Chapter 4

Sustainable forest management

Yeda Maria Malheiros de Oliveira
Patrícia Póvoa de Mattos
Vera Maria Gouveia
Luiz Fernando Duarte de Moraes
Michelliny Pinheiro de Matos Bentes

Introduction

Target 15.2 of Sustainable Development Goal 15 (SDG 15) — by 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally (United Nations, 2018) — describes great global problems, challenges, and strategies for mitigating and reducing the impacts of unsuitable use of natural resources. Since the end of the 1970s, Embrapa has been seeking for solutions for these demands and contributing to create systems to monitor the conversion of forest lands into other uses.

Sustainable forest management

In Brazil, the word "management" usually refers to activities related to the planning and administration of activities and spaces. The United Nations describes sustainable forest management (SFM) as: "[a] dynamic and evolving concept [that] aims at maintain and enhance the economic, social, and environmental values of all types of forests, for the benefit of current and future generations." The concept emphasizes adaptations of SFM in the long run, keeping its primary function of, at least, maintaining all forest values perpetually and their multidimensions, incorporating the economic, social, cultural, and environmental principles of sustainability. Thus, people are also at the center of SFM.

Embrapa research studies on forest management have focused on natural forests and planted forests. In the case of natural environments, approaches vary depending on each biome, type of owner and property size.

Embrapa experience on sustainable forest management of small properties or community management in the Amazon biome, disclosed in reports such as Araújo and Guarino (2015), and Araújo et al. (2017), ranges from search for information on

the presence of species and their composition in the forest to discussions on the productive and sustainable maintenance of the environmental wealth in terms of timber and non-timber products, including those with medicinal and cosmetic properties. As an example, the 1995 experience called Pedro Peixoto Agricultural Colonization Project (d'Oliveira et al., 2007) can be mentioned.

Research on SFM for timber production and forest byproducts has been ongoing mainly in the Amazon and *Caatinga* biomes since the end of the 1970s (Figure 1). Embrapa teams have always had an important role in SFM research and have developed systems focusing on good practices and low impact exploitation. Recommendations range from minimum stock (for species) and cutting cycles to average intensity of exploitation (in volume). The understanding of some businessmen involved in exploitation processes has changed, and currently, some companies are following the system that Embrapa developed. Besides allowing it to be an economically viable activity, planned management adds value to timber. One of the partner companies of the project has already been awarded the certification seal for the third consecutive time, which facilitates its exports to countries in Europe and North America (Silva et al., 1996; Ruschel, 2008; Souza et al., 2017).

Areas located within the Atlantic Forest biome, as defined in Law 11,428/2006 (Brasil, 2006) and other related legal decisions, cannot be managed. Even so, Embrapa research efforts are ongoing for the development of models for the sustainable use of Brazilian pine forests (Mixed Ombrophilous Forest) with species such as yerba mate (*Ilex paraguariensis*), *bracatinga* tree (*Mimosa scabrella*), and Brazilian pine (*Araucaria angustifolia*) (Lacerda et al., 2012; Radomski et al., 2014). Experiments for conservation and sustainable use leading to financial return to land owners occupy approximately 40 ha. Other Embrapa studies are contributing to landscape management and land-use planning and to sustainable integration of agricultural areas with areas for preservation, use and forest conservation. Table 1 shows a quantitative overview of the published bibliography.

As an example of multi-institutional work, Rede Kamukaia started researching in the Amazon region (more precisely in the state of Acre) in 2005, focusing on the creation of basic knowledge on ecology and management of non-timber forest species and the information exchange among (governmental and non-governmental) research institutions acting in the Amazon (Wadt et al., 2017). A fundamental support for monitoring SFM activities are permanent plots, which are periodically observed by researchers organized in a network, mainly in Amazon and *Caatinga* (Coelho et al, 2017).

Photo: Rejane Stumpf Sberze

Figure 1. Sustainable forest management in the Amazon.

Table 1. Contribution of Embrapa for the technological evolution of landscape and timber and non-timber product management in different biomes and scales from 2008 to 2017.

Scope	Management				
	Landscape	Timber	Non-Timber	Timber and non-timber	Total
Amazon Biome	73	24	78	15	190
Cerrado Biome	54	1	10	2	67
Atlantic Forest Biome	53	3	18	5	79
Caatinga Biome	70	1	19	5	95
Pampa Biome	12	0	1	0	13
Pantanal Biome	10	0	1	0	11
Regional Scope	99	0	11	2	112
National Scope	215	6	11	8	240
Total	**586**	**35**	**149**	**37**	**807**

In *Caatinga*, firewood and charcoal represent between 30% and 50% of available energy. After having recognized these natural resources intensive and uncontrolled use, public authorities created laws to regulate timber exploitation in the biome area. Even though some technical questions are still pending, Embrapa and several other partner research institutions established the Rede de Manejo Florestal da *Caatinga* (RMFC), embracing a set of permanent plots, which are coordinated and managed by researchers in charge. Embrapa is also involved in identifying priority actions for conservation, sustainable use, and sharing of benefits from *Caatinga* (Drumond et al., 2000; 2004; Kiill et al., 2007; Alvarez; Kiill, 2014).

