Deliverable 1
Circular Food System Network

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Project title:	Agroforestry systems and circularity in Peru and Colombia
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WUR = Wageningen University & Research, PUCP = Pontificia Universidad Católica del Perú, CAFFS = CGIAR Research Program on Climate Change Agriculture and Food Security, CIAT = Centro Internacional de Agricultura Tropical.

Main

The aim of this report is to inform Wageningen Livestock Research (WLR) on the progress of case study 1 for the Network on Circular Food Systems. The report is structured in three parts: 1) Update on the focus of the case studies, 2) Description of agroforestry systems in Peru and Colombia, as well as the originally proposed case studies 3) Results of the literature review on agroforestry research in Peru and Colombia.

1. Update case studies

The original research idea of the project, which aimed for a common paper titled "Agroforestry systems and circularity in Peru and Colombia: state of the art, opportunities and tradeoffs and synergies for SDGs" has been modified in order to present the results of the Peruvian and Colombian case studies in different papers. This change of plans responded to the availability of data for the Peruvian case study (and absent for the Colombian case study), the different types of agroforestry systems addressed for each country (livestock vs crops), and the risk of having low response rates from scholars and farmers in the planned online interviews and workshops during the end of the year holidays.

Deliverable 2 will include a figure for each case study, deliverable 3 a draft of the progress of the report and deliverable 4 a draft of the two manuscripts. All members of the project will co-author both articles and specific experts might be invited to participate.

1.1. Peruvian case study:

Zero deforestation in carbon-rich landscapes is acknowledged as one of the key actions for the reconfiguration of food systems. In Peru, a country with 70% of its territory covered with Amazon rainforest, agroforestry is the land-use alternative recently promoted by the government to stop deforestation associated to agricultural expansion.

However, with inadequate soil conservation practices, agroforestry systems will not succeed. The lack of soil fertility after a few years of forest clearing and its subsequent effect in reduced crop yields and crop health is one of the causes for the expansion of the agricultural frontier into primary forests.

To restore degraded soils, avoid soil degradation in agroforestry systems and, hence, reduce deforestation into primary forest, we propose to embed circularity into Peruvian agroforestry systems. Peru has a rudimentary waste management system in which most of the food waste and loss produced in urban settlements is disposed of in open dumps or low-sophisticated landfills becoming a source of GHG emissions, especially methane, and unutilized nutrients.

The aim of this case study is to quantify the GHG emissions mitigation potential associated to using composted urban waste streams as soil amendments in agroforestry-based systems. To this end, we will quantify the expansion of the agricultural frontier associated to forest clearing, quantify the potential amounts of compost that could be produced from urban waste streams, estimate a GHG balance accounting for avoided emissions in landfills and open dumps, emissions associated to compost elaboration, emissions associated to transport and avoided emissions associated to deforestation.

Although this circular scenario will require many actions to be implemented at scale (some of them unfeasible at the moment), our paper aims to bring circularity into the debate in Latin America, especially in a context in which the agricultural frontier and deforestation must be managed with care to comply with international agreements. We are combining different challenges and proposed solutions related to food systems: deforestation, soil degradation, agroforestry, food waste GHG emissions and valorization of urban waste streams. In the manuscript we will address the main potential barriers (e.g., investment, new supply chains, weak institutions), the implications of such a measure at a food system level (e.g., not only Amazonian soils need to be kept healthy, but also those soils from where the wasted food came from), and other actions beyond circularity to stop deforestation (e.g., more enforcement, etc.).

2.2. Colombian case study

In Colombia, cattle play a key role for local livelihoods and food security but has a high environmental footprint linked to deforestation. As part of environmental national targets [1] and the increasing societal demands for sustainability standards, different initiatives are setting the environmental standards for the sustainable transformation of Colombian cattle systems.

Examples of these initiatives include The Zero-Deforestation Agreement for beef and milk within the framework of the Tropical Forest Alliance (TFA), the Colombian Sustainable Livestock Roundtable (MGS-Col), the Colombian Sustainable Livestock Program (PCGS), and the GANSO and Grassfed endorsement. Other recent examples include two initiatives promoted by the Colombian government: The Green Taxonomy and the Sustainable Livestock Stamp. A common characteristic of most initiatives is they all incentivize the adoption of silvopastoral systems and the implementation of improved pastures as a land-use alternatives to transform landscapes and halt deforestation.

So far, there has been limited attention to the inclusion of circularity practices into the Colombian cattle sector. Colombia has recently launched a National Strategy for Circular Economy [2] and the only actions linked to livestock are associated to the valorization of manure as an organic fertilizer and as feedstock for bionergy. Considering that most Colombian cattle graze freely in extensive systems, manure collection for valorization is a hardly achievable task. Identifying other opportunities to embed circularity into the Colombian cattle sector, including silvopastoral systems, is valuable to broaden the cattle sustainability discussion beyond the farm level and include a food systems perspective.

For this case study we aim to produce a perspective paper in which we: 1) group and synthetize the interventions proposed by the different initiatives to make the Colombian livestock sector more sustainable, 2) identify the opportunities to include circular strategies as part of sustainable cattle systems, 3) Address the relevance of including circularity elements with local examples and 4) provide a framework to include circularity in the Colombian cattle sustainability agenda.

