CHARACTERIZATION OF CATTLE PRODUCTION SYSTEMS IN THE USE OF NON-TIMBER FOREST RESOURCES (NTFR) AND AGRO-INDUSTRIAL BY-PRODUCTS FOR ANIMAL FEED

CARACTERIZACIÓN DE LOS SISTEMAS DE PRODUCCIÓN GANADERA EN EL USO DE RECURSOS FORESTALES NO MADERABLES (RFNM) Y SUBPRODUCTOS AGROINDUSTRIALES PARA LA ALIMENTACIÓN ANIMAL

Víctor Julio Balanta Martínez[1]
Gustavo Adolfo Celis Parra[2]
Jhoyner Felipe Ortiz Meneses[3]
Diana Ali García Capdevilla[4]

Summary

This paper characterizes the socioeconomic and environmental analysis of the cattle sector in the state of Caquetá, through a survey that assesses the situation of small producers in the prioritized municipalities of San Vicente del Caguán, Puerto Rico, Doncello, Cartagena del Chaira, Albania, in the benefit and sustainable management of NTFPs and agro-industrial forest byproducts, in this context, the harvesting of (4) non-timber species corresponding to Canangucha Palm (*Mauritia Flexuosa*), Milpesos Palm (*Oenocarpus Bataua*), Boca de Indio (*Piptocoma discolor*) and Veranera (*Cratylia argentea*) were identified, two (2) agro-industrial byproducts of the stated known as Palmiste, Cacao shell (*Theobroma cacao*) and Copoazú (*Theobroma grandiflorum),* which originate in the region as a nutritional alternative for animals (cattle); it can be inferred that in spite of their recognition, the majority of cattle farmers have underestimated these resources, and their usability as a feeding alternative for cattle has been little or almost nil in the Amazon piedmont, since the findings indicate that in the region a better facilitating infrastructure is needed in the form of technical assistance, education and governmental support for the widespread adoption of NFTPs.

Keywords: Livestock production systems, forest resources, agro-industrial by-products, animal feed

Recepción: 01 agosto de 2021 / Evaluación 10 septiembre de 2021 / Aprobado: 10 octubre de 2021

[1] Docente Programa de Contaduría Pública, Facultad de Ciencias Contable, Económicas, y Administrativas, Universidad de la Amazonia, Florencia – Caquetá, Colombia. Email: v.balanta@udla.edu.co. ORCID: https://orcid.org/0000-0001-8875-3282

[2] Docente Programa de Medicina Veterinaria y Zootecnia, Facultad de Ciencias Agropecuarias, Universidad de la Amazonia, Florencia – Caquetá, Colombia. Email: gustavoadolfocelisparra@gmail.com. ORCID: https://orcid.org/0000-0002-5671-9677

[3] Médico Veterinario Zootecnista, Facultad de Ciencias Agropecuarias, Universidad de la Amazonia, Florencia – Caquetá, Colombia. Email: felipe.ortiz9511@hotmail.com. ORCID: https://orcid.org/0000-0002-1672-6653

[4] Docente Programa de Administración de empresas, Facultad de Ciencias Contable, Económicas, y Administrativas, Universidad de la Amazonia, Florencia – Caquetá, Colombia. Email: dia.garcia@udla.edu.co. ORCID: https://orcid.org/0000-0002-1672-6653

Resumen

Este artículo caracteriza el análisis socioeconómico y ambiental del sector ganadero en el estado de Caquetá, a través de una encuesta que evalúa la situación de los pequeños productores en los municipios priorizados de San Vicente del Caguán, Puerto Rico, Doncello, Cartagena del Chaira, Albania, en el beneficio y manejo sustentable de PFNM y subproductos forestales agroindustriales, en este contexto, el aprovechamiento de (4) especies no maderables correspondientes a Palma Cananguchа (Mauritia Flexuosa), Palma Milpesos (Oenocarpus Bataua), Boca de Indio (Piptocoma discolor) y Veranera (Cratylia argentea), dos (2) subproductos agroindustriales del dicho conocido como palmiste, cáscara de cacao (Theobroma cacao) y copoazú (Theobroma grandiflorum), los cuales se originan en la región como alternativa nutricional para los animales (ganado); se puede inferir que a pesar de su reconocimiento, la mayoría de los ganaderos han subestimado estos recursos, y su usabilidad como alternativa de alimentación para el ganado ha sido poca o casi nula en el piedemonte amazónico, ya que los hallazgos indican que en la región un se necesita una mejor infraestructura facilitadora en forma de asistencia técnica, educación y apoyo gubernamental para la adopción generalizada de NFTP.

Palabras clave: Sistemas de producción ganadera, recursos forestales, subproductos agroindustriales, alimentación animal

Introduction

UNICEF (2018) One of the challenges facing humanity is economic growth, accelerating the risk of food insecurity and malnutrition, this scenario must be reversed and prevent this threat. Sustainable agricultural growth of small producers will be effective if it allows increasing income, reducing poverty, in the same way strategies must be developed where locally produced goods and services can be taken advantage of (Colciencias, Minagricultura & Corpoica, 2016; Bernal, Rodríguez y Ortegón, 2020; Hernández, Hernández, Gil y Cárdenas, 2018). Development under a traditional approach would lead to the search exclusively to improve parameters that are related to profitability forgetting fundamental aspects such as social and environmental ones, hence the importance of development under a sustainable approach, therefore it is important to implement strategies that allow to know or characterize the productive systems (bovine), forests and natural resources present in the region which will allow a holistic view of the system and thus analyze its economic-productive viability, the support it can give to society and take into account the environmental impacts it can generate.

According to the third National Agricultural Census (NCA), 50.6% of the rural area is natural forest, 40.6% is agricultural, 7.2% is non-agricultural and 0.1% is new urban development. From the agricultural area, 80.5% are pastures and 19.1% are agricultural crops; the grasslands are implemented with few introduced grass species (less than 20 species) (Celis et al., 2004). Research on new species in Latin America is very poor (Tergas and Sanchez, 1979), in the national and regional scientific reports the same type of research is observed, where the species or variety of fashion what varies (Carrillo et al., 2007), the characterization of the attributes of the fashionable variety has not allowed the advancement of research in genetic resources of the regions (Maass and Pengelly, 2021; Mercado, 2018; Duarte, Barrientos y Castro, 2019); Bearing in mind the fact that the bovine production systems of Caquetá are based mainly and exclusively on extensive grazing of monocultures of grasses, where Braquiarias predominate, which are characterized by low levels of protein and high levels of fiber (Canchila et al. 2009); Taking into account the above panorama, it can be seen that the forest area is a source of forest resources with potential to be used as raw materials for the elaboration of balanced feed for animal production, especially for cattle, which is

the agricultural production system that occupies the largest area, which can be carried out through the implementation of technological packages and research products that take into account the rational use of natural resources (Rodríguez et al. , 2020; Arrieta, Lora y Sánchez, 2018; Palacios, Ortiz, Nuñez y Porras, 2019).

