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2 **Agroforestry Systems on Brazilian Legal Protected Lands: 2 Permanent Preservation**
3 **Areas (PPA) and Legal Reservation Areas (LRA)**

4 **Abstract**

5 Forests preservation and restoration are crucial, to sustain ecological and social benefits.
6 However, forest lands have been reducing around the world. In the context of forest
7 restoration, agroforestry systems are important land use instruments, because they allow
8 food production combined with sustainable forest management. There are different
9 kinds of agroforestry systems, and they can occur in degraded areas and also in forested
10 areas which are legally protected or not. In Brazil, where forests cover 46.5% of land
11 area, deforestation continues and there are several challenges to protect and restore
12 forests. In this case, it is necessary to advance sustainable forest management to protect
13 the remaining forests, to restore forest lands and to permit uses which contribute to
14 Brazilian society, especially to the *campesinos*. *Permanent Preservation Areas (PPA)*
15 and *Legal Reservation Areas (LRA)*, which have been institutionalized in Brazilian
16 Environmental Legislation require the maintenance of areas with native vegetation
17 within rural properties restricting certain activities, accordingly with this understanding,
18 the legislation limits the possibility of obtaining income from agricultural activities.
19 Historically, they have not been duly respected by most landowners where riverbanks,
20 springs, slopes and other areas that should be preserved have been occupied suppressing
21 natural vegetation. Thus, there are possibilities for ecological management and use of
22 protected areas, specifically *PPA* and mainly *LRA*, which seek to both preserve
23 environmental resources and contribute to food production and income, especially in the
24 *campesino* smallholders. This paper discusses possibilities and limitations of using
25 agroforestry systems in *PPA* and *LRA*, pointing out that agroforestry systems are also
26 feasible for restoring degraded areas and for expanding enriched areas and uses of their
27 natural resources. Despite legal possibilities, a historical problem in Brazil is related to
28 the lack of compliance with environmental legislation. Moreover, in actuality the
29 scenario of deforestation and several difficulties to advance in environmental
30 management in Brazil have been harming this conservationist possibilities. There is
31 much to be done to facilitate the expansion of agroforestry systems, such as investments
32 in research, extension and public policies that provide grants and loans for this kind of
33 management.

34

35 **Keywords:** Forest Legislation, Deforestation, Agroforestry for Environmental
36 Objectives, Biodiversity.

37

38 **1. Introduction**

39 Certain human activities such as wood extraction, agriculture, forestry and intensive
40 livestock raising, in addition to urban sprawl and industrialization, have been

41 responsible for reducing natural forest cover around the world. These processes lead to
42 harmful consequences for the dynamics of ecosystems, including the loss of biodiversity
43 (plant and animal), erosion and loss of soil fertility, silting of watercourses, etc.

44 To decrease these problems, Environmental Legislation aims to regulate the land
45 use and occupation, especially regarding the institution of rights and duties/obligations
46 related to natural resources. In Brazil, the natural environment is considered a good of
47 common use **[1]** (Milaré, 2007).

48 The Brazilian Environmental Legislation, specifically from 1965 through Law
49 4,771/65, requires the maintenance of areas with native vegetation within rural
50 properties, by the following legal mechanisms: the *Permanent Preservation Areas*
51 (*PPA*) and the *Legal Reservation Areas (LRA)*. These two legal figures restrict certain
52 activities to favor environmental preservation and conservation. History tells us, these
53 areas have not been properly respected by some rural property owners, as well as by the
54 government in the process of rural and urban engagement. Thus, riverbanks, springs,
55 slopes and other areas that should be preserved have been absorbed, suppressing natural
56 vegetation in all Brazilian biomes and ecosystems.

57 To the present date, many lands that should be destined for PPA and LRA
58 continue to be cleared, because farmers consider the legislation useless or unnecessary.
59 Understanding that these areas limit the possibility of obtaining income, most Brazilian
60 farmers oppose the requirements of forest legislation. Although, there are legal
61 possibilities for the management and use of PPA and mainly of LRA, which can
62 contribute to farmers' food and income, especially those that have smallholdings, called
63 "small property" or "family rural tenure" in Brazilian legislation (Law 12,651/2012).

64 Among these alternatives agroforestry systems stand out.

65 Agroforestry is a collective name for land-use systems in which
66 woody perennials (trees, shrubs, etc.) are grown in association with
67 herbaceous plants (crops, pastures) or livestock, in a spatial
68 arrangement a rotation, or both; there are usually both ecological and
69 economic interactions between the trees and other components of the
70 system. (Lundgren, 1982: 3).

71
72 In a global context where agriculture demands much of natural resources, such
73 as water and soil, environmental impacts (deforestation, biodiversity loss, etc.) occur
74 and contribute to environmental contamination (with wide pesticides and fertilizers use)

75 it is necessary to create and implement sustainable land use strategies. In this
76 perspective, agroforestry systems, mainly agroecological and diversified are an
77 important example.

78 Food and Agriculture Organization (FAO) of the United Nations (UN) points out
79 that agroforestry is crucial to smallholder farmers and other rural people because it can
80 enhance their food supply income and health.¹

81 Despite the different agroforestry systems, from the simplest (for economic
82 purposes) to the most complex (which in addition to production, aim to conserve the
83 forest with native species) [2] (Miller, 2009), they are, generally, understood in
84 Brazilian law as agroforestry systems (SAF) [3, 4] (Brazil, 2009 and 2012) or
85 agroforestry and *agrossilvipastoril*² systems [4] (Brazil, 2012).

86 Considering a historic process of inadequate land settlement in Brazil where
87 forests and other natural vegetation have been suppressed for agriculture, pastoral, and
88 other uses, discuss and present actions which combine food production and biodiversity
89 restoration, like agroecological agroforestry systems is very important.

90 By the provisions of Law 12,651/2012, which instituted the “new” Brazilian
91 Forest Code, in Resolutions 369/2006, 425/2010 and 429/2011 of the National Council
92 of the Environment (CONAMA) and in Normative Instruction 5/2009 of the Ministry of
93 the Environment, we sought to analyze in what sense agroforestry systems have been
94 covered in Brazilian legislation to discuss how agroforestry systems can be implemented
95 in areas of LRA and PPA.

96 The methods of this article utilized literature about land and forestry
97 management systems (concept, basic principles, kinds), highlighting the difference
98 between simple and diversified/agroecological systems; an analysis of the legislative
99 tools that govern forest protection in Brazil, especially Law 12,651/2012; data of forest
100 cover and deforestation in Brazil (supplementary file); and results and conclusions from
101 similar literature which analyzed questions related to agroforestry systems in the
102 country. With this information, we have discussed possibilities of agroforestry

¹ Available at <<http://www.fao.org/forestry/agroforestry/80338/en/>>.