2. Description of Agroforestry Systems in Peru and Colombia

2.1. Peru

The Peruvian territory is divided into three distinctive regions, being the Pacific coastline known as "Costa", the Andes highlands known as "Sierra", and the Amazon rainforest known as "Selva" (Figure 1).
The coast is mainly a desertic strip of land. Agriculture is mainly practiced in valleys that flow to the Pacific Ocean due to the availability of water provided by seasonal rivers. In addition, in recent decades, desertic areas have been converted into agricultural land through the use of groundwater and irrigation infrastructure. Agriculture in these areas is large-scale, high-input and export-oriented [3–5]. However, agroforestry systems in the coastal region are scarce and not widely adopted. The agricultural use of trees is associated to 20 species [6], from which a few are for food (e.g., "pacae" *Inga* sp.), and the rest for different functions such as windbreak, plot delimitation, source of wood and medicines [6,7]. Silvopastoral practices are applied by some smallholders in the natural equatorial dry forest of Northern Peru. However, this practice is limited to some villages, performed in a small-scale and practiced as a financial insurance for dry years [8,9].
Agriculture in the Andean highlands is dominated by mixed crop-livestock smallholder farming in agricultural units commonly smaller than 2.5 ha [10]. In 2012, nearly one third of the agricultural land in the Andes was destined for self-consumption. Nonetheless, Andean small-scale agriculture plays a key role for the provisioning of vegetables, fruits and animal products for Peruvian cities. Andean farmers use and maintain a vast crop genetic diversity [11], produce foods with low use of external inputs [12], and manage highland resources to obtain food and materials [13], but many of them live below the poverty line [14]. Trees have been part of the traditional agricultural Andean landscape [15]. Farmers use trees for different means such as erosion control, water conservation, medicines, livestock feed, crop protection, wood and ornamental means [15,16]. Most of the agricultural use of trees in the Andes is associated to non-commercial uses (i.e., except avocado), and many native trees species are endangered due to the high rates of deforestation [6].

The Amazon is Peru's largest geographical region. Like other large and remote biomes, the Amazon is usually viewed as an untamed wilderness, a vast untouched space [17]. However, this rainforest has been managed by indigenous people for millennia through complex slash and burn agroforestry systems, shaping this biome's biodiversity in the process [18–20].
Despite of the vast legislation promulgated since the 1960s to manage Peruvian forest resources [21–23], the Amazon has been subject to extensive deforestation [24]. Deforestation has been mainly linked to agricultural expansion of smallholder migrant farmers, and recently medium and large-scale monoculture projects (i.e., palm and cacao), cattle-ranching, and alluvial gold mining [24,25]. The permanent crops with the largest agricultural area in the Amazon are coffee, cacao, palm oil and Brazilian nut, being coffee and cacao the ones with the largest agricultural area under agroforestry systems (Table 1).

Table 1. Main permanent crops in the Peruvian Amazon, 2019.

	Coffee	**Cacao**	**Oil palm**	**Brazil nut(1)**
N° producers	223738	89789	3185	1261

Agrosilvicultural area (1000 ha)[(2)]	379,9	153,0	0,0	17,6
Total area (1000 ha)	438,2	170,0	74,7	17,6
Agrosilvicultural area as % of national agricultural area[(3)]	3,3%	1,3%	0%	0,2%

Sources: Bennett et al., 2018; Finer & Novoa, 2015; Livia et al., 2021; SEIA-MINAGRI, 2021; SERFOR, 2019; Somarriba & Lopez-Sampson, 2018; Suber & Robiglio, 2016.
Notes:
(1) Area based on the intersection of the 1.075 million ha of brazil nut concessions [28] and agricultural surface mapped by the Peruvian government [29]. Producers based on the number of concession contracts [28].
(2) Assuming 86,7% of shade-coffee cultivation taken from ([31]), 90% of shade-cacao cultivation ([26]), and no agrosilvicultural practices for oil palm. Because of its nature as a non-timber product obtained from primary forests, all brazil nut production was considered agrosilvicultural.
(3) Percentages based on an estimated 11,6million ha of the Peruvian agricultural surface in 2018 [29].

Agroforestry legislation and CUSAF

In 2011, the new Peruvian forest law acknowledged agroforestry as a path to sustainable development and gave a legal figure to the so-called Agroforestry Usufruct Concession (CUSAF in the present document). However, it was not until 2017 that the guidelines for CUSAF became available. CUSAF was proposed as a mechanism to allow small producers (mainly in the Amazon) with less than 100 hectares to formalize with renewable land-use rights for 40 years. In exchange, producers need to commit to avoid deforestation within their concession and to adopt agroforesty as the main land use [32].
Since the approval of this scheme, CUSAF has started to be implemented in the Peruvian Amazon. The region of San Martin has been used as a pilot area to improve civil records checks for petitioners (i.e., not having an environmental crime record), mapping systems (i.e., avoid overlapping protected areas or other land rights with the concessions), and the monitoring schemes for commitments (i.e., confirming adequate management via remote sensing or field-work if needed). A total of 41 CUSAF contracts were approved in San Martin by July 2021 and 500 applications were under process [33]. These experiences are expected to lead towards an increased interest for participation among the 123,000 potential participants of this new legal mechanism that provides land tenure rights via agroforestry concessions [33,34]. CUSAF is expected to reduce deforestation by making agroforestry formalization more economically attractive than slash and burn agriculture [35,36].

Coffee production systems

Among the main commodities produced under agroforestry in Peru, coffee is by far the most extended. It encompasses the work of more than 223,000 producers and approximately 380,000 ha of shade-coffee (considering about 87% of coffee being grown in this system) [30,31].

According to Jezeer & Verweij (2015), coffee production can be divided in two systems and four subsystems according to their use of agro-chemicals and vegetation structure complexity:

- Mono-culture sun –grown coffee, which represents 13% of Peruvian coffee cultivated area (Figure 1), and divided among traditional (i.e., without agrochemical use) and conventional (with agrochemical use) systems [31]:
- Shade-coffee with complex-vegetation structure, which accounts for 87% of Peruvian coffee cultivated area. It is divided among organic shade-coffee (i.e., without agrochemical use) and intensified shade coffee (with agrochemical use) systems (Figure 1) [31].