Historically, the rural population and communities living in tropical forests have been characterized by the use of the territory and ecosystems to satisfy their needs through the appropriation of nature, such as agriculture, livestock, fishing and, above all, the collection, use and processing of non-timber forest resources (NTFRs) and agro-industrial resources, many of which are currently commercialized and contribute to the local and national economy. In this way, Mukerji (1997), points to NTFR as a viable alternative to promote conservation through sustainable economic development alternatives that allow both the conservation of natural areas and the development of the human communities that inhabit them. The present chapter intends to carry out research oriented to the sustainable use and management of Non-Timber Forest Resources (NTFR) and Agro-industrial forest resources in the state of Caquetá, as a nutritional alternative for animals (cattle) contributing to the generation of new scientific knowledge in the territory for the most representative productive sectors and at the same time, as a means to improve the welfare of rural populations and to conserve existing forests.

Theoretical Framework

Utilization of Non-Timber Resources of the NTFR Forest

People living near forests obtain a large amount of forest and non-forest products for direct consumption or for sale in the local or regional market. Products obtained from the forest that are not lumber or timber are called NTFR (Gerez and Purata, 2008). NTFR include all those biological materials, excluding timber, that are extracted from natural forests for human use (Beer and McDermott, 1989) including broad categories of food and food additives, fiber, silks, biomass, phytochemicals and aromatic chemicals, oils, resins and other exudates, organic building materials, decorative items and animal products (Chandrasekharan et al., 1996). Other NTFR that are harvested are honey, bushmeat, edible insects (Kaeslin and Williamson, 2010) as well as ornamental and medicinal vegetation, roots, rhizomes, fruits and seeds (Tejeda et al., 1998).

Beer and McDermott (1996) define NTFRs as all biological materials other than wood that are extracted from forests for human use, including food, medicines, spices, essential oils, resins, gums, latex, tannins, dyes, ornamental plants, wildlife (products and live animals), fuelwood and raw materials, especially rattan, bamboo, small wood and fibers. FAO (1999) defines NTFRs as all goods of biological origin, other than timber, originating from forests, other wooded land and trees outside forests. The FAO team that carried out the Global Forest Resources Assessment (FAO, 2010) defines them as those products obtained from forests that are tangible and physical objects of biological origin, other than timber, which includes all plant and animal products harvested in areas defined as forests, whether natural or planted.

From this definition, among the NTFRs, 16 groups were identified classified into two categories according to the plant and animal kingdom which are as follows: a) plant products/raw materials which include: 1) food; 2) fodder; 3) raw materials for medicines and aromatic products; 4) raw materials for dyes and colorants; 5) raw materials for utensils and handicraft and construction products; 6) ornamental plants; 7) exudates; 8) other plant products; and b) animal products/raw materials classified as: 9) live animals; 10) hides, skins and trophies; 11) wild honey and beeswax; 12) game meat; 13) raw materials for medicines; 14) raw materials for dyes; 15) other edible animal products; and 16) other non-edible animal products. González mentions that currently, there are more than 4,000 NTFPs of interest, of which at least 150 are traded through

regulated markets and are important in international trade, including honey, gum Arabic, rattan, bamboo, cork, nuts, mushrooms, resins, essential oils, and parts of plants and animals for pharmaceuticals. In order to promote NTFRs, it must be ensured that the populations which take advantage of them, benefit from the expansion of markets and that it is sustainable, each country needs a balance between conservation and sustainable use of its tropical forests and a good option could be their use, important in some economies, not only because of their contribution to the GDP, but also because they are a good subsistence option for different rural communities, even though they are not recognized worldwide, which has led to a legal vacuum and specifically in Colombia there is a lack of protocols to regulate their sustainable use (García & Polanía, 2007; Restrepo, 2019).

According to FAO, the production and consumption of NTFRs satisfy food, housing and health needs, in addition to generating income, which for 2014 amounted to approximately 88 billion USD, coming mostly from NTFR of plant origin (77 billion USD), followed by NTFR of animal origin (10.5 billion USD) and the collection of medicinal plants (700 million USD), which accounts for 1/6 of timber forest production.

Despite this great potential and that according to the Colombian Environmental Information System (IDEAM, 2018), the State of Caquetá, is located in the Amazon Natural Region presenting 6,492. 919 ha of natural forest area, statistics of forest areas harvested in NTFR extraction are unknown, in the State some NTFRs have been identified, these have not been registered or systematized; reason for which there is a vacuum of information or theoretical reference on these resources at local and regional scale; Likewise, it is assumed that with the decrease of the rural population due to the effects of displacement to urban areas, traditional knowledge about NTFR, their uses and characteristics are being lost in the cultural memory of their inhabitants; thus, the information on traditional knowledge identified in this research can serve as support for educational programs on conservation of cultural practices and care of natural resources.

Regarding the use of NTFR for animal consumption, there are some records which are presented below:

C. *argentea* is a shrub native to the Amazon, the central part of Brazil and areas of Peru, Bolivia, Colombia and northeastern Argentina and is characterized by its wide adaptation to tropical lowland areas with droughts of up to 6 months and acid soils of low fertility of the Ultisol and Oxisol type (Argel and Lascano 1998). The efficiency of C. *argentea* in ruminant feeding is evidenced in the work carried out in lambs, where supplementation with C. argentea improved dry matter intake (from 1.01 to 1.11 kg/MS/day) and protein digestibility (from 52 to 63%), which demonstrates the potential of C. The use of fresh C. *argentea* in cattle supplementation increased DIVMS (from 55.6 to 60.8%), and increased dry matter intake from 32 to 43% (Ibrahim et al 2001), this is mainly due to the good level of protein it contains (Celis 2004; Martínez, Barbosa, Amaya y Guzmán, 2020). Boca de indio (*Piptocoma discolor*) is one of the few large trees of the large botanical family of Asteraceae and was reported by CIPAV in 2011 as a promising forage tree for the development of livestock systems in the Amazonian piedmont region (Hurtado et al. 2011). Guayara et al., (2009) evaluated the biomass production of *Piptocoma discolor*, in an intensive silvopastoral system and Álvarez et al., (2018), carried out a nutritional and mineral characterization in two landscape units, demonstrating this the potential of the species in bovine feeding for the region.