² The word *agrossilvipastoril* means a combination of agriculture, planted trees and pasture land use.

103 management in PPA and LRA, reflecting about difficulties and challenges for expansion
104 of agroforestry systems in Brazil.

105 The article is structured in four sections and a supplementary file beyond introduction
106 and conclusion. The supplementary file provides data about world forest configuration
107 and deforestation, to highlight the importance of Brazilian forests.

108 Section 1: provides an overview of the topics of the article. Section 2: discusses
109 briefly agroforestry systems basic principles in the context of sustainable forest
110 management. Section 3: presents elements of Brazilian forest legislation foremost PPA
111 and LRA. Section 4: argues the possibilities of agroforestry use in PPA and LRA
112 considering Brazilian legislation. Section 5: discusses the feasibility and difficulties for
113 applying agroforestry in PPA and LRA, considering actual challenges to advance in the
114 accomplishments of environmental and forest legislation in Brazil. Section 6: provides a
115 conclusion.

116

117 **2. Agroforestry for Sustainable Forest Management**

118 In the context of forest restoration, agroforestry systems are important land use
119 tools because they allow food production (plants and animals) combined with forest
120 rehabilitation and sustainable management. The goals, principles, history and kinds of
121 agroforestry systems are discussed by international[5,6,7,8,9,10] (Lundgren, 1982; De
122 Jong et al., 2001; Mead, 2004; Roshetko et al., 2008; Smith, 2010; Umrani and Jain,
123 2010) and Brazilian authors[11,12,13,2,14] (May and Trovatto, 2008; Deitenbach, 2008;
124 Porro, 2009; Miller, 2009; Ewert et al., 2016).

125 The term agroforestry is an “umbrella” term for those land-use
126 practices and technologies where trees or other woody perennials are
127 deliberately grown with crops, pastures or animals on farms. [...] agroforestry as a dynamic, ecologically based, natural resource
128 management system that, through the integration of trees on farms and
129 in the agricultural landscape, diversifies and sustains production for
130 increased social, economic and environmental benefits for land users
131 at all levels. [...] it is seen by many as a means of poverty alleviation,
132

133 particularly for rural peoples. The scientific application is relatively
134 new, although many of the practices are ancient [7] (Mead, 2004: 8).
135

136 Agroforest consists of land use that combines ‘planted trees’ with forest flora
137 and fauna, either retained or naturally regenerated vegetation [6] (De Jong et al., 2001),
138 creating environmental, economic, and social benefits[15] (USDA, 2019³).

139 Agroforestry is a productive and sustainable alternative for socioenvironmental
140 contexts. They allow a dynamic and ecological management of natural resources,
141 contributing to the maintenance of biodiversity and to the food and income of farming
142 families [13] (Porro, 2009).

143 There is potential for an agroforestry ecosystem to move from a
144 relatively simple one to one of greater complexity, which is akin to
145 natural succession in forests. [...] The three basic components of an
146 agroforestry land-use system are the tree or woody perennial, the
147 herbaceous component, and animals. Agroforestry systems must have
148 trees and at least one of the other components. This is the basis of the
149 classification into trees plus crops (agrosilvicultural), trees plus
150 pastures and/or animals (silvopastoral), and trees plus crops and
151 animals (agrosilvopastoral) [7] (Mead, 2004: 11).
152

153 Agroforestry can contribute to reducing agriculture’s vulnerability to climate
154 change, improve water quality and availability among other services. It also can increase
155 and diversify farmers’ incomes, allow them to have access to more nutritious food and
156 impel other social benefits. Because agroforestry integrates multiple natural
157 components, it necessarily brings together people from diverse fields of knowledge [16]
158 (FAO, 2015⁴).

159 “Tree planting in agroforests can occur in an open field stage, often in between
160 food crops, or in small gaps or clearings in existing forest.” [8] (Roshetko et al., 2008:
161 466). Agroforestry can occur in degraded areas and in forested areas legally protected or
162 not. For each area there are different kinds of agroforestry systems that can be applied
163 according to farmer opposition and interest.

³ Available <https://www.usda.gov/topics/forestry/agroforestry>

⁴ Available <http://www.fao.org/forestry/agroforestry/80338/en/>

164 [8] Roshetko et al. (2008) present four kinds of tree-based land use systems: 1)
165 *Natural forests*; 2) *Sustainably Managed Forests*; 3) *Forest and Tree Plantations*, with a
166 commercial goal and one or two planted species; and 4) *Smallholder Tree-Based*
167 *Systems*. For the discussion in this paper, we will focus on *smallholder agroforestry*
168 *systems* (4), understanding that this kind of land use is possible and viable in Brazilian
169 protected areas, i.e., PPA and LRA, especially in “campesino”⁵ properties.

170 Considering that smallholder tree-based systems play significant roles in the
171 livelihoods of local communities it is important to 1) recognize the contribution and
172 importance of smallholder agroforestry systems; 2) provide technical support; 3) adopt
173 holistic and sustainable strategies to support and strengthen the market orientation; 4)
174 develop supportive institutions and policies (rules and organizations); 5) utilize enabling
175 conditions that support the success of these systems [8] (Roshetko et al., 2008).

176 According to [7] Mead (2004: 10), “in both the developing and industrialized
177 world, agroforestry is now accepted as an important land-use system, driven by the need
178 to create sustainable and robust agroforestry ecosystems.”

179 In Brazil, despite forest covering 46.5% of land area [17] (Mapbiomas, 2021),
180 deforestation continues and there are several challenges to forest protection and
181 conservation. In this sense, it is necessary to advance sustainable strategies for forest
182 management, to protect the forests and to permit uses which could contribute to
183 Brazilian society, especially campesinos. In this context, complex agroforestry systems
184 can play an important role to improve campesino lives.

185 [2] Miller (2009) differentiates two major groups of agroforestry in Brazil: 1)
186 based on an agroecological perspective, that seek to combine food production and
187 restore forests with diverse native species and 2) agronomic and conventional systems,
188 which are based on few species and seek to produce wood. The first works with dense
189 planting, diversified species, rapid accumulation of organic matter, ecological and
190 economic stability contributing to biodiversity. The second promotes lower density and
191 diversification of species, few species and interactions, offering fewer products. In this

⁵ The term “campesino” refers to farmers who live and work in smallholders. It is a word from Spanish language which has been used in academic literature around the world. In Brazil, Law 11,326/2006 use the terms “family farmer” and “family agriculture”.

192 sense, our focus is to discuss the possibilities of agroforest land use in PPA an LRA in
193 smallholder are based on agroecological agroforestry systems.

194 The sequences in addressing this thesis are, the main Brazilian laws of forest
195 protection, the definitions of PPA and LRA and the possibilities of management in these
196 areas with agroecological agroforestry systems.