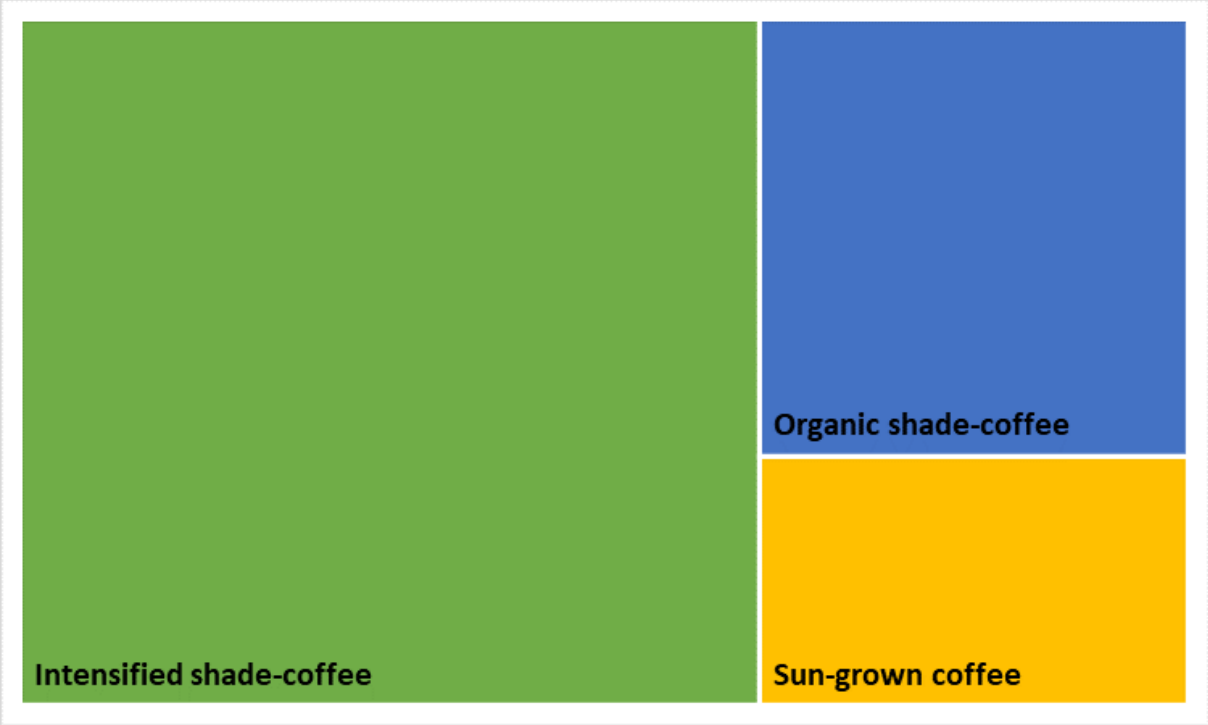


Figure 1 – Agricultural area for each type of production system. A bigger rectangle means larger area. Note: (1) Total coffee ha: 438 thousand ha in 2019 [30]. (2)Proportion of shade-coffee (87%) based on Suber & Robiglio (2016). (3) Organic shade-coffee based on 102,7 thousand ha estimated in 2016 [37].

Challenges associated to coffee production

Peruvian coffee producers face different challenges such as low profit margins, phytosanitary problems and recently the impact of Covid-19.

Considering that coffee is an international commodity, its price is set at the New York and London stock exchanges [38]. Brazil and Vietnam together produce more than 50% of the world's coffee production [39–41], and international prices are set in line to their costs, which are lower than those of Peruvian producers. In this context, Peruvian coffee producers depend on family labour to attain small profit margins [40,42].

Coffe leaf rust (*Hemileia vastatrix*) was first discovered in Peru in 1979. However, it was not a relevant issue until 2013 when an epidemic that started in Colombia in 2008 began to hit Peruvian coffee production. Despite the rapid implementation of a 100 million Peruvian soles plan (28 million euro in 2013) by the Peruvian government, 40 thousand hectares of coffee cultivated area were lost between 2013 and 2014 [42,43]. The heavy burden of production losses led to a reduction in the cultivated area from 429,000 ha in 2013 to 335,000 in 2016 [30,42]. Research on coffee leaf rust control and the government's investment to safe this sector, led to a recovery that begun in 2017 [30,43–45]. However, this recovery was halted by Covid-19. Although coffee value chain is highly integrated, the area covered by coffee in 2020 reduced by about 25%, from 438,000 ha to 328,000 ha [30,46].

Coffee producers in Peru have been addressing their vulnerabilities on multiple fronts. There has been a broad replacement of Arabica coffee plants to hydrids with greater resistance to coffee leaf rust. There has also been some land use intensity changes among producers. Some have changed towards intensification, reducing shade cover and increasing the use of agrochemicals and bush density. Meanwhile, other

producers have expanded by deforesting new areas to increase their profits[47]. Some producers have also started growing other crops. Some of them have diversified their crops to reduce the impact of price changes. Others have switched to coca production, which allows them to produce 3 to 4 times a year, allowing them to achieve higher profits. Since coca is grown under full-light exposure, this change in land use increases deforestation [46,48].

Coffee value chain

Once coffee cherry is ripe, the journey to the cup begins (Figure 2). As abovementioned, because of the low coffee prices and high labour costs, most harvest is undertaken by family labour. After harvest, the cherries are processed either by individual producers or by cooperatives which usually gather the production of several small-holders. Wet processing is the most usual method applied to coffee cherries, which involves the processes of sieving, pulp and mucilage removal and a final washing [49,50]. After washing, coffee is sundried, to reduce its moisture from 60% to approximately 12%. The resulting product is called parchment coffee, which is the coffee bean still enclosed by its husk. After the husk removal and packaging, green coffee beans are sold to intermediaries, with 95% of Peruvian coffee being exported abroad [42]. Although there are multiple possibilities for the use of agro-residues along the chain [49] (i.e., pruning waste, washing water, pulp and mucilage, husks), no research has been done in Peru about their current uses. After export, coffee undergoes a roasting process which takes place in the importing countries, leading to the final consumed product.