Quispe *et* al., (2009), reported good protein contents (11.33%) at animal level works have been carried out in supplementation to improve productive levels in different livestock production systems. Lima *et* al. (2018), evaluated the effect of supplementation with *Mauritia flexuosa* oil in crossbred lactating goats, evaluating behavioral, physiological and hematological responses in

these animals. Farias *et* al. (2020), compared the effects of adding *Mauritia flexuosa* oil in sheep and evaluated physiological responses, feeding behavior and water intake. Ferreira *et* al. (2016), evaluated the physicochemical composition and ruminal degradability of *Leucaena* ensiled with different levels of *Mauritia flexuosa* fruit husk, works that report the use and acceptance of Canangucha in ruminant feeding. Queiroz et al, (2020), evaluated the inclusion of patauá meal (Oenocarpus bataua) in elephant grass silages for cattle feed, where they showed that the inclusion of patauá meal has positive effects on the chemical composition and effluent loss in silages since it significantly increased dry matter, organic matter, crude protein, insoluble nitrogen in neutral and acid detergent, ethereal extract, lignin and non-fibrous carbohydrates, contributing to reduce the environmental impact caused by the production of effluents during tropical grass silage and providing a potential use of patauá palm for animal feed.

Agroindustrial by-products

According to Saval (2012), defines agroindustry as the economic activity that is dedicated to the production and/or primary agricultural, livestock or forestry transformation for commercial purposes; in the same way they originate some by-products or waste that cause problems with their final disposal (Cury et al., 2017); which can be converted into raw material for another product (SAVAL, 2012), in this same sense the environmental and economic benefits in the use of these wastes have promoted sustainable development (Corredor & Pérez, 2018).

In this sense, it is necessary that these wastes are transformed, generate goods destined for the local market with greater added value, economic income and solve problems, in the same way take advantage of technological alternatives (Yepes et al., 2008; Mirabella et al., 2014). Industrialization promotes human development when it uses available resources that improve people's well-being and quality of life (Wang et al., 2020).

On the other hand, agro-industrial resources are used in animal feed because of their nutritional contributions (protein and/or energy, etc.), additionally, it is a strategy that helps in environmental conservation because they are potentially polluting (Martin 2009), as is the case of palm kernel cake, used as a non-conventional food source available in oil palm (*Elaeis guineensis*) processing zones, which is obtained from harvesting the palm bunch, composed of fruit, which is processed to obtain the oil mechanically, leaving the palm kernel (Vargas and Zumbado, 2003).

In Colombia there are more than 360,000 hectares a (2012) in 73 municipalities of the country distributed in four productive zones (Gómez and Ospina, 2016). The oil is obtained from the fruit of the oil palm (*Elaeis guineensis)* both from the pulp between 40 and 50% in crude oil, in a smaller portion oil is obtained from the kernel 5% average and is called palm kernel oil from the crude oil are generated several by-products such as cooking oil, margarines, soaps and detergents, cosmetics varnishes, gums and inks and lately for biofuels in addition to the kernel of the fruit the residues obtained in the extraction process can be used and it is called almond or palm kernel cake to generate animal feed (Gómez and Ospina, 2016). "The first harvest is obtained around 3 years after planting, the fruits in bunches with units of 1000 to 4000, weigh up to 15 kilos depending on the care of the crop, the vegetative period of the palm is more than 100 years, but under economic exploitation is from 25 to 30 years" (Gómez and Ospina, 2016).

Similarly, the increase in cocoa production causes the organic remains such as cocoa waste to increase, turning this waste into a problem for production units, organizations and government institutions (Ponguillo Lucín, 2018). In fact, Cardona et al. (2002) determined that the use of cocoa is an alternative for feeding ruminants; the elaboration of feed made from cocoa by-products has become a sustainable alternative for the incorporation of animal diets due to its excellent nutritional content (protein, lipids, dietary fiber and epicatechin) (Delgado et al., 2021).

In the state of Caquetá, 394 hectares are planted with palm, with a yield of 3,991 kg/ha, with a better yield than at the national level (3,299 kg/ha) (Gobernación del Caquetá, 2007) and 1,847 hectares are reported planted with cocoa, where one of the varieties is Copoazú, with a production of 48 tons of dry beans/year. 847 hectares planted with cocoa, where one of the varieties is Copoazú, with production of 48 tons of dry beans/year, an approximate of 4,320 tons of agro-industrial residue represented in cocoa husk nullly exploited corresponding to 90% of the fruit, which indicates high availability of this organic residue to be transformed, which corresponds to approximately 25720 kg of cocoa per year (ACAMAFRUT, 2017, Gómez et al. 2012), taking into account the amount of relative humidity that contains 23.34 (Acuña, 2017), the amount of DM/year is 6003 kg DM/year (data adapted from Gómez et al 2012 and Acuña, 2017); Brenes (1990), determined that the use of cocoa husk is an alternative for ruminant feeding, due to its chemical composition: 3.2% potassium, 6.25% crude protein and 27% crude fiber, it can be used in fresh form with good acceptance and rapid digestibility, which allows high dry matter intakes in ruminants, they have used it in Costa Rica, Brazil, and Africa in cattle, sheep and goat feeding replacing up to 60% of traditional feed and in non-ruminant animals replacing traditional feed up to 20% in pigs and 10% in poultry. In the State of Caquetá there are 817 ha of Amazonian fruit trees (CORPOAMAZONIA, 2018).

Cattle production systems

According to Mahecha et al., (2002), cattle production systems in Colombia are generalized production models developed in almost the entire country, mostly by small producers, where cattle ranching is considered a socioeconomic sector with great importance for the development of the countryside, likewise, it has been and is strongly criticized for its low productive performance and high negative impact on the environment.

Most of the country's livestock area is used for the development of pastures in extensive cattle raising systems, which are characterized by low efficiency in land use, in addition to great environmental deterioration due to problems such as deforestation, burning and loss of biodiversity, factors that have led cattle raising to be seen as a productive sector that threatens global ecological sustainability (Mahecha 2003).

Vergara (2010), states that most cattle production systems in the country are characterized by low technological levels; all productivity indicators show this, including the percentage of the herd that is slaughtered, meat yield, exports, meat quality and the duration of the cattle cycle. These conditions generate low liquidity in the business and high production costs, affecting the profitability of the activity and, consequently, low income for the producer.