197

198 **3. Brazilian Forest Legislation and Agroforestry in the Context**

199 **3.1. Background and Overview of Forest Protection**

200 The legal instruments that direct the Legislation have different segments. No
201 legal device can be above or contradictory to the content of the Federal Constitution.
202 The

203 Legislative Power is responsible for creating Laws, whether at the Federal (Chamber of
204 Deputies and Federal Senate), interstate (Legislative Assemblies) or Municipal (City
205 Councils) levels⁶.

206 To make some Law acceptable it is necessary to regulate it by Decrees, which
207 are prepared by law-related agencies. The elaboration of a Decree by the Ministry of the
208 Environment (ME), which is sanctioned by the President of the Republic, is essential to
209 regulate a Law on the environment. Another legal tool is normative instructions (NIs),
210 which details contents, administrative procedures and permitted and prohibited
211 practices. Other bodies with attributions in the environmental area are the
212 Environmental Councils. The main Council at the Federal level is the National Council
213 of the Environment (CONAMA). The states of the federation and municipalities must
214 also have their Councils. The councils aim at expanding the participation of sectors
215 involved with the environmental issue (public, private or social organizations).

216 Regarding forest protection standards, the first to be published in Brazil was in
217 1934, through Decree 23,793/34, which institutionalized the first Brazilian Forest Code.
218 The main objective of the Decree was to order the exploitation of forest resources [18]
219 (Zakia and Derani, 2006).

⁶ There are 27 states and 5,570 municipalities in Brazil.

220 In the 1960s, with the emergence of the ecological movement, new legislative
221 texts were institutionalized to the prevention and control of environmental degradation⁷,
222 Forest Code (Law 4,771/65).

223 In 1965, through the enactment of Law 4,771, a new Forest Code was
224 established in Brazil. Unlike the 1934 Code, which dealt with the protection of forests
225 against the dilapidation of the country's forest cover, limiting individuals to the
226 unrestricted power over rural properties the new text of 1965 had an interventionist state
227 policy on private property. Forests came to be considered goods of common interest of
228 the country [19] (Laureano and Magellan, 2011).

229 The Forest Code of 1965 also established the *Permanent Preservation Area*
230 (*PPA*) and the *Legal Reservation Area (LRA)*, which, although not properly delimited
231 and maintained by most of landowners, constitute legal requirements to date. This Law
232 could

233 _____
234 have been a milestone for the effective protection of forests throughout Brazilian
235 territory whether in rural or in urban areas.

236 If it had been fulfilled since 1965, the process of land use in Brazil would have
237 taken place with more caution, protecting areas with greater environmental fragility
238 (wetlands, areas with high slopes, refuges for plant and animal biodiversity). Though,
239 the Law has not properly applied, generating problems that continue. The lack of
240 adequate environmental management with guidance, inspection and enforcement of
241 infractions has made this law ineffective.

242 Recently, Law 4,471/65 and other legislative tools⁸, were repealed or amended
243 with the new Forest Code, institutionalized through Law 12,651/2012. Considering the
244 relevance of this Law, called “new Brazilian Forest Code” either as an incentive for
245 conservation and forest preservation, or as a limiting factor in the expansion of

⁷ Other Laws in this context are the Land Statute (Law 4,504/64); the Wildlife Protection Act (Law 5,197/67); the Fishing Code (Decree 221/67); the Mining Code (Decree 227/67); and the National Basic Sanitation Policy (Decree 248/67) (Milaré, 2007).

⁸ Laws 4,471/65, 7,754/89 and Provisional Measure 2,166-67/2001 have been repealed and Laws 6,938/81, 9,393/96, and 11,428/2006 have been amended.

246 agribusiness, it is worth mentioning that it was developed and approved after various
247 debates between the “ruralist bench” (composed by politicians linked to agribusiness)
248 and environmental groups in the country⁹.

249 It indicates different intentions and territorialities, and despite the enactment of
250 the Law, continue to exist. Although, the debates on Law 12,651/2012 lasted for months
251 involving meetings, consultation with specialists and public hearings, environmentalists
252 and many environmental and forestry researchers concluded that the agribusiness sector
253 managed to press their interests on this law.

254 On the other hand, many argue that Law 12,651/2012 allowed the legal
255 regularization of thousands of rural establishments, which were not in compliance with
256 Law 4,471/65. Through the creation of “consolidated rural areas”, Law 12,651/2012
257 made it possible to regularize construction and occupation of areas that should have
258 been preserved. Still, it is necessary to consider why these establishments did not follow
259 the provisions of the 1965 Law?

260 The Forest Code requires the maintenance/preservation of a portion of the rural
261 property with existing native or secondary vegetation and if there is no such vegetation,
262 forest regeneration within rural properties is necessary. The two legal figures of forest
263 Preservation/conservation are the so-called *Permanent Preservation Areas (PPA)* and
264 the *Legal Reservation Areas (LRA)*. In them, especially in PPA activities are restricted.
265 Even so, there are possibilities of conservation use in these areas.

266 These areas are similar, but have different usage and restrictions. They play
267 important roles such as maintaining and/or restoring forest areas. Even though, PPA and
268 LRA are the target of criticism from the agribusiness sector because they are seen as
269 useless from an economic perspective.

270 Many farmers revolt against environmental laws without realizing that they fight
271 against ecosystems, which have an immeasurable wealth and if properly managed, can
272 bring environmental and economic benefits. In the midst of existing environmental
273 conflicts related to compliance with environmental legislation, types of conservation

⁹ The debate about the construction process and the changes that occurred in the Forest Code promulgated in 2012 will not be addressed here. The documentary “The Law of Water”, available in <https://www.youtube.com/watch?v=jgq_SXU1qzc> presents the main points that generated controversy in this context.

274 use, such as agroforestry systems appear as a strategy for the environmental
 275 regularization of protected areas in rural properties, i.e., PPA and LRA[20] (Meirelles,
 276 2003).

277

278 **3.2 Permanent Preservation Areas (PPA) and Legal Reservation Areas (LRA)**

279 The concept of PPA was established in Law 4,771/65 and was not changed in the
 280 new Forest Code (Law 12,651/2012). It legally corresponds to a:

281 protected area covered or not by native vegetation, with the
 282 environmental function of preserving water resources, landscape,
 283 geological stability, and biodiversity, facilitating the gene flow of
 284 fauna and flora, protecting the soil, and ensuring the well-being of
 285 human populations[4] (Brazil, 2012, Article 3rd, III).
 286

287 Unlike the LRA, which can be instituted in any portion of the rural property,
 288 PPA are delimited according to the relief and hydrography of the rural property.