Halting illegal deforestation

The concept of deforestation shall be considered based on legal versus illegal deforestation. Thus, for example, in the Amazon biome, each property (individual or limited company ownership) can convert 20% of its area into other uses, and should maintain 80% of its native vegetation coverage. In other regions, removal of native vegetation is authorized at different rates. Therefore, not all natural vegetation removal is illegal deforestation; such removal shall be provided by law and depends on approval of the local environmental authority.

When it comes to deforestation, the global focus is on tropical countries, especially Brazil, for it holds a great part of the Amazon Rainforest. According to the National

Institute for Space Research (Inpe), from 2004 to 2014, when the Plano de Ação para Prevenção e Controle do Desmatamento na Amazônia Legal (Action Plan for Deforestation Prevention and Control on Legal Amazon – PPCDAm) was launched, there was an 80% reduction in the annual deforestation rate in the Amazon and, consequently, a reduction in greenhouse gas emissions due to deforestation. Even though the reduction trend had not been sustained in 2015, the decreasing deforestation rate resumed in 2016. Thus, as compared to 2004 rates, illegal deforestation decreased by 76%.

Over the last 10 years (2008 to 2017), Embrapa research teams have been dealing with the "deforestation" topic of SDG 15 under different aspects. As assessed by the authors of this chapter, some results are directly related to measuring deforestation, while others address ways to halt deforestation. Besides, it can be observed that, over that period, regional or even local approaches prevailed mainly focusing on the mapping and use of geotechnologies. Studies addressing forest fires were also included in the assessment.

As regards to the six Brazilian biomes, the assessment revealed that Amazon and *Cerrado* biomes were frequently studied during the period. By joining efforts with partners involving geotechnologies, Embrapa has contributed to monitoring the vegetation in large areas. However, there are concerns regarding the follow up of the substitution of land coverage for agricultural and forest uses in both *Caatinga* and *Pantanal*. The Atlantic Forest has been addressed in reports with a strong trend for regional results, in view of the characteristics of its geographic and latitudinal distribution. In 2006, a governmental initiative took place for the mapping of the remaining native forests all over the country, with the launching of *Mapas de Cobertura Vegetal dos Biomas Brasileiros* (*Maps of Vegetation Cover of Brazilian Biomes – Probio*) by the Ministry of Environment (MMA) (Brasil, 2018). Embrapa took part by joining efforts of consortiums between institutions for each biome.

Figure 2 shows that reports of Embrapa researchers constantly address the "deforestation" theme, particularly focusing on the Amazon biome. There are fewer reports on the biome as a whole than reports on local or regional contexts since several studies are concentrated in regions, such as specific river basins or biomes.

Regarding the theme "monitoring changes in land use/land cover", different strategies have been used to develop technologies mainly in the Amazon (for which there are regional studies and solutions) and *Pantanal* biomes. In monitoring

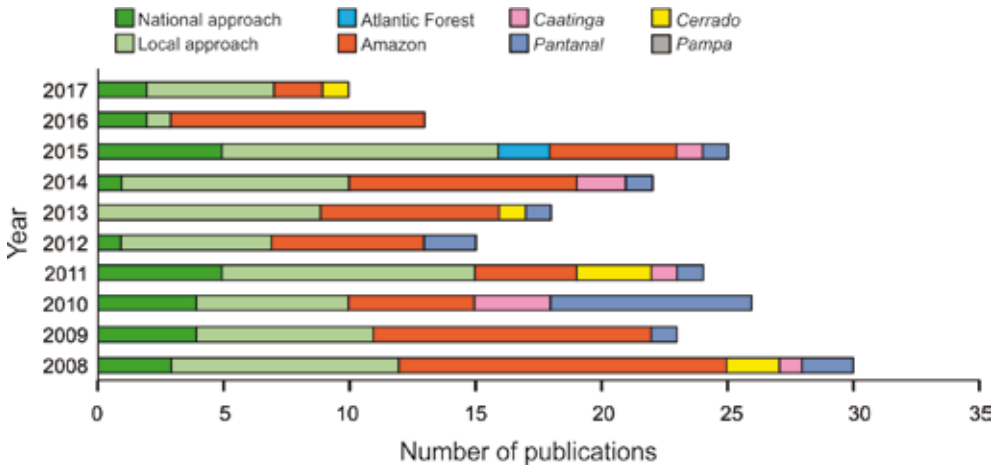


Figure 2. Number of technical-scientific reports by Embrapa researchers, from 2008 to 2017, approaching "deforestation" as a theme.