According to FEDEGAN (2006), there are barriers that affect cattle production systems in Colombia such as:

- Low Specialization of breeding, rearing, milk or meat activities.
- Insufficient technical and business training for cattle farmers.
- Low productivity indexes.
- Incipient development in genetic improvement.
- High production costs.
- Informality.
- Insufficient technology transfer.
- Competitive gaps with leading countries.
- Low consumption rates.
- Non-compliance with the regulatory framework.

- Inadequate access to financial resources.
- The predominance of extensive cattle raising over intensive cattle raising.

According to Velázquez, the predominant cattle production systems in the Colombian Amazon are dual-purpose cattle ranching systems, which are implemented by indiscriminately slashing and burning the forest to establish pastures. Productive indicators are generally low, with stocking capacities of less than one head per hectare, 180-day lactation and milk production below the national average, among others. (Velázquez et al., 2012).

According to Anderson and Wadsworth (1995), dual-purpose bovine production systems (DPBPS) are defined as cattle farms that produce both milk and meat to be sold, where a percentage of the cows in the herd are partially milked and the excess milk is consumed by the calves directly from the mammary gland.

Methodology

This research is exploratory because the study to be determined is very little investigated or recognized and descriptive, it makes previous considerations about the depth of the study, thus generating a diagnosis provided by secondary and tertiary sources that will offer approaches to the scientific study it intends to dimension.

Methodological Design

A systematic review of scientific documents has been carried out, through the databases (Scopus, Redalyc, Scielo, DOAJ), taking into account the search equations of Boolean operators, on animal feeding alternatives with non-timber forest resources (NTFR) and agro-industrial, whose purpose is to generate scientific knowledge on these animal feeding alternatives, in the state of Caquetá, emphasizing that the study will have a differential approach due to the characteristics of the territory, determined with the participatory collaboration of the beneficiaries in such a way that it can serve as useful scientific support information to be delivered to the community and decision-making entities as inputs for their potential agro-industrial use and also for the preservation, conservation and sustainable use for competitiveness. Simultaneously, based on a study, a qualitative analysis will be made through in-depth surveys of cattle producers in the state of Caquetá, and exercises will be carried out to exchange knowledge and know-how with the community through participatory action research strategies, gathering basic socio-economic and ecological information on the productive units in the prioritized municipalities.

108 properties were selected, prioritizing in the five (5) Municipalities (Cartagena del Chaira 8, Albania 17, El Doncello 6, Puerto Rico 18 and San Vicente del Caguán 59, taking into account the DANE survey (2014), for the valuation of the supply and socio-economic characterization of agro-industrial and non-timber production systems for the identification of productive niches and nutritional levels required in the development of animal feed in the State of Caquetá, in the 16 municipalities of the state that report planting and production areas of these raw materials, the compilation of existing information on crop production and management will be carried out, which will allow defining the types and particular characteristics of the production systems identified at the level of the prioritized municipalities. This exercise will also make it possible to determine physical, environmental, socioeconomic, cultural and technological requirements and activities that will make it possible to define the local technological level and crop management alternatives according to the needs and conditions of the producers and their territory. In order to know the state of scientific knowledge worldwide, a bibliometric analysis was carried out based on the

database obtained from Scopus, which was analyzed through the Bibliometrix web interface in relation to the use of non-timber forest resources (NTFR) and agro-industrial by-products as a source of feed for cattle.

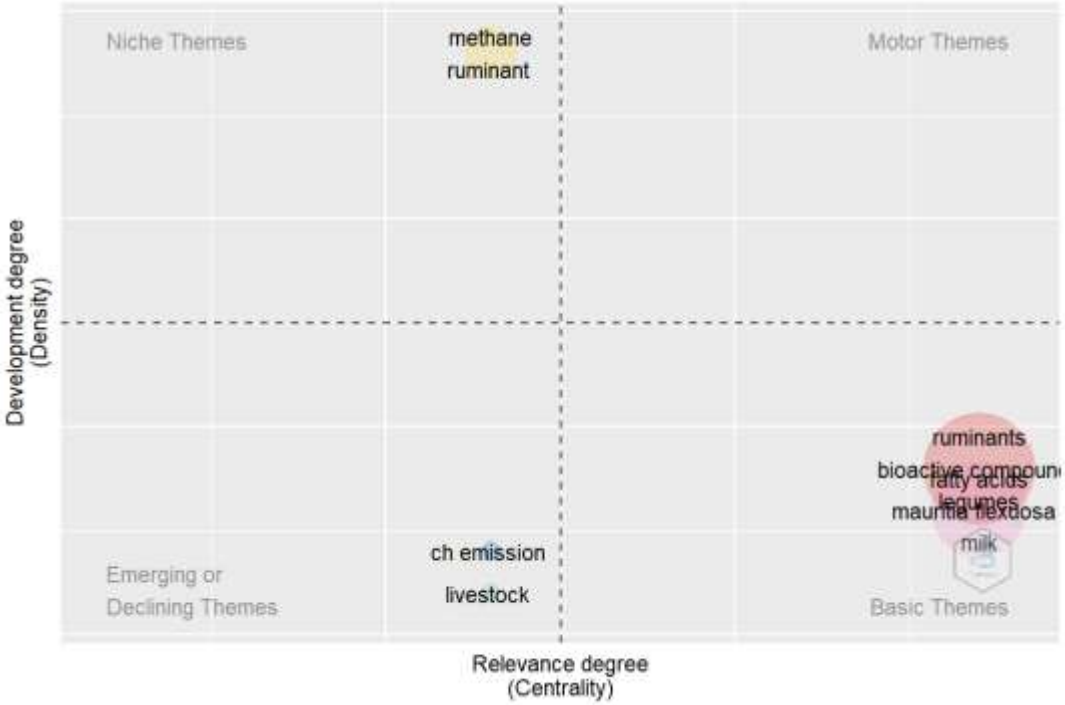
Findings and Discussion

Bibliometric analysis

Through the bibliometric analysis carried out in the Scopus database of bibliographic references and citations using the Boolean formulas constructed in relation to the use of non-timber forest resources (NTFR) and agro-industrial by-products, including promising resources linked to the territorial identity of the peasant communities such as the Canangucha (*Mauritia Flexuosa*) and Milpesos (*Oenocarpus Bataua*) palms, Similarly, forage woody plants such as Boca de Indio (*Piptocoma discolor*) and Veranera (*Cratylia argentea*), which due to their bromatological properties are a potential source for cattle feed, it became evident that the scientific production of documents worldwide during the last five years with emphasis on the use of NTFR is led by authors from Brazil with an average of 72 publications, followed by Mexico, China and Colombia with an average of 14, 8 and 6 respectively. In this way, it is possible to perceive that scientific production is related to the economies where bovine livestock contributes to economic growth (Table 1), as is the case of the United States and Brazil, which are the first and second producers of cattle worldwide respectively (Orús, 2021), with Brazil as a differentiating factor that it is the country that has the largest area of the Amazon with 4. 245,278 km2, that is, 63.7% (Otero, 2008), which means that it has a greater amount of non-timber resources and, in turn, a greater number of research and scientific documents.