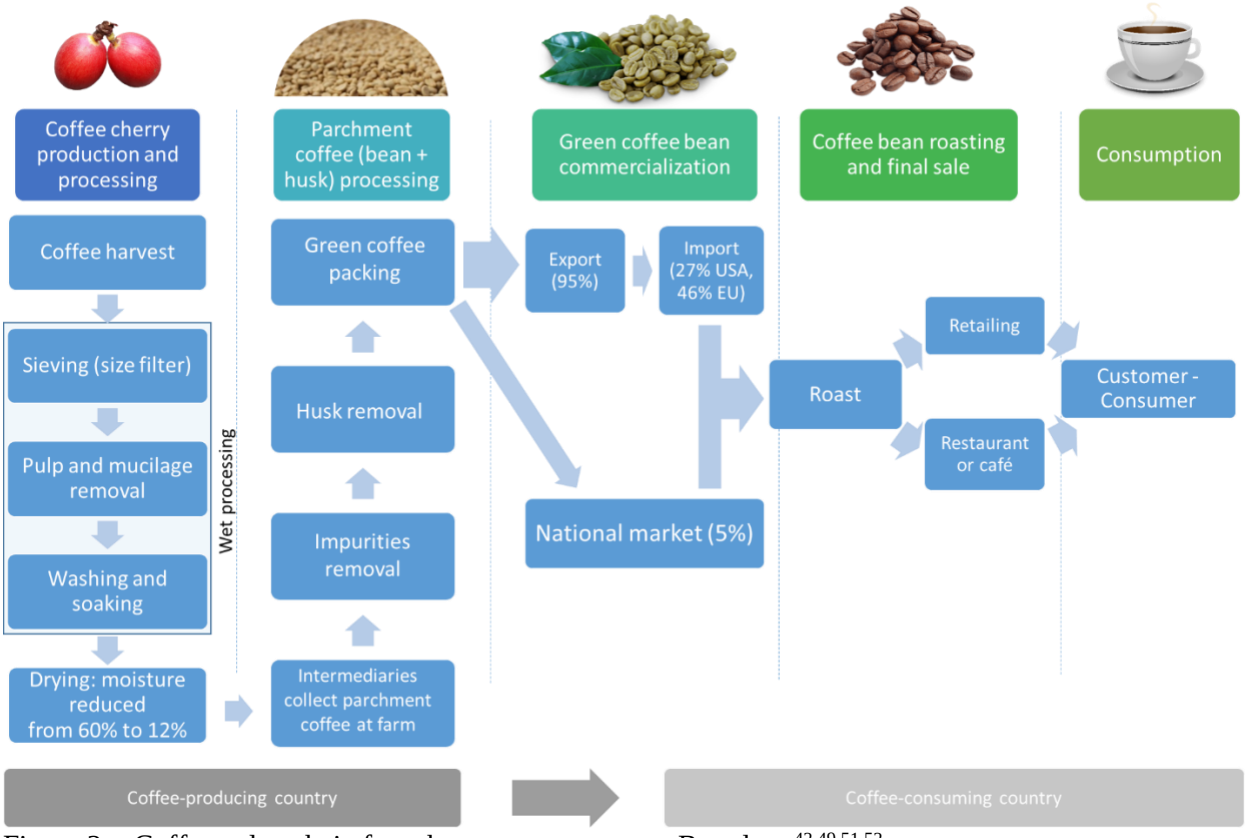


Figure 2. - Coffee value chain from harvest to consumer. Based on [42,49,51,52].

Opportunities in coffee production systems

There is a positive outlook for agroforestry in Peru, especially in the coffee sector. As mentioned in earlier sections, Peru has established a clear legal framework for agroforestry, promoting formalization based on commitments and benefits through CUSAF contracts [36,53].

In 2015, the United Nations Development Programme launched the "Resilient Amazon" project, which sought to improve resilience of protected areas in the Peruvian Amazon. This project, set to end in December 2021, has also provided technical assistance to rural communities in protected areas' buffer zones to promote sustainable coffee and cacao production [54].

Since November 2017, the "Coffee Alliance for Excelence" (CAFE) project led by USAID has provided technical assistance to more than 7800 small coffee producers in the San Martin and Huanuco regions, increasing the yields of 16 thousand ha in 40% [55]. This project also teaches coffee producers about sustainable practices and connects them to markets, to improve their access to inputs, fair selling prices and formal financial services (e.g., credits). This project has a funding of 11 million US dollars and is planned to go on until November 2022 [55].

Furthermore, in January 2020, the "Alliance for Sustainable and Competitive Coffee" project was lunched by a group of organizations led by the Swiss Cooperation in Peru and the Andes. This coalition includes Helvetas Peru, the National Coffee Board, Peruvian Coffee and Cacao Chamber, SOLIDARIDAD and World Agroforestry-ICRAF. This alliance has been working to improve governance, promote sustainability and increase climate resilience. It is set to finish in February 2022 [56,57]. Organic shade-coffee is also undergoing improvements. The biggest certification standards, UTZ and Rainforest Alliance, have signed a deal to join forces in a new standard called Multitrace, coordinated by Rainforest Alliance. It is expected that this new standard will simplify processes and set digital trazability tools [58].