studies, identifying changes in land use or cover serves as a basis for other works that evaluate consequences of these changes over time by following up climatic and environmental parameters, which include soil and water characteristics, as well as pressures on the natural vegetation in each place under study. TerraClass project, which, since 2008, monitors land use and cover in deforested areas in Legal Amazon (and has been extended to the *Cerrado* biome), is an example of that. In 2014, Embrapa selected it as an outstanding outcome, which strengthened its partnership with Inpe in searching for solutions for this national challenge (Figure 3). Developing the Sistema Interativo de Análise Geoespacial da Amazônia Legal (Geospace Analysis Interactive System for Legal Amazon – SIAGEO Amazônia), which systematically collects information on the regional ecologic-economic zones (EEZ), with partner institutions was also an important decision.

A nationwide joint initiative between the Serviço Florestal Brasileiro (Brazilian Forestry Service – SFB) and Embrapa has been the methodology development for the Landscape Sample Units (LSU), a component of the Inventário Florestal Nacional (National Forestry Inventory – IFN-BR), also under SFB's coordination. LSUs (each one covering an area of 10 km^2) are distributed every 40 km in the same grid of field data. As the methodology predicts a time analysis of the involved areas, these changes may be monitored and followed-up in regions where deforestation is more intense and where vegetation fragmentation is greater all over the country (Archard et al., 2017).

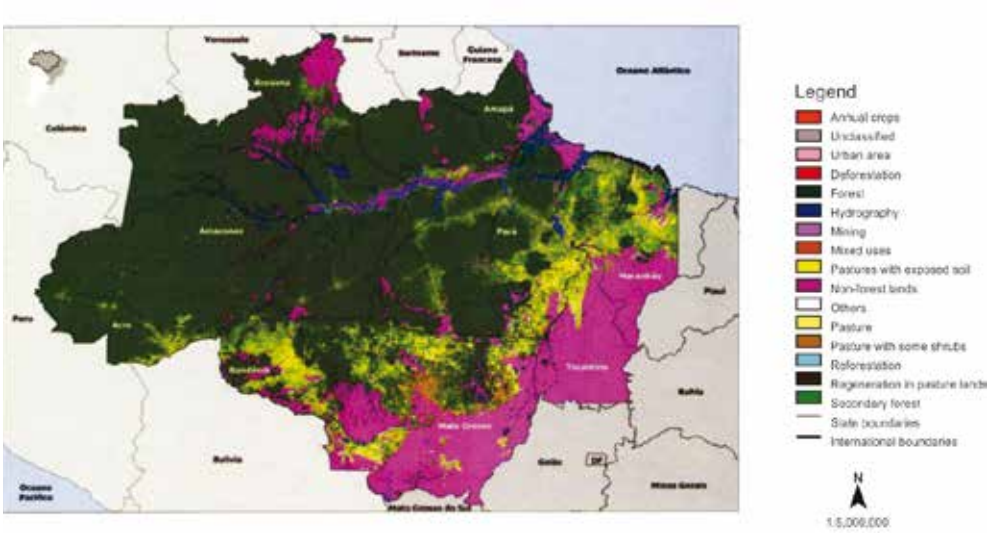


Figure 3. Mosaic of images of TerraClass project, developed in partnership between the National Institute for Space Research (Inpe) and the Brazilian Agricultural Research Corporation (Embrapa).

Source: TerraClass... (2016).

Regarding research and development projects, it is important to stress the partnership with national institutions, such as the Operação Arco Verde, which involves the Office of the President's Chief of Staff and Brazilian ministries. Partnerships with international institutions include, for example, the Programa de Grande Escala da Biosfera-Atmosfera na Amazônia (Program of Large Scale of Biosphere-Atmosphere in Amazon – LBA) and the Great Green Wall, an African initiative. Most actions take place in the Amazon biome, although local and regional initiatives are also being implemented in other biomes based on particular case studies.

Degraded forest restoration

Degraded forest restoration has been addressed in Embrapa using different words, but the use of the word "restoration" and its related concepts has recently increased. In one of the ongoing projects, an analysis is being performed to promote an internal debate to design a conceptual framework for forestry restoration in Embrapa.