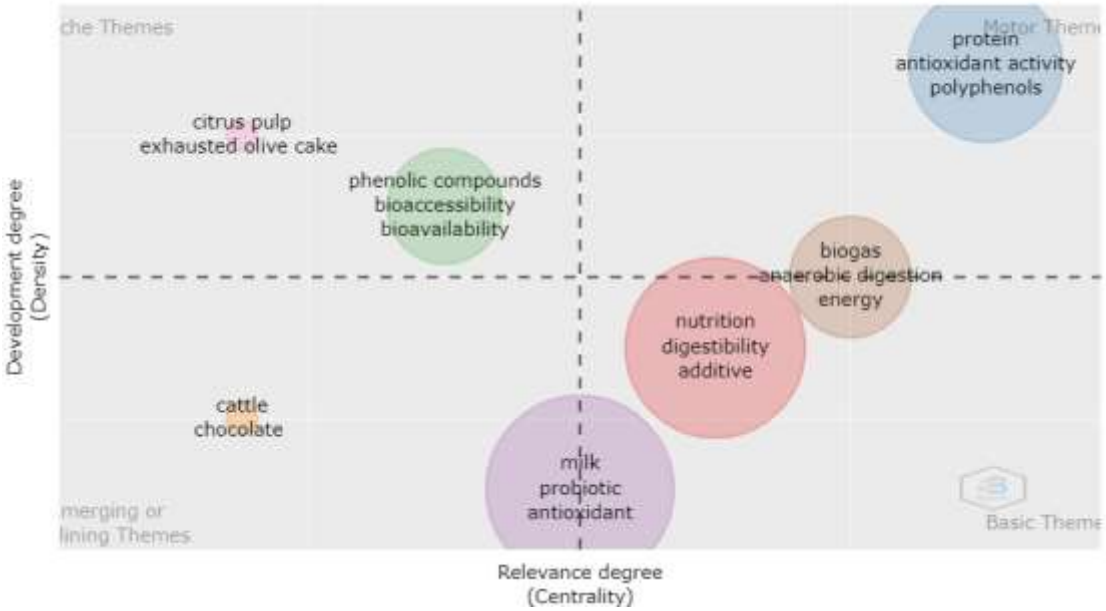
On the other hand, in terms of the average number of scientific documents with emphasis on the use of by-products derived from agroindustry, Brazil is the country with the highest scientific production with an average of 115 publications, followed by China and the United States with an average of 73 and 30, respectively. Thus, it is evident that scientific production is subject to some of the economies with the greatest agroindustrial development worldwide, which concentrate the generation of scientific documents oriented to nutritional aspects for the potentialization of the production of agroindustrial derivatives.

Figure 1. Trend of the conceptual structure of the scientific production of the use of NTFR as a feed source for cattle.



The trend in the conceptual structure of scientific production on the use of NTFR as a feed source for cattle has cross-cutting elements such as ruminants, bioactive compounds, fatty acid and milk (Figure 1), since many current research studies show the potential benefits to human health of a regular intake of milk, However, it has now been demonstrated that milk fatty acids have specific properties that are linked to important physiological functions such as the production of bioactive compounds, maintenance of the intestinal microbiota, weight control and prevention of chronic inflammatory diseases (Gómez & De la fuente. , 2018). Likewise, methane emissions related to livestock stand out as an emerging issue (Figure 1), due to global trends on climate change, efficient use of resources, decrease in pollution and other environmental indicators, which have forced producers to implement practices and systems designed to reduce environmental impacts through evaluations that allow quantifying and comparing the effects of these strategies over time, Therefore, a wide variety of tools and models have been developed that seek to empower communities to quantify the environmental impacts generated by their production systems, which in turn satisfies the need of today's consumers for information on how their food is produced (Capper, 2021).

Figure 2. Trend of the conceptual structure of the scientific production of the use of agro-industrial by-products in cattle feed.



The trend in the conceptual structure of scientific production linked to the use of agro-industrial by-products is given by the cross-cutting elements milk, probiotics, antioxidants, which are going from being emerging to cross-cutting (Figure 2), given the interest of current production models that have recognized the potential of agro-industrial wastes, since they still contain in their composition a high nutritional content and a large amount of bioactive compounds that are used as a source of antioxidants for the development of biotransformations that generate finished products of high biological quality (Vicenssuto & Castro. , 2020), which is related to the topics nutrition, digestibility, additives, biogas, anaerobic digestion and energy (Figure 2), which have the tendency to become driving or consolidated topics, due to the processes carried out to transform agro-industrial by-products from waste to usable raw material, being anaerobic fermentation the most widespread, since this allows creating usable compounds such as biogas and generating renewable energy (Villa et al., 2020), as well as the evaluation of different by-products as additives in diets used in animal feed to determine their digestibility and their effect on animal nutrition (Gasco et al., 2020). On the other hand, the consolidated topics in current research are protein, antioxidant activity and polyphenols, while the emerging ones are beef cattle in relation to cocoa husk, as new trends in scientific research (Figure 2).