2.2. Colombia

Agroforestry systems in Colombia

The International Center for Research in Agroforestry (ICRAF) defines agroforestry as a sustainable crop and land management system that seeks to continuously increase yields, combining the production of wooded forest crops (including fruit trees and other tree crops) with field or arable crops and / or farm animals simultaneously or sequentially on the same unit of land, also applying management practices that are compatible with the cultural practices of the local population [59]. Based on the components of the systems, Nair (1985) [60] classifies agroforestry systems as follows:

Table 2. Classification of agroforestry systems

System	Components	Function/Products
Agrosilvicultural	Crops and trees, including shrubs / trees with trees	Food, wood, soil conservation, maintain soil moisture, improve soil structure
Silvopastoral	Pasture, animals and trees	Food, wood, fodder, shade, windbreaker, soil conservation, maintains soil moisture, improves soil structure
Agrosilvopastoral	Crops, pasture, animals, and trees	Food, wood, fodder, shade, windbreaker, soil conservation, maintains soil moisture, improves soil structure
Multiporpuse Forestry Production	Multipurpose trees, beekeeping with trees, aquaculture with trees, etc.	Food, wood, fodder, shade, windbreaker, soil conservation, maintains soil moisture, improves soil structure

Modified from Nair (1985).

In Colombia, the third national agricultural census, reported about 584.802 ha of systems "in association", which also included agroforestry [61]. Among the most common agroforestry systems are those associated with coffee, cacao, and livestock (Table 3). In Latin America, 1,5 million hectares of cocoa are cultivated,

of which 70% are in agroforestry systems [62]. In Colombia by 2016, the cacao crop was an economic activity that covered 173,016 ha and considered the "crop for peace" for its use as a substitution for illicit crops [63]. For this reason, the department of Caquetá in the Colombian Amazon has increased its area from 555 ha in 2007 to 1350 ha in 2016 [63]. However, despite the importance of the cacao crop for Caquetá and Colombia, no studies have been reported on the typologies of predominant agroforestry arrangements [64]. Some authors estimate that approximately 25% of the cacao crop in Colombia is under agroforestry systems [62]. Coffee production in Colombia represents 4% of the current GDP and more 550,000 families cultivate coffee in mixed agricultural systems [65]. By 2014 of the 920,000 hectares cultivated, 33.1% were in semi-shade and 16.8% were under shade [66].

In the case of livestock, silvopastoral systems have been promoted through projects financed by different international organizations, royalties from hydrocarbons extraction and research centers dedicated to studying the benefits of these systems for the producers and the environment. In the following sections the livestock cattle production systems, its value chain and silvopastoral systems in Colombia are described.

Table 3. Main agroforestry systems in Colombia

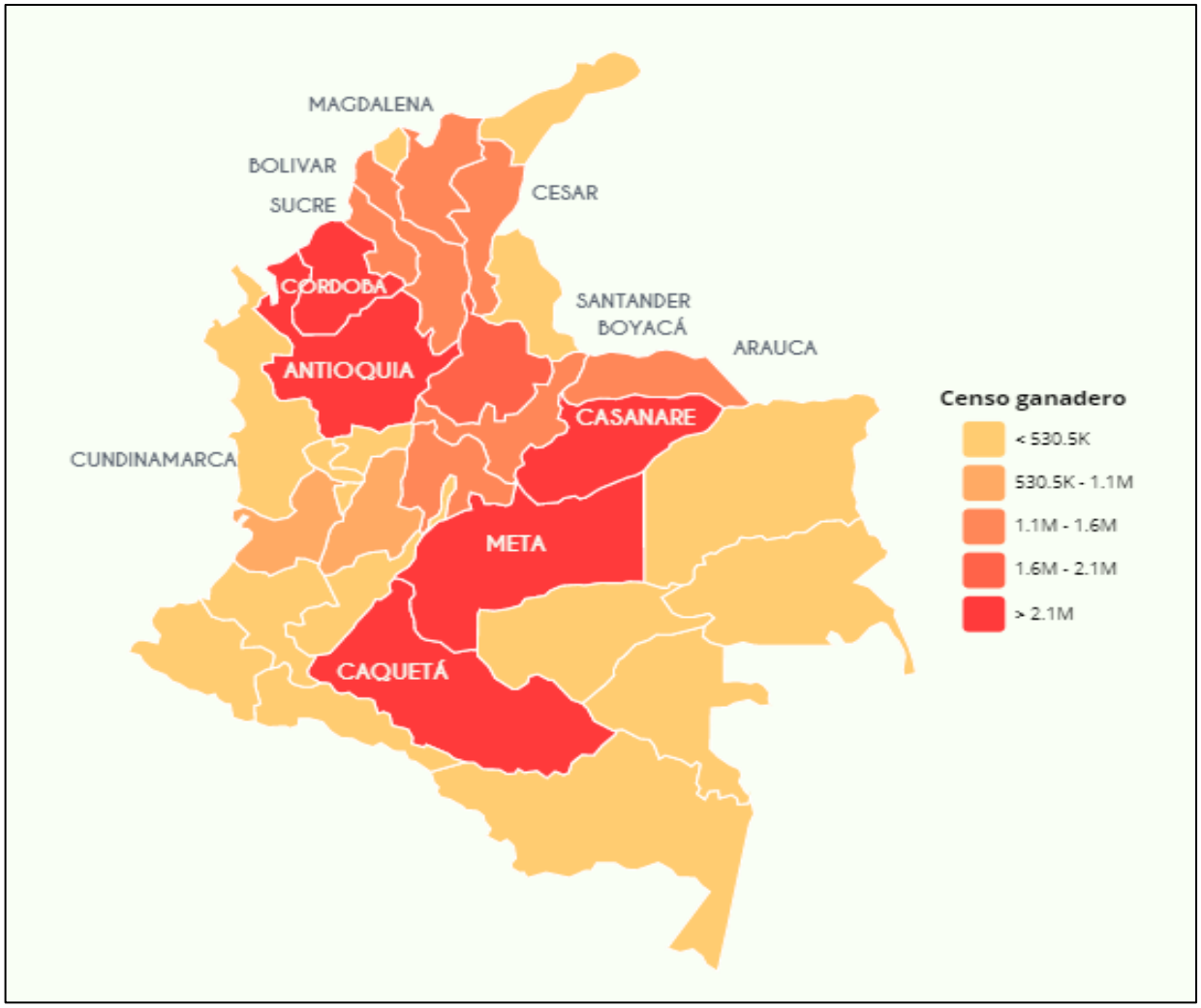
Crop/System	Departments	Total area (ha)	Agroforestry system (ha)	References
Coffee	Nariño, Norte de Santander, Antioquia, Valle del Cauca, Cundinamarca, Huila, Cauca, and the "Eje Cafetero": Tolima, Caldas, Quindío and Risaralda.	902.424	308.000	[61]
Cacao	77% of the cacao production in Colombia is concentrated in the departments of Santander, Antioquia, Arauca, Huila, Tolima, and Nariño.	188.000	Approximately 47.000*	[62,67]
Livestock	Antioquia, Caquetá, Meta and Casanare	34,4 million	77.000	[61,68]