Embrapa Board of Directors included the New Forest Code (Brasil, 2012) among its priorities. Embrapa special project called Soluções Tecnológicas para a

Adequação da Paisagem Rural ao Código Florestal Brasileiro (Technological Solutions for the Adequacy of Rural Landscape to the Brazilian Forest Code) organized the technologies created by the Company to protect and restore Brazil's native vegetation. Several national partner institutions, among them universities, research institutes and MMA, joined this initiative. The guidelines for Permanent Preservation Areas (PPAs), Legal Reserve Areas (LRAs), and Restrict Use Areas (RUAs) for different biomes and vegetation in Brazil are available and with free access at Código Florestal: Contribuições para Adequação Ambiental da Paisagem Rural (Forest Code: Contributions for Environmental Adequacy of Rural Landscape).

With the purpose of contributing to discussions on the improvement of the Brazilian environmental law, the Projeto Biomas (Biome Project) was performed in partnership between the Brazilian Confederation of Agriculture and Livestock (CNA) and Embrapa over the six Brazilian biomes. The mission of this institutional initiative is to present farmers with models for tree use leading to economic and environmental gains. It was based on research on sustainable use of forest species in PPAs, LRAs, and in production system areas. The constitution of a national research network for standardizing the entire process and offering interdisciplinary and multi-institutional training was one of the project's distinguishing features. Also joining the project are the National Rural Learning Service (Senar), Brazilian Micro and Small Business Support Service (Sebrae), Brazilian Development Bank (BNDES), and private partners and sponsors.

Afforestation and reforestation

The target 15.2 of SDG 15 confirms that expanding afforested and reforested areas is one of the recommended solutions to consolidate sustainable management.

The word "afforestation" refers to the establishment of a forest by planting or deliberately seeding land that, until that moment, was not classified as a forest; this implies a change in land use (Global..., 2015). In turn, the word "reforestation" refers to forest restoration by planting or deliberately seeding land classified as forest, and it does not imply changing in land use. Afforestation or reforestation may have both commercial and conservation purposes, but afforestation does not always represent the most suitable option for conservation, such as in the case of restoration of springs in ecosystems in which the predominant native vegetation is herbaceous.

Brazil's suitability for forests is revealed by factors such as great areas not used for agricultural purposes, suitable climate, and successful research programs, which allowed a minimum 7-times expansion in the area with forest plantations for commercial purpose over approximately 40 years. In 2017, the Brazilian Tree Industry (Ibá) reported a 7.8-million-hectare area planted by associated companies. If these figures were added to forested areas ran by small and medium farmers (either into the forestry business or not), it could achieve up to 10 million hectares. After negotiations during the *21st Conference of the Parties (COP 21)* of the *United Nations Climate Change Conference* in Paris, a new agreement was reached to strengthen the global response to the threat of climate change. Among other commitments, Brazil is to recover and reforest 12 million hectares of multiple purpose forests by 2030 by means of so-called nationally determined contributions (NDC).

One must recognize that, since the creation of the Programa Nacional de Pesquisa Florestal (National Program on Forestry Research) in 1978, Embrapa not only has sought for solutions to increase forest production and productivity in commercial areas with non-native species, but also has encouraged the use of native species from different biomes as an alternative. This is the case of the Brazilian pine (*Araucaria angustifolia*), yerba mate (*Ilex paraguariensis*), and *bracatinga* tree (*Mimosa scabrella*) in Southern Brazil, and *parica* tree (*Schizolobium parahyba* var *amazonicum*) in Northern Brazil.

Embrapa research efforts for afforestation and reforestation since that time were focused on the reality of each region of Brazil. In the Amazon, research teams conducted projects for sustainable forest management, as reported in the Sustainable Forest Management section. In turn, in Southern Brazil, initially, contributions were more focused on more productive species and progeny selection (aiming at commercial use) and on silviculture of regional native species (d'Oliveira; Braz, 2006). In *Caatinga*, efforts were towards both the management of natural environments and the crops, particularly agroforestry systems. Over time, concerns about adaptation of genetic material to be used in the states of Mato Grosso, Mato Grosso do Sul, and Goiás grew, in addition to the traditional crops in Minas Gerais.

Embrapa publications on the theme, emphasizing the Amazon and the Atlantic Forest, stand out. More recently, *Cerrado* became a theme of more interest. Substantial efforts were made in the beginning of the analyzed period (between 2008 and 2009), and resumed in 2014, but an emphasis on nationwide themes as of 2014 is noted (Figure 4).