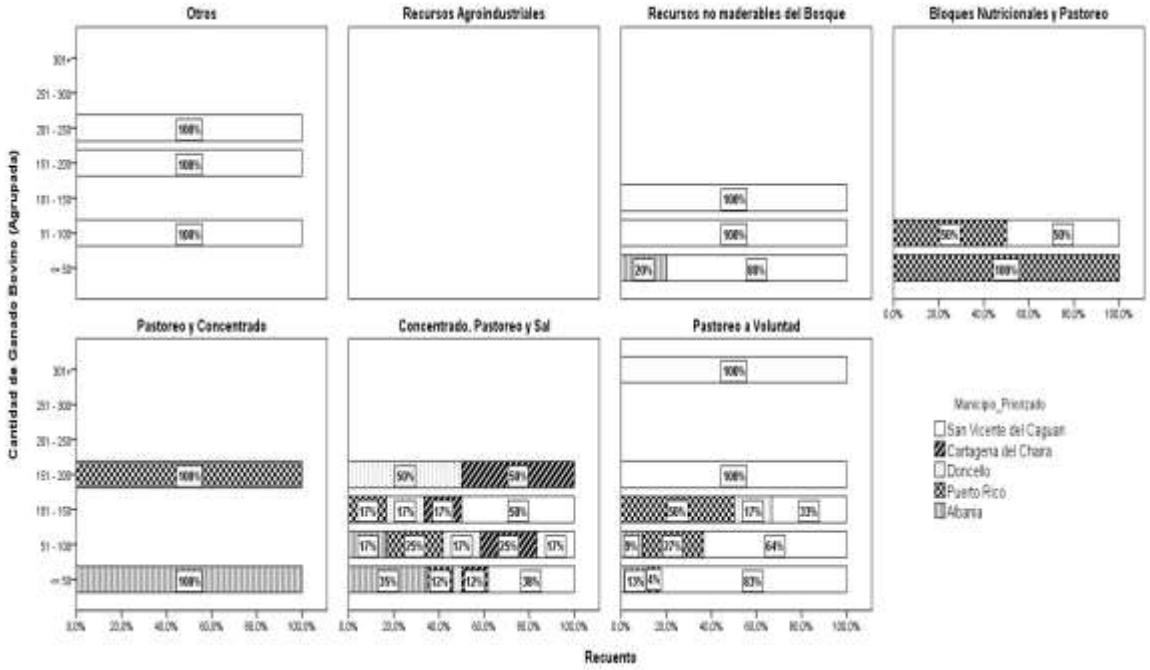
Characterization of the use of NTFRs and agro-industrial by-products in cattle production systems in the prioritized municipalities in the state of Caquetá.

The use of non-timber forest resources - NTFRs and agro-industrial by-products in animal feed in cattle production systems is an effective and sustainable nutritional alternative that proposes the use of various resources that have great potential for cattle intake, contributing to the reduction of the cost structure and the use of raw materials that are wasted due to lack of knowledge of their properties. It also allows for a paradigm shift from traditional cattle ranching based on grazing large tracts of land to an innovative system that would supplement and/or complement forage grasses that provide low levels of protein (Cipaguata et al., 1998). The state of Caquetá has not been oblivious to this reality, which is why these production systems are characterized by being

extensively based on monocultures of protein-poor grasses that are not sufficient for the nutritional demand of livestock, as reflected in the territory's production indicators.

It should be added that, faced with the problem of nutritional requirements, the productive systems have decided to supply different complements that guarantee the minimum nutritional values such as: concentrates, mineralized salts and nutritional blocks; which increase costs and decrease the profitability of the cattle herds. However, systems with a cattle inventory of less than 150 head of cattle are forced to look for alternatives that do not represent high monetary values because this activity is the main or only source of income for their productive units, for which they have been using NTFR, while agro-industrial by-products have not been used due to the lack of knowledge of their potential in animal intake.

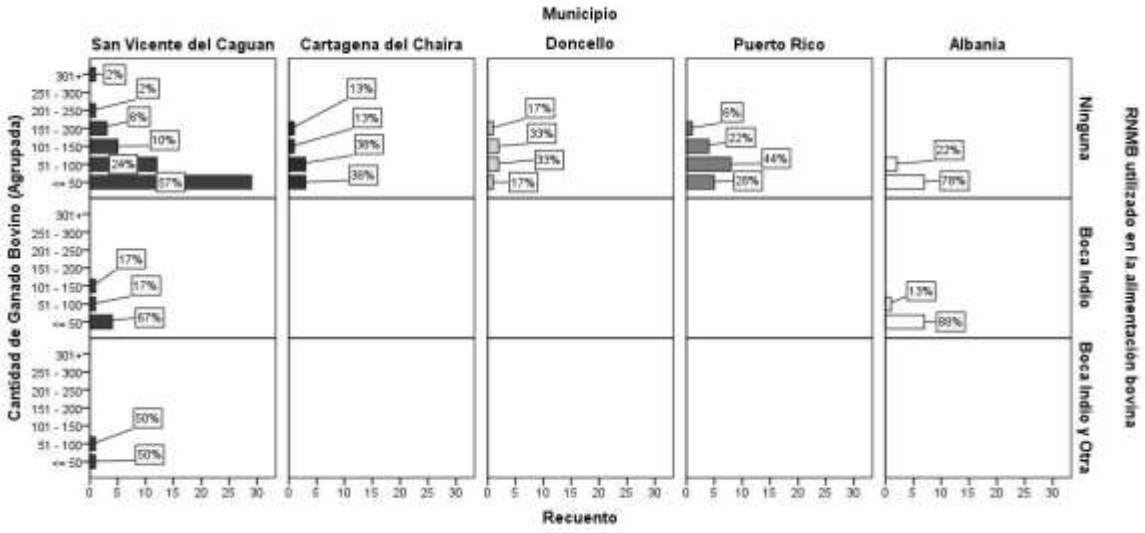
Figure 3. Relationship of nutritional supplies of cattle production systems with inventory of head of cattle in the prioritized municipalities.



It is necessary to highlight that of the five municipalities where the study was carried out, only in San Vicente del Caguán and Albania NTFRs have been used in low proportion due to the lack of knowledge of the capacity of these products and the little articulation between the academy and the Colombian countryside; in the transmission of knowledge that generates sustainable practices that positively impact the producers and the environment (Figure 3).

It is evident that the traditional livestock model developed in the state of Caquetá has a feeding system where the main and, in most cases, the only source of food is extensive grazing, as stated by Canchila et al 2009; which leads to a dependence on commercial concentrates, nutritional blocks, among others, to supplement their feed. And that in productive units that have more than 150 head of cattle; they do not use feeding alternatives found in the environment.

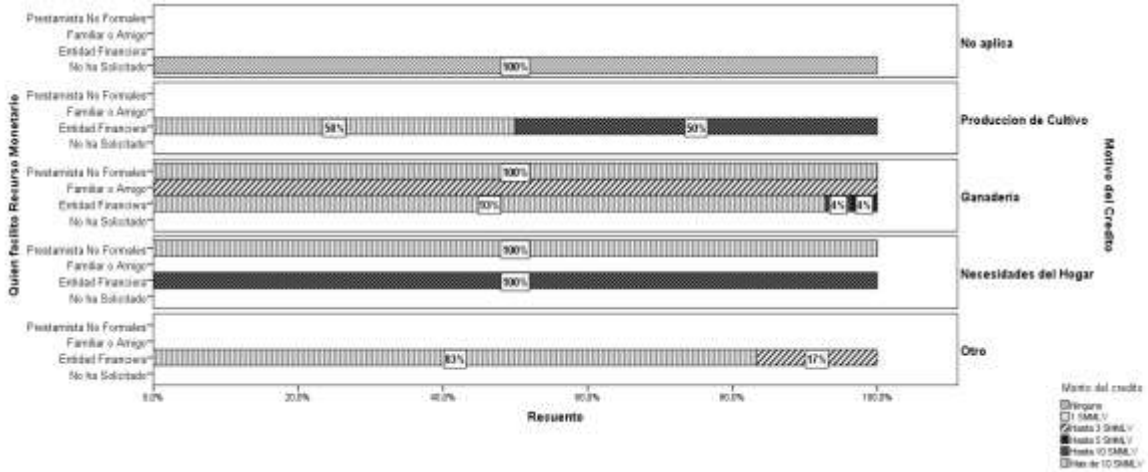
Figure 4. Use of Non-Timber Forest Resources and Agro-industrial By-products for cattle feed.