289 PPA¹⁰ are the marginal strips of any natural watercourse, from the edge of the
 290 regular watercourse bed, areas around the lakes and natural lagoons, the areas
 291 surrounding artificial water reservoirs resulting from impoundment or damming of
 292 natural
 293 watercourses [...]; the areas around the springs [...]; the slopes [...] greater than 45°;
 294 the *restingas*¹¹; the mangroves; the edges of the plateaus; on top of hills; and areas at an
 295 altitude greater than 1,800 meters[4] (Brazil, 2012, Article 4h).

296

297 Considering that diverse ecosystems encompass PPA, agroforestry systems
 298 could be recommended for marginal strips of natural watercourses (Table 1) and natural
 299 lagoons, areas surrounding artificial water reservoirs and slopes greater than 45°, only if
 300 these areas have been without natural vegetation.

301 **Table 1: Width of the Marginal Watercourse Range of the PPA**

Width of Regular Watercourse (meters)	Marginal Band (meters)
---------------------------------------	------------------------

¹⁰ Article 4th of Law 12,651/2012 provides in detail the delimitations corresponding to PPA [4] (Brazil, 2012).

¹¹ *Restinga* is a sandy deposit parallel to the coastline, generally elongated, produced by sedimentation processes, where different communities that receive marine influence are found, with mosaic vegetation cover, found on beaches, sandy ridges, dunes and depressions, presenting, according to the successional stage, herbaceous, shrubby and arboreal strata[4] (Brazil, 2012, Article 3rd, XVI).

Less than 10	30
10 to 50	50
50 to 200	100
200 to 600	200
Higher than 600	500

302 Source: Law 12,651/2012 Chapter II, Article 4th.

303

304 Yet, in the case of proof of the existence of “consolidated rural areas” in “small”
 305 properties (smaller than 4 fiscal modules¹²), the requirements in terms of the size of the
 306 marginal areas to the watercourses were reduced. Article 61-A of Law 12,651/2012
 307 details this flexibilization.

308 As in the case of PPA, LRA was practically not changed in the current Forest
 309 Code (Law 12,651/2012). The LRA corresponds to an:

310 area located within a property or rural property, delimited in
 311 accordance with art. 12, with the function of ensuring the sustainable
 312 economic use of the natural resources of the rural property, assisting
 313 the conservation and rehabilitation of ecological processes, and
 314 promoting the conservation of biodiversity, as well as the shelter and
 315 protection of wild fauna and native flora^[4] (Brazil, 2012, Article
 316 3rd).

317

318 The LRA is a percentage of the rural property according to the total area of the
 319 property. Article 12 defines the percentage that each region needs to maintain in rural
 320 properties and this area can be delimited by the owner. This law establishes that “every
 321 rural property must maintain an area with native vegetation cover as a LRA, without
 322 prejudice to the application of the rules on PPA” ^[4] (Brazil, 2012, Article 12).

323 Article 12 of Law 12,651/2012 provides the percentage that each region needs to
 324 maintain in rural properties with native vegetation as a LRA which are: I - located in the

325 _____

¹² In Brazil, the size of a fiscal module in an agricultural establishment (farm) varies between municipalities, with the smallest being 50,000 m² and the largest being 1,100,000 m². Thus, the area of an establishment with up to 4 fiscal modules can reach 4,400,000 m².

326 Legal Amazon: a) 80% in the property located in forest area, b) 35% in the property
327 located in Cerrado¹³ area, c) 20% in the property located in general field area, II -
328 located in the other regions of the country: 20%**[4]** (Brazil, 2012, Article 12). Therefore,
329 except for the Amazon Biome in the other Brazilian biomes, including the Atlantic
330 Forest, it is required that 20% of each rural property be destined as LRA.

331 LRA is a portion of the rural property that must be destined to forest
332 conservation **[22]** (Delduque, 2008). If the area were preserved it can be maintained. If
333 LRA were without natural vegetation or with some land use, legislation allows
334 sustainable management, like agroforestry. Despite the priorities for the delimitation of
335 LRA it is necessary to question if the criteria and studies to define the location of legal
336 reservation areas, present in Article 14 of Law 12,651/2012, will be properly followed,
337 and conducted.

338 LRA could be in strategic areas to contribute to ecological functions. It could
339 improve ecological corridors for animals, linking PPA areas and rivers, establish tree
340 barriers to reduce pesticide contamination, etc. Although the concept and dimensions of
341 PPA and LRA have been maintained, Law 12,651/2012 relaxed some requirements for
342 smallholders, as will be discussed in the next section.

343

344 **3.3. PPA and LRA in Smallholders**

345 In Brazil, the recognition of the need to decipher smallholders and large rural properties
346 as well as campesinos and farmers with a capitalist and commercial profile, including
347 big landowners, is recent. This kind of debate is wide and involve Brazilian agrarian
348 problems.

349 Historically, benefits such as agricultural public policies and financing were
350 restricted to large-scale farmers. A National Policy for campesino smallholders was
351 created only in 2006**[22]** (Candioto, 2011). According to Law 11,326/2006, which
352 broaches the “National Policy on Family Agriculture and Rural Family Enterprises”, to
353 be considered a family farmer the following requirements should be met: 1) must not
354 hold an area greater than 4 fiscal modules; 2) predominantly use his family’s labor force

¹³ Cerrado is one of the five major biomes in Brazil, which covered about 25% of Brazilian territory. It is similar to Savannah. More information is available at <<https://www.icmbio.gov.br/cbc/conservacao-dabiodiversidade/biodiversidade.html>>.

355 in the economic activities of his establishment or enterprise; 3) have part of family
356 income originated from economic activities of smallholder.

357 _____
358 Law 12,651/2012 lessened some requirements for forest restoring for smallholders. In
359 spite of that, according to Law 11,326/2006, any rural property that has a land area
360 smaller than 4 fiscal modules can be a smallholder. But in Brazil, the area of a property
361 with less than 4 fiscal modules can reach 4,400,000 m², i.e., 440 hectares. In this sense,
362 in Brazil big areas can be legally accepted in the context of smallholder. For many
363 experts it is a problem because large land areas can benefit from this loophole.

364 Firstly, Law 12,651/2012 allows that a Brazilian “smallholder” which can have
365 440 hectares, include the area of LRA in the same area of PPA in the cases when more
366 than 25% of the rural property is covered by PPA and in other situations (Article 16).

367 With the creation of “consolidated rural area” in Law 12,651/2012, other
368 advantages have been institutionalized for who occupied legal forests land. Any portion
369 of PPA with some construction, crop or stockbreeding implemented before June 2008
370 can be pronounced a consolidated rural area by the owner, in the *Cadastro Ambiental*
371 *Rural* (Rural Environmental Registry – CAR). **Table 2** presents the possibilities of PPA
372 reduction in consolidated rural areas, according to the size of rural establishment or
373 property.