It is worth highlighting the book *Plantações florestais: geração de benefícios com baixo impacto ambiental* (*Forestry plantations: reaping environmental low-impact*

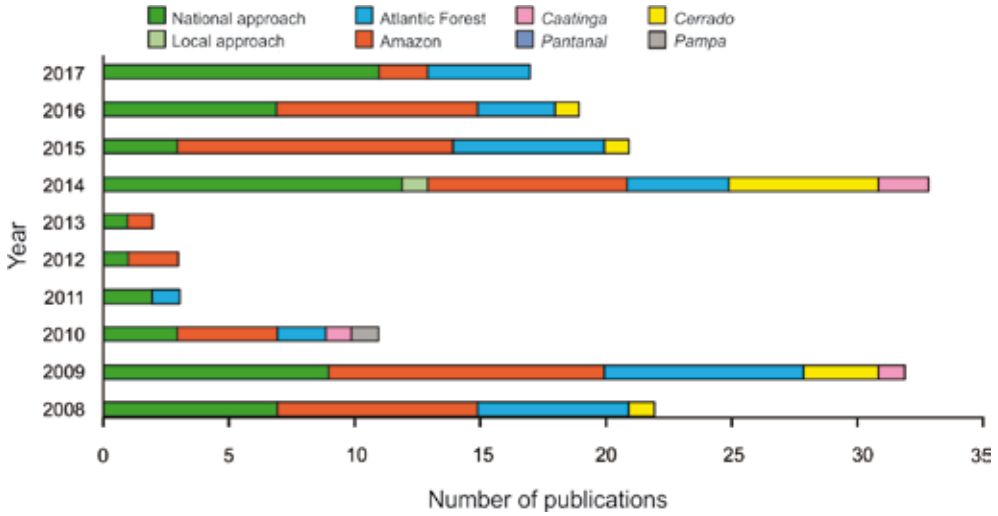
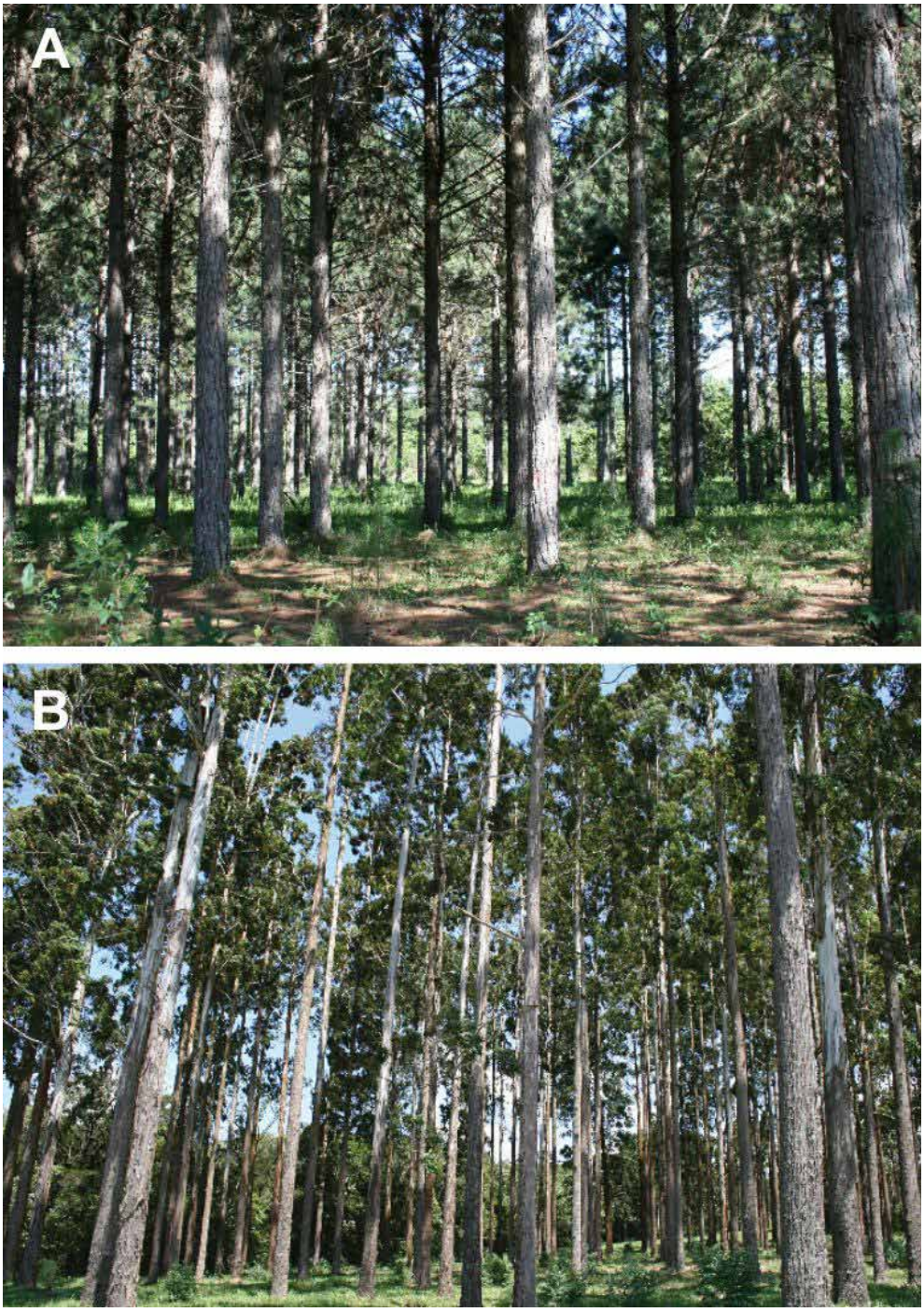