Livestock cattle production in Colombia

Livestock production is one of the most important productive activities in the country due to its socioeconomic contribution, cultural connotation and its appreciation as a source of food with high nutritional value in most of the territory [69]. The agricultural sector occupies 38.6% of rural area from which 80% is destinated to livestock [61,69]. Between 2005 and 2019, the livestock sector contribution to the annual agricultural GDP ranged between 24.8% and 27.9% [70]. During 2018, 16.7% (approximately 3.7 million people) of the employed population was dedicated to agricultural activities of which 19% were specifically engaged to cattle production [71]. These jobs substantially support the livelihoods of smallholder families in rural areas, where more than 51% of livestock cattle producers have less than 50 animals per farm [69].

Cattle production systems in the country are managed mainly under extensive conditions. According to the Colombian Agricultural Institute (ICA), cattle herds are present in 655,661 farms that have an average animal stocking density of 0.714 cattle per hectare [72]. Pastures occupy 80% of Colombia's agricultural land with low stocking rates that promotes an overuse of the land by cattle [69] due to the permanence of few animals during long periods of occupation in large areas. This traditional practice promotes overgrazing and a consequently degradation of the pasture.
In the 2019 cattle inventory 28.2 million heads were registered [72]. The four main production orientations had the following participation in the inventory: 39% breeding, 20% fattening, 35% dual purpose and 6% specialized dairy [73]. Cattle is distributed around the country (Figure 3).

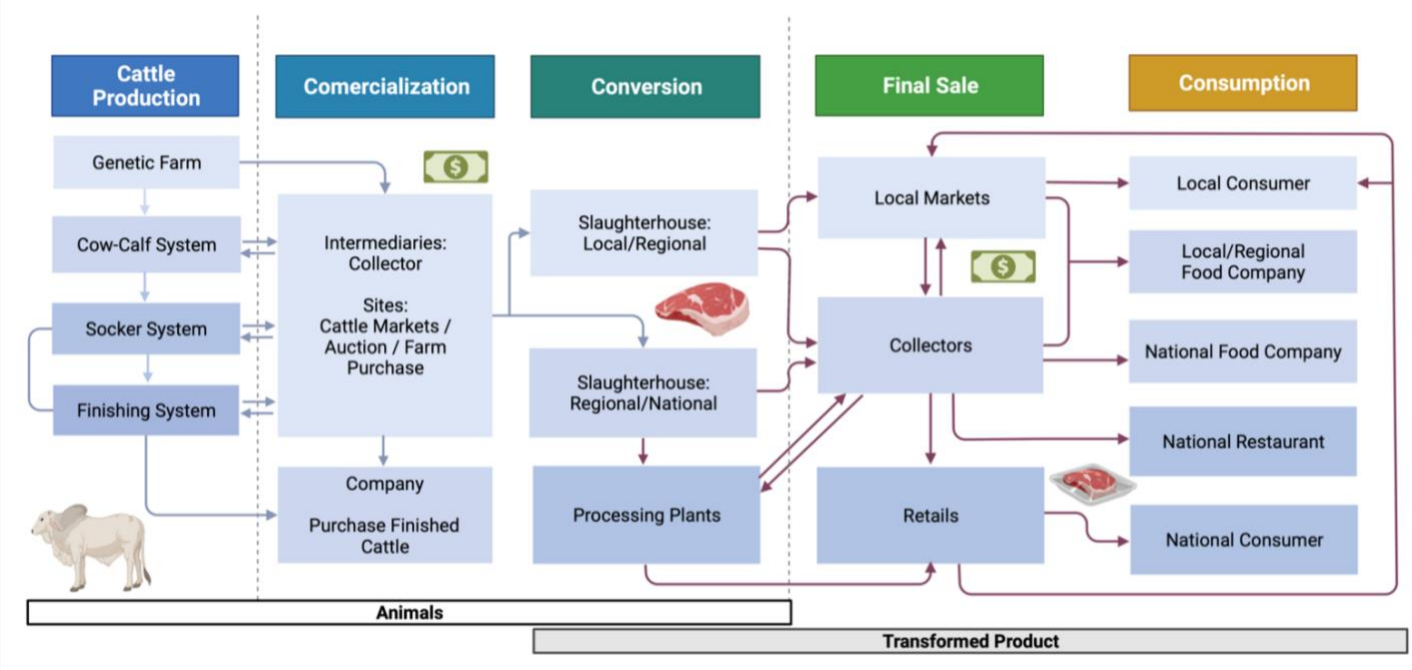
Figure 3. Distribution of cattle heads in Colombian regions. “Censo ganadero” refers to Cattle census.



Colombian cattle production specializes mainly in meat production. Throughout 2019, 932,813 metric tons of carcass meat were produced [74], of which 96% was destined for internal consumption and 4% for external markets [75]. Meat production mainly supplies the need for domestic consumption and beef is the second option of animal protein, after chicken, with a 25% share of the average annual consumption of animal protein. Total animal protein consumption is 74 kg per capita/year [69].