374 **Table 2: Width of the Marginal Watercourse Range of the PPA with Consolidated**
375 **Rural Areas**

Establishment or Property Size (fiscal module)	Minimum Marginal Band (meters)
Less than 1	5
1 to 2	8
2 to 4	15
4 to 10	20
Higher than 10	30

376 Source: Law 12,651/2012, Article 61-A.

377

378 Moreover, the exigence of PPA around springs in consolidated rural areas has
379 been reduced by 50 meters to 15 meters, beyond other facilities allowed in these
380 situations¹⁴.

381 Section 4 discusses the main legislation which allow agroforestry management in
382 PPA and LRA and the limits of those uses in protected areas.

383 **4. Agroforestry in Protected Areas**

384 Despite PPA and LRA have been generally considered untouchable lands by
385 many landowners, it is possible to use them in a conservation manner. Considering the
386 importance of regulating these areas and restoring lands in properties that have
387 environmental liabilities, it is necessary to advance the debate on forest management
388 and other forms of conservationist use especially regarding agroforestry. Since 2006,
389 Brazil institutionalized legislative tools which allow agroforestry systems in PPA and
390 LRA.

391

392 **4.1 Brazilian Normality Linked to Agroforestry in PPA and LRA**

393 Through a review of the provisions of Law 11,428/2006, Law 12,651/2012,
394 Decree 6,660/2008, Resolutions 369/2006, 425/2010 and 429/2011 of CONAMA and
395 Normative Instruction (NI) 05/2009 of the Ministry of the Environment, we sought to
396 analyze in what sense agroforestry systems can be implemented in LRA and PPA.

397 With Law 12,651/2012, some exigences of the other cited legislation have been
398 changed or invalidated. But the presentation of some parts of these legislative tools
399 show the possibilities to use agroforestry systems in PPA and LRA have been
400 considered in Brazil.

401 Law 11,428/2006 established the use and protection of Atlantic Forest Biome. *Primary*
402 *vegetation* (Art. 20) and *Secondary vegetation in an advanced stage of regeneration*
403 (Art. 21) can only be suppressed for activities of public utility, scientific research, and
404 preservationist practices with authorization. Nevertheless, cutting part of *Secondary*
405 *vegetation in an advanced stage of regeneration* is authorized when necessary for small
406 rural producers and traditional populations for the exercise of activities or agricultural,

¹⁴ Candiotta and Vargas (2018) provide additional information about Law 12,651/2012.

407 livestock or silvicultural activities essential to their subsistence and that of their family,
408 except for PPA (Article 23).

409 In 2008, Decree 6,660 was launched, which identifies what can be done in the
410 remnants of Native Atlantic Forest vegetation in terms of sustainable use. We highlight
411 here the following aspects:

- 412 - Possible exploration, with no direct or indirect commercial
413 purpose, of native flora species originating from natural formations,
414 for consumption on rural properties, possessions of traditional
415 populations or small rural producers, with respect to primary
416 vegetation and endangered species is free (Cap. II);
- 417 - Ecological enrichment with native species is encouraged to
418 restore biodiversity in the remaining secondary vegetation (Cap. III);
- 419 - Planting and reforestation with native species can be done
420 without the need for authorization from environmental agencies (it is
421 also included, in a single paragraph in this provision of Art. 12,
422 sustainable agroforestry management activities) (Cap. IV);
- 423 - Cutting and exploitation of native species that are proven to be
424 planted is permitted, provided they are registered and have
425 authorization from the environmental agency (Cap. III);
- 426 - Free collection of leaves, fruits and seeds is allowed during the
427 periods of collection and maturation, if there is no risk to the survival
428 of individuals and species collected (Cap. IV).

430 Items listed above are just some regulations for the use of the Atlantic Forest, which
431 may be directly related to agroforestry management, given the restrictions and
432 permissions of use. On the use of agroforestry systems in PPA, CONAMA Resolutions
433 369/2006, 425/2010 and 429/2011 complemented and strengthened the points made in
434 the Forest Code of 1965 (Law 4,771/65).

435 CONAMA Resolution 369/2006 allows the existence of:

436 exceptional cases in which the competent environmental agency may
437 authorize the intervention or removal of vegetation in PPA for the
438 implementation of works, plans, activities or projects of public utility
439 or social interest, [...] and of low environmental impact^[23] (Brasil,
440 2006b, Article 1st).

442 Since agroforestry is considered an activity of social interest for smallholders
443 and has a low environmental impact, it can also occur in PPA of small family rural
444 establishments, if there is authorization from the competent Environmental Agency. The
445 implementation of agroforestry is permitted both in PPA and LRA of family farms if

446 there is no degradation or damage to the ecological function of the area. Though,
447 CONAMA Resolution 369/2006 does not describe specific procedures.

448 CONAMA Resolution 425/2010 also defines exceptional cases of social interest
449 in which the competent Environmental Agency can regularize intervention in vegetation
450 in PPA with agroforestry management being one of those cases. It is set out in Section
451 III of Article 2nd that social interests include “the activities of sustainable agroforestry
452 management, as long as they do not degrade the vegetation cover and do not undermine
453 the environmental function of the area”.

454 In CONAMA Resolutions 369/2006 and 425/2010, there are possibilities for
455 agroforestry management in PPA by campesinos when the chance of enhancing the use
456 of these areas has become greater.

457 In 2009, the NI 05 was the first legislative tool that defined methodological
458 procedures for the restoration of PPA and LRA. In Chapter VII of this NI, the use of
459 agroforestry is instituted as inducers to restore PPA in the property or possession of the
460 family farmer, the campesino entrepreneur or traditional peoples and communities.

461 Based on subparagraph “b”, item II of Article 2nd of CONAMA Resolution
462 369/2006 (which provides that agroforestry management practiced on small family
463 farms or rural tenure cannot deprive the native vegetation cover or obstruct its
464 restoration besides not harming the ecological function of the area), Article 9th of NI
465 05/2009 presents the requirements and procedures for the implementation of
466 agroforestry in PPA, being:

- 467 I - soil tillage and erosion control when necessary;
468 II- the restoration and maintenance of the native vegetation,
469 permanently maintaining the soil cover;
470 III - establishment of at least 500 (five hundred) individuals per
471 hectare of at least 15 perennial species native to local
472 phytophysiognomy; IV - limitation of the use of agrochemical inputs,
473 giving priority to the use of green manure;
474 V - restriction of the use of the area for grazing domestic animals,
475 except as provided in art. 11 of CONAMA Resolution 369, of 2006¹⁵
476 VI - in the use of agricultural species of annual crops, the maintenance
477 of the environmental function of the APP must be guaranteed and the
478 provisions of Art. 10 of this Normative Instruction;

¹⁵ CONAMA Resolution 369/2006, Article 11, deals with what it considers of intervention or suppression of vegetation, eventual and of low environmental impact, in a PPA. Thus, in NI 05/2009 and in CONAMA Resolution 429/2011, the use restriction is for obtaining water by domestic animals, which is considered of low impact.