Figure 4. Number of technical-scientific reports by Embrapa researchers, from 2008 to 2017, approaching "afforestation" and "deforestation" as themes.

benefits) published in 2017 (Oliveira; Oliveira, 2017), which presents research results on the relations between planted forests and soil, water, and biodiversity, and demonstrates the importance and challenges of the coexistence among production forests, conservation and other production environments, even in landscape scale (Figure 5).

In terms of afforestation and reforestation, Embrapa regarded the following as its annual outstanding initiatives: in 2008, the first commercial crop of açaí in the world, named 'BRS Pará', to ensure the increase of açaí agribusiness (*Euterpe* sp.) on a solid basis. In 2009, BRS Manicoré cultivar, which ensures a sustainable dendê (*Elaeis* sp.) production in the Amazon and in the American continent. In 2010, Sistema Agroflorestal Cambona 4 (Cambona Agroforestry System 4), which suggests yerba mate intercropped with native trees for natural habitat restoration. Some years later, in 2015, Sistema de Produção de Pupunha para Palmito (Pupunha Palm Tree System for Heart-of-Palm Production), which leads to a 5-time increase on farmers' income per palm tree. Also in 2015, the chip for genotyping *Eucalyptus* sp. named EucHIP60k was launched globally. Its main advantage is reducing the time for genetic breeding of such plant (which is around 9 to 18 years) to 6 to 9 years. Finally, in 2016, Projeto Estradas com Araucária (Roads with Brazilian Pine Project), which



Photos: Luciane Jacques

Figure 5. *Pinus* sp. (A) and *Eucalyptus* sp. (B) plantations.

aims at stimulating family farmers in the states of Paraná and Santa Catarina, with the support of public and private institutions of the region, to plant Brazilian pine seedlings in the borders of their properties with roads.

Final considerations

There are several governmental programs focused on biodiversity. However, there is a lack of consolidated information on all Brazilian biomes related to productivity, occurrence, and management recommendation for the main commercially-used species. In addition, there is a lack of information on the use of several other flora and fauna species and environmental services (such as pollination, which is fundamental to the sustainability of agricultural crops) based on multiple uses of forests. Research results on forest products are fundamental to governmental policies, such as the definition of technical guidelines for management, processing, and commercialization aiming at promoting viable products from the socio-biodiversity, thus strengthening the market and promoting forest management as part of primary production in Brazil.

It is important to emphasize that many themes take medium-to-long-term research, which take more time between its conclusion and its validation before they are made available in the future as technologies and processes to farmers and technicians. These technologies are important contributions to the Brazilian rural sector to evolve and implement a sustainable management in each farm.

References

ALVAREZ, I. A.; KIILL, L. H. P. Arborização, floricultura e paisagismo com plantas da Caatinga. **Informativo ABRATES**, v. 24, n. 3, p. 63-67, dez. 2014. Available at: <https://ainfo.cnptia. embrapa.br/digital/bitstream/item/114240/1/4297.pdf>. Accessed on: Jan. 4, 2018.

ARAUJO, H. J. B. de; D'OLIVEIRA, M. V. N.; MIRANDA, E. M. de (Ed.). **Manejo florestal madeireiro para pequenas áreas**. Rio Branco: Embrapa Acre, 2017. 16 p. (Sistemas de produção, 8). Available at: <http://ainfo.cnptia. embrapa.br/digital/bitstream/item/164522/1/26383.pdf>. Accessed on: Jan. 4, 2018.