It is worth mentioning that, in terms of the use of NTFR, *Piptocoma Discolor* or popularly known as Boca indio, Congo or Mulato, is the only species used in cattle feed in the municipalities mentioned above, so producers are unaware of the potential of species such as Cratylia Argéntea, Palma de Canangucha and Palma de Mil pesos. Bocaindio is an arboreal species, which is found inside stubble and secondary forests being used mainly for timber uses constituting an important source of income that serves to complement the earnings of rural households; being a pioneer species that regenerates in disturbed and sugarcane forests, it is ideal for sustainable management (Figure 4) (Erazo et al., 2014).

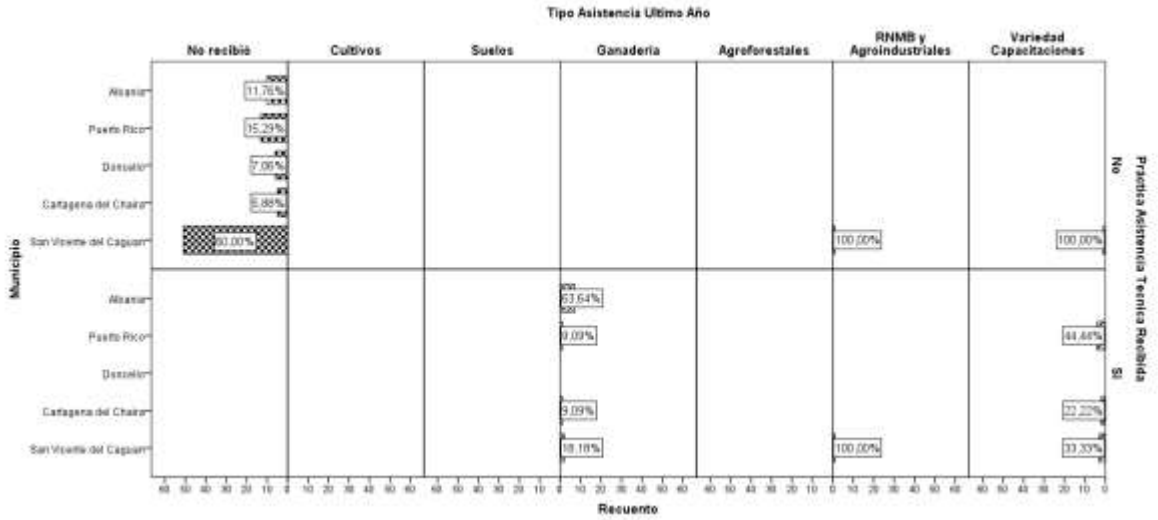
Likewise, agro-industrial by-products such as cocoa or palm kernel have not been used in food due to the lack of knowledge of producers regarding the nutritional contributions of these products. For example, in several production units, cocoa crops were found where cocoa was used as fertilizer for the plantations themselves, ignoring the uses, potential and economic and environmental benefits that could be generated with the use of this large volume of cocoa. It should be emphasized that countries with a higher degree of industrial development are pioneers in the use of HS in ruminant feeding; being significant the results obtained in intake, nutrient digestibility, milk production yields and economic profitability while countries such as Colombia would have a great potential in the use of NTFR (Godoy et al., 2021; Pazla et al., 2018).

Figure 5. Indebtedness in cattle production systems.



On the other hand, it is evident that most of the producers who have acquired debt have acquired it with the purpose of investing in livestock activity through financial entities, informal lenders and relatives or friends, for amounts ranging between 3 and 10 SMMLV; highlighting that it has been the main destination of the investment compared to other activities such as crop production, household needs, among others. Despite the fact that the impacts of livestock farming in the State have been negative against the model it practices and its role in deforestation, the livestock sector in Colombia generates 19% of rural agricultural employment being close to 6% of national employment contributing approximately 1.4% of the National GDP and about 19% of the agricultural GDP (Figure 5) (FEDEGAN, 2017).

Figure 6. Technical assistance received in the last year (2019).

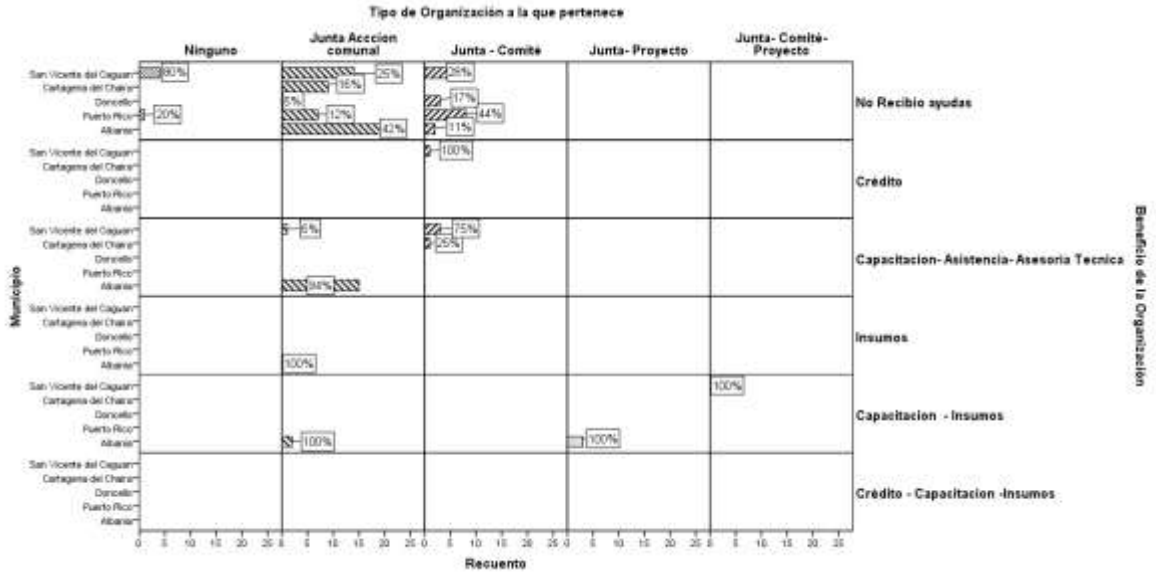


Due to the technical assistance to cattle production systems has been scarce due to the lack of coordination between the state, organizations, academia and the Colombian countryside, there is a need to dialogue and build knowledge, generating the social appropriation of knowledge in the communities on various topics that allow the resolution of environmental problems and challenges in the different production systems.

