? *Elementa: Science of the Anthropocene*, v.3, n.48, p.1-8, 2015.

[20] UNITED NATIONS. *Integrated environmenal and economic accounting: an operational manual*. New York: UN, 2000. (Series F, 78)

[21] VALE, F. A. F. *Sustentabilidade de sistemas de produção florestal no estado do Pará.* Dissertação (Mestrado em Ciências Florestais) – Universidade Federal Rural da Amazônia, Belém, 2010.

ANNEX I

Table 1A. Net updated prices (PLa), Quantity (Q), economic value (EV), prices of standing timber (PMP), roundwood (PMT), lumber (PMS) and marketing margins, in Marajó, State of Pará , 2010.

Local Name	Scientific Name	PLa	QP	VE	PMP	PMT	PMS	Kd	TMM	MMM	MME
Ipê	*Tabebuia serratifolia (Vahl) Nichols.*	71,90	0,35	25,17	85,60	262,70	1.050,00	38,7%	78,9%	43,6%	35,3%
Cedro	*Cedrela odorata L.*	91,28	0,15	13,69	86,54	287,68	1.025,00	40,7%	79,2%	48,3%	31,0%
Average C1 Category		**81,59**	**0,25**	**20,40**	**86,07**	**275,19**	**1.037,50**	**39,7%**	**79,1%**	**45,9%**	**33,1%**
Jatobá	*Hymenaea courbaril*	41,00	1,40	57,40	57,00	180,00	793,75	30,3%	76,3%	51,2%	25,0%
Cumaru	*Dipteryx odorata (Aubl.) Willd.*	31,00	0,50	15,50	51,00	168,00	815,00	33,9%	81,5%	42,4%	39,1%
Freijó	*Cordia goeldiana Huber*	34,00	0,10	3,40	51,00	173,00	850,00	33,7%	82,2%	42,6%	39,5%
Angelim	*Dinizia excelsa Ducke*	32,00	2,50	80,00	51,00	170,00	725,50	44,0%	84,0%	37,3%	46,7%
Maçaranduba	*Manilkara huberi (Ducke) Chevalier*	33,00	3,30	108,90	47,00	170,00	792,86	30,1%	80,3%	51,5%	28,9%
Sucupira	*Bowdichia nitida Spruce*	42,50	0,20	8,50	46,00	165,50	857,14	35,1%	84,7%	39,7%	45,0%
Muiracatiara	*Astronium ulei Mattick*	33,00	0,90	29,70	45,00	162,00	785,71	38,4%	85,1%	38,8%	46,3%
Louro	*Ocotea spixiana (Nees) Mez.*	52,50	1,50	78,75	41,50	176,00	597,14	36,2%	80,8%	62,3%	18,5%
Average C2 Category		**37,38**	**1,30**	**48,59**	**48,69**	**170,56**	**777,14**	**35,2%**	**81,9%**	**45,7%**	**36,1%**
Goiabão	*Pouteria pachycarpa Pires*	28,00	0,25	7,00	36,00	149,00	555,00	37,0%	82,5%	55,0%	27,4%
Itaúba	*Mezilaurus itauba (Meisn.) Taub. ex Mez*	30,00	0,70	21,00	35,00	147,00	725,00	47,0%	89,7%	32,9%	56,9%
Andiroba	*Carapa guianensis Aubl.*	16,50	0,70	11,55	33,50	130,00	662,00	38,6%	86,9%	37,8%	49,1%
Pau Roxo	*Peltogyne paradoxa Ducke*	26,00	0,20	5,20	32,00	140,00	705,00	34,2%	86,7%	44,8%	41,9%
Amarelão	*Apuleia leiocarpa (Vogel) J.F.Macbr.*	12,00	0,60	7,20	31,00	125,00	600,00	34,0%	84,8%	46,1%	38,7%
Quaruba	*Vochysia paraensis Ducke*	29,50	0,80	23,60	30,50	140,00	501,67	46,3%	86,9%	47,2%	39,7%
Cedrorana	*Vochysia maxima Ducke*	24,00	0,25	6,00	27,50	130,00	556,25	39,9%	87,6%	46,2%	41,4%
Pau Amarelo	*Euxylophora paraensis*	26,00	1,75	45,50	27,00	135,00	707,50	34,0%	88,8%	44,9%	43,9%
Tatajuba	*Bagassa guianensis Aubl.*	16,00	0,50	8,00	24,00	123,00	721,67	35,8%	90,7%	38,3%	52,4%
Jarana	*Lecythis lurida (Miers) S.A.Mori*	22,00	0,45	9,90	22,00	130,00	640,00	37,0%	90,7%	45,6%	45,1%
Average C3 Category		**23,00**	**0,62**	**14,26**	**29,85**	**134,90**	**637,41**	**38,4%**	**87,5%**	**43,9%**	**43,6%**
Cupiúba	*Goupia glabra Aubl.*	22,50	1,05	23,63	18,00	115,00	622,00	40,3%	92,8%	38,7%	54,1%
Curupixá	*Micropholis nelioniana*	16,00	0,10	1,60	18,00	115,00	733,50	33,0%	92,6%	40,1%	52,5%
Copaíba	*Copaifera guianensis Desf.*	16,50	0,10	1,65	17,50	115,00	500,00	34,0%	89,7%	57,4%	32,4%
Tauarí	*Couratari guianensis Aubl.*	23,50	1,10	25,85	16,50	115,00	587,50	39,5%	92,9%	42,4%	50,4%
Tanimbuca	*Terminalia amazonica*	15,00	0,50	7,50	16,00	110,00	607,50	39,3%	93,3%	39,4%	53,9%
Taxi	*Triplaris surinamensis Cham.*	9,00	0,50	4,50	16,00	105,00	575,00	37,0%	92,5%	41,8%	50,6%
Melancieira	*Alexa grandiflora Ducke*	18,00	0,10	1,80	16,00	114,00	540,00	33,0%	91,0%	55,0%	36,0%
Timborana	*Piptadenia suaveolens Miq.*	19,50	0,90	17,55	15,50	110,00	506,00	44,8%	93,2%	41,7%	51,5%
Marupá	*Simarouba amara Aubl.*	18,50	0,45	8,33	15,50	114,00	593,50	32,8%	92,0%	50,6%	41,4%
Garapeira	*Apuleia leiocarpa (Vogel) J.F.Macbr.*	5,00	0,45	2,25	15,00	100,00	700,00	32,3%	93,4%	37,6%	55,8%
Faveira	*Piptadenia suaveolens Miq.*	13,00	1,10	14,30	15,00	110,00	433,50	29,5%	88,3%	74,3%	14,0%
Piquiá	*Caryocar microcarpum Ducke*	33,00	0,70	23,10	15,00	128,00	593,00	38,8%	93,5%	49,1%	44,4%
Mandioqueira	*Qualea lancifolia Ducke*	17,00	0,35	5,95	15,00	114,00	533,50	41,6%	93,2%	44,6%	48,6%
Ucuúba	*Virola melinonii (R.Benoist) A.C.Sm.*	18,00	0,50	9,00	15,00	105,00	575,00	34,0%	92,3%	46,0%	46,3%
Average C4 Category		**17,46**	***0,56***	**9,85**	***16,00***	***112,14***	***578,57***	***36,4%***	***92,2%***	***47,1%***	***45,1%***
Average		**27,55**	**0,74**	**20,26**	**31,89**	**142,17**	**669,59**	**36,9%**	**87,6%**	**45,7%**	**41,9%**

Source: Compiled from the research.