479 VII - intercropping of perennial, native or non-invasive alien
480 species, intended for the production and collection of non-wood
481 products, such as fibers, leaves, fruits or seeds; and
482 VIII - maintenance of established, planted and/or germinated
483 seedlings, by crowning, control of disturbance factors such as
484 competing species, insects, fire, or others and fencing or isolation of
485 the area, when necessary and technically justified.
486

487 In addition to these two Resolutions, in 2011, CONAMA created Resolution
488 429, which presents the methodology for restoring PPA through sustainable agroforestry
489 management practiced on small family farms (Article 6th of Chapter IV). In this
490 standard, authorization from the competent Environmental Agency for the agroforestry
491 of PPA is not required; still, similar aspects of NI 05 of 2009 must be considered. Both
492 NI 05/2009 and CONAMA Resolution 429/2011 provide for procedures and
493 requirements for developing agroforestry activity in PPA in a similar way. In general,
494 the possibility of

495 productive use is clear, limiting the activity mainly to non-wood products. These two
496 standards also restrict the use of alien species in these areas, but while the NI 05/2009
497 obligated a minimum of native species composition (15 per hectare), CONAMA
498 Resolution 429/2011 excluded this requirement. In whatever manner, with Law 12,651
499 published in 2012, alien species have been approved to be planted in consortium with
500 regional native species through agroforestry systems.

501

502 **4.2. Agroforestry Systems in PPA and LRA According to Law 12,651/2012**

503 The Forest Code (Law 12,651/2012) is an important instrument that outlines how
504 PPA and LRA should be applied to avoid degradation of remnant forests and permit
505 forest regeneration of degraded areas. It provides possibilities for utilizing agroforestry
506 systems in these areas especially in smallholder. This represents an advance in the sense
507 that campesinos may be conducting agroforestry activity and at the same time,
508 complying with the legislation [24] (Dubois, 2008).

509 Agroforestry systems, mainly complex and agroecological, have been indicated and
510 boosted in smallholders by Law 12,651/2012, in the context of “Social Interest” (Article
511 3rd, Section IX).

512 The sustainable agroforestry exploitation practiced in the small family
513 property or rural possession or by traditional peoples and
514 communities, as long as it does not degrade the existing vegetation
515 cover and does not undermine the environmental function of the area
516 [\[4\]](#)(Brazil, 2012, Article 3rd, Section IX, Line B).
517

518 Depending on the type of agroforestry management developed, agroforestry has
519 the function of protecting the area, not degrading the forest cover, thus making it an
520 acceptable and viable activity. In this sense, agroecological agroforestry are widely
521 recommended for smallholders.

522 Another important instrument given by Law 12,651/2012 is the concept of Eventual
523 Activities or of Low Environmental Impact, in which agroforestry activity is also
524 included. Among the low-impact activities that may be related to diversify agroforestry
525 systems, the following stand out:

- 526 h) collection of non-wood products for subsistence purposes and
527 production of seedlings, such as seeds, nuts and fruits, in compliance
528 with specific legislation on access to genetic resources;
- 529 i) planting of native species that produce fruits, seeds, nuts and
530 other plant products, provided that it does not imply the suppression of
531 existing vegetation or impair the environmental function of the area;
- 532 j) agroforestry exploitation and sustainable, community and
533 family forest management, including the extraction of non-timber
534 forest products, if they do not disfigure the existing native vegetation
535 cover or harm the environmental function of the area; [\[4\]](#) (Brazil,
536 [2012, Article 3rd, Section X](#)).

537
538
539 Hence, extractive activities (collection of forest products, such as seeds, nuts, and
540 fruits), the planting of native species, agroforestry and sustainable forest management
541 are permitted in areas of LRA that are classified as small properties or family rural
542 tenure, i.e., which have less than 4 fiscal modules. Nevertheless, if the LRA area is in a
543 “consolidated rural area”, it is stated that the LRA can be restored through the
544 interspersed planting of native and exotic or fruit-bearing species, in an agroforestry
545 system provided that the area recomposed with exotic species does not exceed 50% of
546 the total area to be recovered (Article 66, Paragraph 3rd). Chapter XII, Article 54
547 provides that:

548 to comply with the maintenance of the legal reserve area in the
549 properties referred in item V¹⁶ of Art. 3, fruit tree plantations, either
550 ornamental or industrial composed of alien species cultivated in
551 interim system or in consortium with species native to the region in
552 agroforestry systems^[4] (Brazil, 2012, Article 54).
553

554 In this case, the restoration of LRA with native species should be prioritized, so as not
555 to degrade the natural biodiversity of each ecosystem. Knowing that it is necessary to
556 expand technical assistance on agroforestry management for farmers, Sole paragraph of
557 Article 54 set governmental institutions to provide technical support. In this matter, the
558 governmental role for the expansion of diversified and agroecological agroforestry
559 systems is fundamental.

560 In the same way, if rural tenure is classified as owned by a family farmer or rural
561 family entrepreneur and part of the PPA is in a consolidated rural area¹⁷, the owner will
562 be able to recompose up to 50% of the degraded PPA with alien species. As the main
563 function of PPA is to optimize the gene flow of animals and plants, we believe that the
564 authorization to plant alien species in these areas implies an unnecessary risk as it can
565 generate competition between native and exotic species as well as invasion of the latter
566 in areas that are ecologically important.

567 Article 41 says that the Federal Executive Government may institute programs to
568 support and encourage environmental conservation, such as payment for environmental
569 services or compensation for environmental conservation measures. Among the forms of
570 compensation there should be lines of financing for sustainable forestry and agroforestry
571 management. In Article 58, possibilities of governmental incentives for the handling of
572 agroforestry and agrosilvopastoral systems are also mentioned.

573

¹⁶ Item V of Article 3rd of Law No. 12,651/2012 defines small family property or rural tenure according to Article 3rd of Law 11,326/2006.

¹⁷ To be considered a consolidated rural area, a given area must have been occupied until 22th July of 2008 and pronounced in the *Cadastro Ambiental Rural* (Rural Environmental Registry – CAR). However, as the CAR is still in the implementation phase and as the Environmental Regularization Program (ERP), instituted in Article 59 of Law 12,651/2012, has not yet been implemented, thus agroforestry use in PPA depends on the interpretation of environmental agencies state. Despite the delay in complying with the legislation and implementing its legal mechanisms, the most important thing here is to emphasize that there is the possibility of expanding the areas of agroforestry, both in LRA and in PPA that are to be restored.