Beef production systems in Colombian are carried out in stocker, stocker/finishing and finishing farms and the animals come from double purpose and cow-calf farms. The stocker period starts when the calf is weaned and reaches a live weight of 300 kg approximately. In the finishing period, the animal reaches a live weight between 480 and 500 kg to sacrifice. The meat value chain is presented in Figure 4.

Figure 4. Colombian meat value chain



Colombian Silvopastoril Systems

Silvopastoral systems are an agroforestry model where forage plants such as pasture or legumes interact with shrubs and trees destined for animal feed and protection [76,77]. Pezo & Ibrahim (1998) [78] differentiate neotropical silvopastoral systems into two groups, traditional silvopastoral systems and improved silvopastoral systems. Traditional silvopastoral systems are developed empirically by the local population as a form of production according to the resources to which they have access to [78]. Improved silvopastoral systems have been developed as models in research centers that are subsequently promoted for adoption by producers [78]. According to different authors [79], the main silvopastoral arrangements are:

- Scattered trees in pasturelands
- Timber plantations with livestock grazing areas
- Pasture between alleys
- Windbreaks and live fences
- Fodder banks
- Intensive silvopastoral systems

In Colombia the most used silvopastoral arragements are live fences, forage banks (protein and/or energy banks), trees and/or shrubs scattered in pastures. Live fences are mainly used to delimit pastures and agricultural lands [80], in addition, they serve as windbreaks and generate structural landscape connectivity, functioning as biological corridors [81]. Live fences are commonly established by planting large stakes 2 to 3 meters of height harvested from the branches of adult trees with the capacity to re-sprout vegetatively [82]. The implementation of live fences is a traditional and widely used practice in the American tropics [83]. The protein bank consists of planting shrub species with high protein content, especially legumes to cut and carry and thus improve the quality of the animals' diet. Scattered trees in paddocks are a fairly common practice among ranchers and consists of letting trees or shrubs grow in paddocks. These provide shadow, foliage, and fruits for the feeding and welfare of the animals. Likewise, they constitute a source of income and food for producers. Intensive silvopastoral systems combine high-density cultivation of fodder shrubs

(4000–40,000 plants ha^{-1}) with improved grasses; and tree or palm species at densities of 100–600 trees ha^{-1} [79].

Silvopastoral systems in Colombia are established to restore natural resources, reduce deforestation, for a sustainable intensive production and for the sustainable diversification of land use addressing specific sustainability goals [79]. These systems have been implemented under different climatic conditions and in different production systems such as beef finishing, dual purpose, tropical dairy and cattle breeding [79] which also determines the selection of species for its establishment and the arrangements to be implemented.

Barriers that prevent the scaling of silvopastoral systems in Colombia

In the last decade, sustainable practices in livestock have received increasing attention, however, the transition to sustainable cattle production systems at the national scale still face multiple bottlenecks. These include but are not limited to 1) lack of knowledge about sustainable production models, their profitability, and technical assistance for the transition [84–86]; 2) little formality of land tenure; 3) limited access to investment capital or stable cash flows to obtain loans to finance the transition [79,87]; 4) low demand and willingness to pay premium prices for sustainable products; 5) limited access to infrastructure and formal markets [88]. These barriers directly affect the competitiveness of the sector and its prevalence in the future, which increases its vulnerability to economic, social, and environmental risks. To this extent, the livestock sector has an important opportunity to develop sustainable practices but requires support from initiatives and approaches that stimulate and facilitate the transition to sustainable value chains.

Projects/Initiatives/Policies that promote silvopastoral systems in Colombia

In recent years, different public and private approaches have been developed to incorporate and give value to sustainable practices in livestock production systems in Colombia. Efforts have been directed at creating awareness in producers, processors, markets, consumers, and the financial sector to promote the adoption of sustainable practices, including the implementation of silvopastoral systems, and create incentives and enabling conditions to transform the sector throughout the value chain. Some of the approaches that are betting on the sustainability of the sector are: The Zero-Deforestation Agreement for beef and milk within the framework of the Tropical Forest Alliance (TFA), the Colombian Sustainable Livestock Roundtable (MGS-Col), the Colombian Sustainable Livestock Program (PCGS), and the GANSO Endorsement. Other recent examples include two initiatives promoted by the Colombian government: The Green Taxonomy and the Sustainable Livestock Stamp. The result is the emergence of different approaches with a common goal: sustainability in the livestock sector. However, the variety of approaches also causes confusion for users, which is why it is necessary to seek alignment and articulation of approaches.

3. Results literature review on agroforestry research in Peru and Colombia

Hereby we include the abstract (confidential) submitted to the 5th World Congress on Agroforestry 2022. On the 1st of February 2022 we will be notified if it has been accepted. After the abstract, we included some Figures that showed visually the outcomes of the literature review.