ARAÚJO, H. J. B. de; GUARINO, E. de S. G. Mortalidade e mudanças na composição de área sob manejo florestal comunitário. In: SANTOS, R. C. dos; SIVIERO, A. (Org.). **Agroecologia no Acre**. Rio Branco: Ifac, 2015. p. 347-372. Available at: <http://ainfo.cnptia. embrapa.br/digital/bitstream/item/142019/1/25822.pdf>. Accessed on: Jan. 4, 2018.

ARCHARD, F.; OLIVEIRA, Y. M. M. de; MOLLICONE, D. Monitoring forest cover and deforestation. In: DELINCÉ, J. (Ed.). **Handbook on remote sensing for agricultural statistics**. Rome: Global Strategy to improve Agricultural and Rural Statistics, 2017. p. 185-215. Available at: <https://www.

embrapa.br/florestas/busca-de-publicacoes/-/publicacao/1083312/monitoring-forest-cover-and-deforestation>. Accessed on: Dec. 21, 2017.

BRASIL. Lei nº 11.428, de 22 de dezembro de 2006. Dispõe sobre a utilização e proteção da vegetação nativa do Bioma Mata Atlântica, e da outras providências. **Diário Oficial da União**, 26 dez. 2006. Available at: <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/lei/l11428.htm>. Accessed on: Nov. 23, 2017.

BRASIL. Lei nº 12.651, de 25 de maio de 2012. Dispõe sobre a proteção da vegetação nativa; altera as Leis nº 6.938, de 31 de agosto de 1981, 9.393, de 19 de dezembro de 1996, e 11.428, de 22 de dezembro de 2006; revoga as Leis nº 4.771, de 15 de setembro de 1965, e 7.754, de 14 de abril de 1989, e a Medida Provisória nº 2.166-67, de 24 de agosto de 2001; e dá outras providências. **Diário Oficial da União**, 28 maio 2012. Available at: <http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm>. Accessed on: Nov. 23, 2017.

COELHO, F. de A.; PINTO, M. V. P.; FERREIRA, F. N.; RUSCHEL, A. R. Avaliação da eficiência do monitoramento de parcelas permanentes em uma unidade de manejo. In: SEMINÁRIO DE INICIAÇÃO CIENTÍFICA DA EMBRAPA AMAZÔNIA ORIENTAL, 21., 2017, Belém, PA. **Anais**... Belém, PA: Embrapa Amazônia Oriental, 2017. Available at: <https://www. embrapa.br/busca-de-publicacoes/-/publicacao/1076214/avaliacao-da-eficiencia-do-monitoramento-de-parcelas-permanentes-em-uma-unidade-de-manejo-florestal>. Accessed on: Dec. 21, 2017.

D'OLIVEIRA, M. V. N.; ARAUJO, H. J. B. de; CORREIA, M. F.; SILVA, M. P. da. **Manejo florestal sustentável na pequena propriedade**. Rio Branco, AC: Embrapa Acre, 2007. 32 p. (Embrapa Acre. Documentos, 106). Available at: <http://ainfo.cnptia. embrapa.br/digital/bitstream/item/117349/1/17287.pdf>. Accessed on: Jan. 4, 2018.

D'OLIVEIRA, M. V. N.; BRAZ, E. M. Estudo da dinâmica da floresta manejada no projeto de manejo florestal comunitário do PC Pedro Peixoto na Amazônia Ocidental. **Acta Amazonica**, v. 36, n. 2, p. 177-182, 2006. Available at: <https://ainfo.cnptia. embrapa.br/digital/bitstream/item/112604/1/13891.pdf> Acesso em: 5 jan. 2018.

DRUMOND, M. A.; KILL, L. H. P.; LIMA, P. C. F.; OLIVEIRA, M. C. de; OLIVEIRA, V. R. de; ALBUQUERQUE, S. G. de.; NASCIMENTO, C. E. de S.; CAVALCANTI, J. Estratégias para o uso sustentável da biodiversidade da caatinga. In: SILVA, J. M. C. da; TABARELLI, M.; FONSECA, M. T. da; LINS, L. V. (Org.). **Biodiversidade da caatinga**: áreas e ações prioritárias para a conservação. Brasília, DF: Ministério do Meio Ambiente: Universidade Federal de Pernambuco, 2004. p. 329-340.

DRUMOND, M. A.; LIMA, P. C. F.; OLIVEIRA, M. C. de; OLIVEIRA, V. R. de; ALBUQUERQUE, S. G. de.; NASCIMENTO, C. E. de S.; CAVALCANTI, J. **Estratégias para o uso sustentável da biodiversidade da caatinga**. Petrolina: Embrapa Semi-Árido, 2000. 21 p. Documento para discussão em Grupo de Trabalho-GT Estratégias para o uso sustentável, apresentado no Seminário Biodiversidade da Caatinga. 2000, Petrolina. Avaliação e identificação de ações prioritárias para a conservação.