574 **5. Impressions about the Feasibility and Difficulties for Implementing Agroforestry**
575 **in PPA and LRA**

576 In spite of, the possibilities of agroforestry in PPA and LRA that are important
577 protected areas in Brazil, there are situations where agroforestry land use may be a
578 problem and not a solution. Ecologically, an agroforestry composition based on alien
579 species can reduce biodiversity, mostly in cases where some alien (invasive) species
580 suppress or outcompete native species.

581 While in LRA areas some exotic individuals could be used to generate biomass
582 for the agroforestry system or supply the family's demand for firewood and wood, we
583 understand that PPA should be managed primarily only with native species as they are
584 important corridors of biodiversity.

585 Considering the flexibility of forestry legislation in Brazil is linked to the
586 predominance of interests of landowners with large extension of land, it is necessary to
587 be cautious when interpreting the legal provisions that allow the use of protected areas.

588 We believe that agroecological agroforestry systems fully recommended in
589 degraded and protected areas as simple systems are not suitable for PPA and LRA.

590 According to [25] Santos, Crouzeilles and Sansevero (2019: 140), “[...] biodiverse
591 agroforestry system is the best option to enhance biodiversity and ecosystem services
592 (ES) in degraded areas where production systems based on sustainable management of
593 natural resources are allowed by law”. Likewise, it is necessary to analyse the
594 experiences of management and commission of agroforestry in PPA and LRA, to verify
595 the practices that have been carried out and their ecological, social, and economic
596 results.

597 Analysing Brazilian reality, [26] Ewert et al. (2016: 103) alert that “the absence
598 or inadequacy of protocols and registration systems stipulated in legal instruments, but
599 incipiently established by environmental agencies has made the regulation of
600 agroforestry practices practically impracticable.”

601 [27] Martins and Raniere (2014) have identified some limits of agroforestry use
602 in Brazilian LRA. They argue that agroforestry systems in LRA areas need to be
603 implemented “[...] on solid ecological bases, on the principles of ecological succession
604 and on agroecological management practices.” (p. 86). Considering that many kinds of

605 agroforestry systems in Brazil have been established with limited species diversity
606 (simple systems with alien species), the goals of environmental restoration and
607 sustainable use of LRA need to be carefully analysed. In addition, there are problems
608 with the institutional structure of Environmental Agencies for the management of native
609 vegetation.

610 The literature points out that the potential of simple agroforestry
611 systems for conservation is quite limited and not guaranteeing the
612 fulfilment of the LRA functions, especially regarding the protection of
613 biodiversity. To achieve this objective, careful observation of the
614 composition of the agroforestry system is recommended, especially
615 regarding the richness and abundance of native species and their
616 population dynamics over time [27] (Martins and Raniere, 2014: 88).

617 According to [28] Deitenbach (2008) with the possibility of using agroforestry in
618 PPA, farmers can adapt to the Legislation and take advantage of the resources available
619 in these areas. However, there are some reservations regarding use.

620 The important thing is that the agroforestry system to be installed must
621 guarantee the protection function of the PPA in question. [...] Therefore, it will not be any agroforestry system that can be
622 authorized in PPA. [...] Environmental authorities have little
623 experience with this type of licensing, and it is therefore up to family
624 farming organizations to make proposals for agroforestry systems [28]
625 (Deitenbach, 2008: 131).

626 [29] Silva and Steenbock (2011) indicate that different productive practices or
627 production and reproduction systems of distinct social groups do not correspond in laws,
628 decrees or other legal instruments in the environmental area. This may erroneously
629 assume that such practices are illegal and are often prohibited by the environmental
630 agencies themselves. If agroforestry encounters barriers and/or difficulties to be
631 regulated this is mainly due to the lack of knowledge about them.

632 Considering that diversified and agroecological agroforestry systems provides an
633 ecologically balanced environment for present and future generations and restores
634 ecological processes, they need to have protection and recognition from the government.
635 In whatever way, to have legal support according to the provisions of Forest Code and
636 other mentioned legislative tools, the question of the type of agroforestry needs to be
637 raised as not all of them can be used.

638 Agroforestry plays an important role in the regeneration of vegetation, as well as
639 in effecting the process of conservation and expansion of forest remnants. The use of
640

641 this alternative in PPA and LRA is potentially favorable and is a strategy to regularize
642 rural establishments.

643 The actual scenario of deforestation and environmental public policies regression
644 in Brazil, in the context of Bolsonaro's government, started in 2019 have been harming
645 preservation and conservation possibilities. Regardless of the legal possibilities
646 discussed in this paper, the Environmental Regularization Program (ERP) provided in
647 Law 12,651 of 2012, as well as agroforestry management practices within the scope of
648 the agroecological perspective, have not been advancing in Brazil. Thus, it is necessary
649 to consider the weakness of Brazilian environmental agencies [28, 27, 26] (Deitenbach,
650 2008; Martins and Raniere, 2014; Ewert et al., 2016).

651 Regarding legal means presented here, that could disseminate and support the
652 use of agroforestry, [28] Deitenbach (2008) comments that the Federal Government
653 should consider the social interest, in most of cases, providing financing for family
654 farmers, in addition to the environmental interest in the use of natural resources.
655 Although the law provides for technical support for agroforestry management, it is
656 necessary to move forward in this direction, prioritizing campesino smallholders.

657 More work is needed on the qualitative improvement and quantitative expansion
658 of agroforestry systems in Brazil especially in smallholders. Therefore, it is necessary to
659 advance public policies, funding, training of technicians and campesinos and other
660 aspects, considering the importance of agroforestry in food security [30] (Neves, 2013)
661 and food sovereignty; to reduce the effects of climate change [31] (Schembergue et al.,
662 2017), expand carbon storage [32] (Torres et al., 2014); and the advance of agroecology
663 practices [33, 34] (Candiotto, 2020; Gregio, 2020).

664 According to [20] Meirelles (2003), despite the offer of credit for the
665 implementation of agroforestry, technical assistance has neither prioritized nor
666 promoted strategies. Even NGOs working with agroforestry have not been able to
667 expand them.

668 With such problems remaining, the tendency is to maintain insecurity
669 as farmers reject the introduction of trees on their properties. The
670 damage falls on the entire society due to the difficulty of advancing
671 feasible proposals that reconcile conservation and environmental
672 restoration and production of food, wood, fibers, fuels, medicinal
673 plants, and of environmental services [35] (Méier et al., 2011: 14).
674

675 [35] Méier et al. (2011: 14) states that, “when the management of agroforestry in PPA
676 is configured, the posture of environmental agencies has been punitive and restrictive
677 when it should be more instructive and informative”. This punitive bias can result in
678 farmers’ rejection of implementing this form of land use.