Five-decade trends of agroforestry research in Peru and Colombia

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Background: It is widely acknowledged that agroforestry can contribute to achieving several sustainable development goals. To channel future research for sustainable development efforts, there is a need to identify long-term research trends and knowledge gaps adequately. This review focused on Peru and Colombia, tropical countries that have historically produced globally traded agroforestry commodities such as coffee, cocoa, and livestock.
Objective: Review, classify and identify main trends in agroforestry research in Peru and Colombia since the 1980s.
Methods: A systematic literature review was performed using Scopus, Web of Science and Scielo. Duplicates and articles based on research outside Peru or Colombia were removed. The remaining articles were classified according to the country researched (i.e., Peru, Colombia), type of agroforestry system (e.g., agrosilvicultural), commodity (e.g., coffee), and research topic (e.g., carbon sequestration).
Results: In total, 400 papers were reviewed and classified. For Peru (n=163), the main commodities represented in the scientific literature were coffee (15 %), cattle (14 %), and cacao (12 %); while the main topics were genetic resources with 12%, land use (7%) and soil (7%). For Colombia (n=257), the main studied commodities were cattle (54 %), coffee (20 %) and cacao (10 %); while biodiversity (17 %), soil (13 %) and animal nutrition (9 %) were the main research topics. Finally, while most research in Colombia focused on silvopastoral systems (52%), there was no specific trend in Peru.
Discussion: A steady growth in agroforestry research was identified in both countries, especially in Colombia, where publications increased from less than 20 between 2000 and 2010 to more than 150 in the past decade. Nevertheless, considering that only 47% (n=188) of the articles were open access and that institutions from both countries face paywall limitations, it is critical to guarantee open access practices for future research.
The focus on production-related factors and biodiversity evidence the relevance of agroforestry for SDG 2 (no hunger) and SDG15 (life on earth). There has also been research linked to SDG13 (climate action) via carbon sequestration. However, there are clear knowledge gaps for strategic food system research areas such as circular economy, food waste and losses, and reduction of environmental impacts along supply chains using a life-cycle approach.
Conclusion: The past five decades of agroforestry research in Peru and Colombia have focused on the links between agroforestry and biodiversity, soil quality and genetic resources. Future agroforestry research should cover research questions with a systemic approach, looking beyond the farm and landscape levels.
Figure 1. Treemap showing the topics researched within agroforestry systems and countries

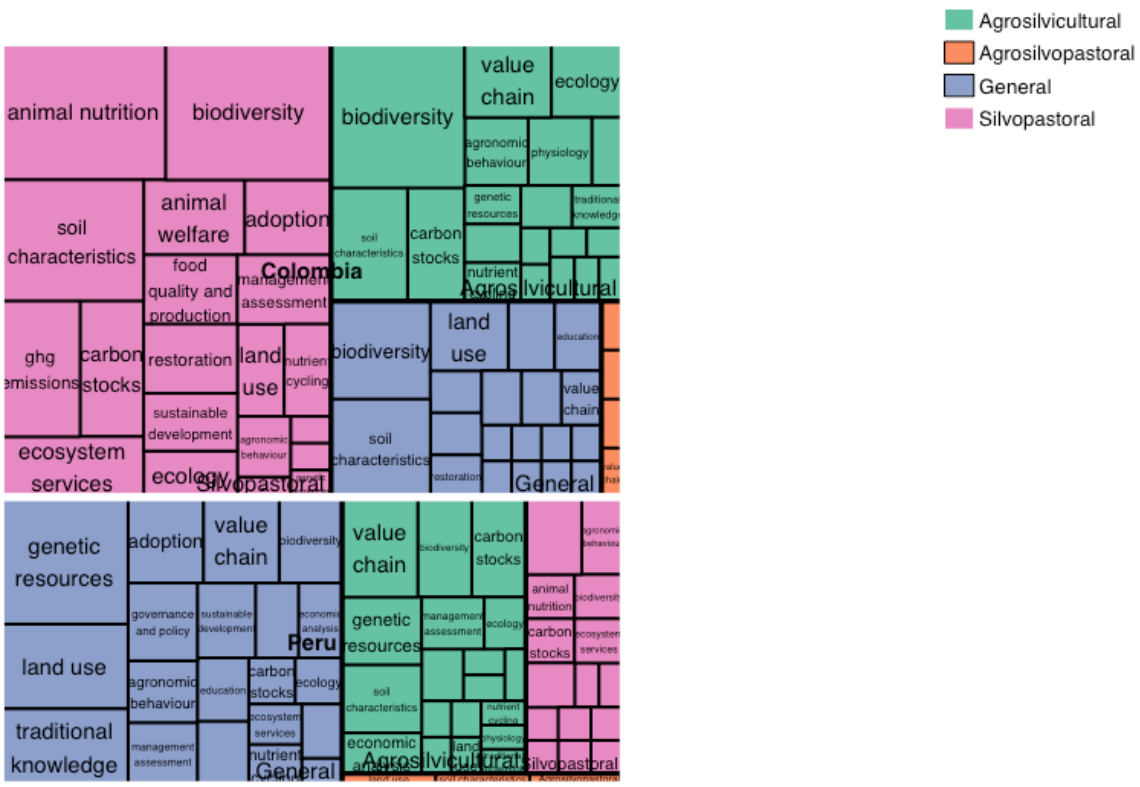
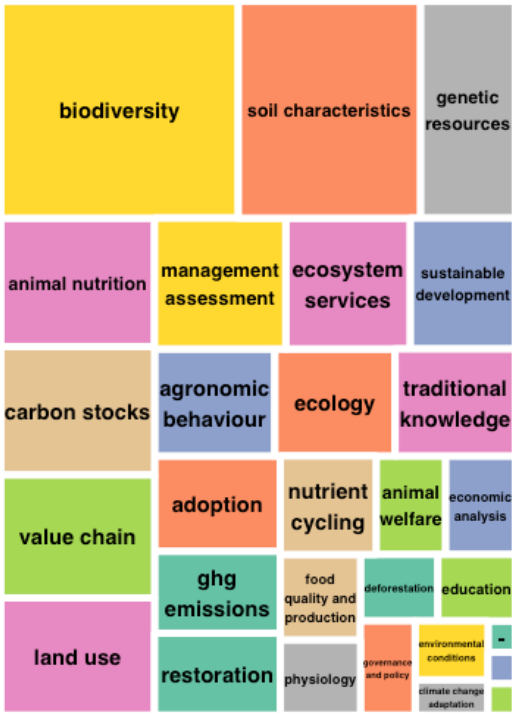


Figure 2. Treemap showing the topics researched within agroforestry systems and countries



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