GLOBAL forest resources assessment 2015: how are the world's forests changing? 2nd ed. Rome: FAO, 2015. 46 p. Available at: <http://www.fao.org/3/a-i4793e.pdf>. Accessed on: Nov. 17, 2017.

KIILL, L. H. P.; DRUMOND, M. A.; LIMA, P. C. F.; ALBUQUERQUE, S. G. de; OLIVEIRA, V. R. de. **Preservação e uso da Caatinga**. Brasília, DF: Embrapa Informação Tecnológica; Petrolina: Embrapa Semi-Árido, 2007. 36 p. (ABC da agricultura familiar, 16).

LACERDA, A. E. B. de; ROSOT, M. A. D.; FIGUEIREDO FILHO, A.; GARRASTAZU, M. C.; NIMMO, E. R.; KELLERMANN, B.; RADOMSKI, M. I.; BEIMGRABEN, T.; MATTOS, P. P. de; OLIVEIRA, Y. M. M. de. Sustainable forest management in rural Southern Brazil: exploring participatory forest

management planning. In: MARTIN-GARCIA, J.; JAVIER DIEZ, J. (Ed.). **Sustainable forest management**: case studies. Rijeka: InTech, 2012. p. 97-118. Available at: <http://ainfo.cnptia.embrapa.br/digital/bitstream/item/63352/1/AndreBiscaia.pdf>. Accessed on: Jan. 5, 2018.

OLIVEIRA, Y. M. M. de; OLIVEIRA, E. B. de (Ed.). **Plantações florestais**: geração de benefícios com baixo impacto ambiental. Brasília, DF: Embrapa, 2017. 112 p. Available at: <https://www. embrapa.br/florestas/busca-de-publicacoes/-/publicacao/1076130/plantacoes-florestais-geracao-de-beneficios-com-baixo-impacto-ambiental>. Accessed on: Jan. 5, 2018.

RADOMSKI, M. I.; LACERDA, A. E. B. de; KELLERMANN, B. **Sistemas agroflorestais**: restauração ambiental e produção no âmbito da Floresta Ombrófila Mista. Colombo: Embrapa Florestas, 2014. 47 p. (Embrapa Florestas. Documentos, 276). Available at: <http://ainfo.cnptia. embrapa.br/digital/bitstream/item/121202/1/Doc.-276-Izabel.pdf>. Accessed on: Jan. 5, 2018.

RUSCHEL, A. R. **Dinâmica da composição florística e do crescimento de uma floresta explorada há 18 anos na Flona Tapajós, PA**. Belém, PA: Embrapa Amazônia Oriental, 2008. 57 p. (Embrapa Amazônia Oriental. Documentos, 341). Available at: <http://ainfo.cnptia. embrapa.br/digital/bitstream/item/27916/1/Doc341.pdf>. Accessed on: Jan. 4, 2018.

SILVA, J. N. M.; CARVALHO, J. O. P. de; LOPES, J. do C. A.; OLIVEIRA, R. P. de; OLIVEIRA, L. C. de. Growth and yield studies in the Tapajós region, Central Brazilian Amazon. **The Commonwealth Forestry Review**, v. 75, n. 4, p. 325-329, 1996.

SOUZA, M. A. S. de; AZEVEDO, C. P. de; SOUZA, C. R. de; FRANÇA, M.; VASCONCELOS NETO, E. L. Dinâmica e produção de uma floresta sob regime de manejo sustentável na Amazônia Central. **Floresta**, v. 47, n. 1, p. 55-63, Jan./Mar. 2017.

TERRACLASS 2004 a 2014: avaliação da dinâmica do uso e cobertura da terra no período de 10 anos nas áreas desflorestadas da Amazônia Legal brasileira. Belém, PA: Instituto Nacional de Pesquisas Espaciais/Centro Regional da Amazônia: Embrapa Amazônia Oriental; [Campinas]: Embrapa Informática Agropecuária, 2016. 1 folder.

UNITED NATIONS. **Life on Land**: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation, and halt biodiversity loss. Available at: <https://sustainabledevelopment.un.org/sdg15>. Accessed on: Mar. 26, 2018.

WADT, L. H. de O.; SANTOS, L. M. H.; BENTES, M. P. de M.; OLIVEIRA, V. B. V. (Ed.). **Produtos florestais não madeireiros**: guia metodológico da Rede Kamukaia. Brasília, DF: Embrapa, 2017.