679 According to [36] Russo (2002: 77), agroforestry systems “should not be
680 presented as a magic solution that will solve all environmental and social problems”, but
681 be promoted as a “correction of conduct in relation to PPA and LRA”.

682 Certainly, agroforestry should not be seen as the only “solution” in discussions
683 about the restoration of environments, but as a viable and promising mechanism.
684 Depending on the ecological relevance of the area, as the case of PPA, the forest must
685 be regenerated with only native species. Nonetheless, agroforestry can contribute to
686 overcoming the idea that PPA and LRA are unproductive and unnecessary areas.

687 In addition, to being important alternatives for forest regeneration, the
688 accomplishment of agroforestry systems in PPA and LRA allows to reconcile the
689 restoration of degraded areas with the diversified production of food and other products,
690 and may contribute to the expansion of agroecology, food sovereignty, improvement of
691 smallholder livelihoods [37] (Dawson et al., 2014) and the income of rural family.

692 In this manner, only to illustrate some examples of diversified agroforestry
693 systems in Brazilian smallholders, it is interesting to mention experiences in different
694 ecosystems.

695 1) The work of *Cooperafloresta*, located in Ribeira River Valley, in the east
696 frontier between São Paulo State (Southeastern Region) and Paraná State
697 (Southern Region). This experience has been analyzed in a book with 15
698 chapters organized by [29] Steenbock et al. (2013), and in [38] Ewert et al.
699 (2016) paper;

700 2) The Ernst Götsch Syntropic Agriculture, created in Olhos D’Água Farm,
701 in the South of Bahia State (Northeastern Region). It was analyzed in [39]
702 Götsch (1997); [40;41] Gregio (2018; 2020) and on the website
703 “agendagotsch.com”;

704 3) Agroforestry systems in the Tomé-Açu municipality, Pará State
705 (Northern Region / Amazon Region), which involve commercial farmers

706 through Tomé-Açu Mixed Agricultural Cooperative (CAMTA) and campesinos
707 linked to Association of Rural Family Farmers of the Municipality of Tomé-Açu
708 (APPRAFAMTA). [42]Pompeu, Kato and Almeida (2017) and [43] Yamada
709 (2009) analyzed elements of this experiences.

710

711 **6. Conclusions**

712 Agroforestry corresponds to new possibilities for ecological management,
713 characterized by integrated cultivation, (whether of annual, perennial, forest, wood,
714 ornamental, medicinal, native and/or alien plant species). They can restore deforested
715 and degraded environments and conserve ecosystems and their biodiversity.

716 Important role in the restoration of native vegetation can be played by
717 Agroforestry, as well as in effecting the process of conservation and expansion of forest
718 remnants [5, 36, 7, 28, 46, 40] (Lundgren, 1982; Russo, 2002; Mead, 2004; Deitenbach,
719 2008; Paludo and Costabeber, 2012;Gregio, 2018). In this situation, some kinds of
720 agroforestry have the potential to restore degraded lands, to improve conservation
721 practices and to contribute to forest preservation [25] (Santos, Crouzeilles and
722 Sansevero, 2019). The use of this alternative in PPA and LRA is potentially favorable,
723 being a viable and promising strategy to regulate rural context, mainly smallholders [8,
724 45, 37] (Roshetko et al., 2008; Dawson et al., 2013; Dawson et al., 2014), which are
725 mainly managed by campesinos.

726 Charging, punishing and demanding compliance from farmers and campesinos is
727 not enough, it is necessary to create conditions that enable farmers to produce quality
728 food, conserve natural resources, and restore the existent environment on their rural land
729 (water, soil, forests).

730 Depending on the ecological relevance of the area, the most important aspect of
731 PPA is to regenerate the forest with only native species. But exotic and alien species can
732 be planted in LRA, either to serve as support for native species in the initial stages of
733 implantation or to be used as products to support farm livelihoods or organic matter to
734 cover and regenerate the soil.

Considering Law 12,651 of 2012, there are several opportunities to use agroforestry systems in the process of forest restoration and legal regularization of smallholders and in greater rural establishment. For example:

- 1) Agroforestry systems can improve to mitigate emissions of greenhouse gases (GHGs) through capturing and storing atmospheric carbon [46] (Torres et al., 2014);
- 2) Compositions and farmers can be benefited by Payment for Environmental Services (PES);
- 3) Agroforestry can optimize the creation of ecological corridors, linking forest remnants, which are generally located in PPA and LRA;
- 4) Farmers that administer and have profit with agroforestry systems can expand this kind of land usage beyond PPA and LRA;
- 5) Agroforestry can contribute for river basin planning and management, at various spatial scales, optimizing environmental and territorial management.

Finally, this paper shows that Brazil has a forest legislation that allows combining preservation, restoration and productive use, through agroecological and diversified agroforestry systems. It can be used as an example in other countries and compared with other initiatives and experiences around the world.

In the Brazilian context, the article highlights the importance of prioritizing agroecological and diversified agroforestry systems (with native species and diverse biodiversity) in LRA and PPA restoration, mainly in campesinos smallholders, to contribute to environmental and social sustainability. If simple agroforestry systems (with the introduction of alien species and a few diversity) expand in LRA and PPA, it can hasten the problem of native biodiversity loss. So, simple agroforestry systems should be used in degraded lands or to substitute other agriculture or pastureland use, but not in PPA and LRA. Thus, institutions linked to environmental conservation and to campesinos need to focus on agroecological and diversified agroforestry systems to reconcile food production and forest restoration.

Agroforestry can contribute to expand sustainable land use strategies, along with overcoming the idea that PPA and LRA are unproductive and unnecessary areas. Nevertheless, for this alternative be actualized, there are many challenges, which may require the proper application of forest legislation; the training of technicians and farmers regarding the institution and management of agroforestry systems; the strengthening of research and rural extension actions based on a conservation and integrated perspectives between society and

nature; the creation and implementation of public policies that provide subsidies, credits or funds for the expansion of agroecological agroforestry systems in Brazil.

HIGHLIGHTS This part is not necessary. It should be removed

Forests preservation and restoration are crucial to sustain ecological and social benefits.

In the context of forest restoration, agroforestry systems are important land use instrument because they allow sustainable forest management combined with food production.

Brazil's forest legislation permits to combine preservation, restoration, and productive uses in Legal Reservation Areas (LRA) and Permanent Preservation Areas (PPA), which are protected lands of rural properties.

This paper discusses possibilities and limitations to introduce agroforestry systems in Brazil through LRA and PPA, highlighting the importance of agroecological and diversified agroforestry systems.

Agroforestry systems are also viable for the restoration of degraded areas and for expanding forested areas and uses of their natural resources, especially in campesino properties.

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NB: 1- Some authors you provided are not found in the whole text. It is compulsory to withdraw all of them

2- You must redo references by referring to the order of the authors in the text. You have to begin by

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