It should be noted that Albania has been the municipality with the highest percentage of training in livestock issues while in the municipality of Doncello its community has not received

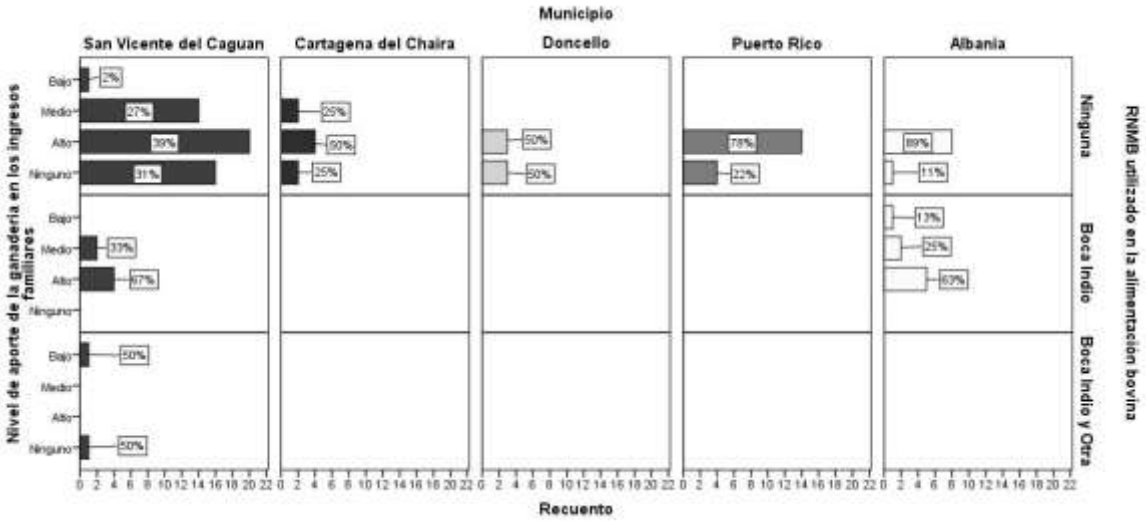
any training. This shows the low level of coverage of training and technical assistance for the livestock sector in the state of Caquetá. As mentioned by Contreras and Rodríguez (2017) in the agricultural sector, its development and increased competitiveness depends, among other factors, on its capacity for technological innovation and the technical assistance received from different institutions, both state and private. Technical assistance or rural extension has been characterized by levels of coordination and articulation that have not achieved the expected impacts in terms of coverage and technological adoption by the sectors involved, as well as the scarce depth of organizational and commercial aspects that are vital for the agricultural business (Figure 6) (Contreras and Rodríguez, 2017).

Figure 7. Benefits received from the organizations to which producers belong.



In turn, the main form of association in cattle production systems are the Community Action Boards (CABs), which directly or indirectly have coordinated the few trainings and technical assistance activities between producers, the government and/or organizations. On the other hand, it is highlighted that no producer is part of any association or cooperative, thus evidencing the lack of management and accompaniment by governmental entities for the creation of agricultural associative organizations in the state. Also, highlighting the lack of knowledge, negative experiences in joint work or the absence of leadership in the communities, which are determining factors that prevent the creation of associative organizations (Figure 7) (Estrella and Flores, 2020).

Figure 8. Perception of the level of income from livestock activity in properties where NTFR is used.



The perception of the producers regarding the level of income that livestock activity contributes to the family economy indicates that most producers are directly dependent on these production systems for the subsistence of their families; however, the farms where the use of NTFRs varies, and in some units livestock is a secondary economic activity, with the use of other types of resources being a more constant and substantial source of income, due to the diversification of the activities carried out within the productive unit in relation to NTFRs (Figure 8). The intensification of pasture-based livestock systems is a necessary strategy to mitigate the environmental impacts generated by activities such as deforestation and to improve the livelihoods of people who depend on livestock, since livestock farms are currently characterized by low incomes and low productivity, However, the adoption of strategies that make use of NTFR is limited by structural factors that interact with the personal perceptions of the ranchers that prevent them from shaping the information that would allow them to understand the costs and benefits of adopting this type of strategy (Arbuckle and Roesch. , 2015).

Producers who harvest NTFRs perceive this as a strategy to increase the economic value and competitiveness of the farm, while ranchers who do not harvest NTFRs recognize that the use of such resources is necessary to maintain livelihoods given declining profits due to rising input costs and increasing state environmental oversight, however, However, producers who harvest and those who do not agree that there are many barriers that prevent a high adoption of this type of model in the region, such as the difficulty of obtaining skilled labor, poor infrastructure, limited forms of marketing with a non-regulatory and unfavorable environment for the producer, in addition to cultural practices that in most cases drive decisions regardless of the possibilities of maximizing benefits (Cortner et al. , 2019).

Conclusions

The scientific production of documents worldwide concerning the use of non-timber forest resources (NTFPs) and agro-industrial by-products as alternative feed for cattle has been carried out mainly by the countries with the highest level of industrialization in the agricultural sector, such as China, the United States and Brazil, mainly developed by agricultural sciences and biology,

where they have been studied individually or in conjunction with other raw materials, evaluating their effects, nutritional contributions, degree of nutritional value and d egree of digestibility and daily weight gain in cattle.

The producers of the bovine production systems of the prioritized municipalities mostly have present the species of the NTFR, however, the use of these as an alternative animal feed has been at very low levels, being used only the Boca Indio (Piptocoma discolor) by some of the producers of the municipalities of San Vicente del Caguán and Albania.

Agro-industrial by-products are not used in any bovine production system as a feeding alternative, which indicates that there is a lack of knowledge or interest on the part of producers to use them as an alternative for animal nutrition.

The results suggest that research and research processes should focus not only on agronomic and socioeconomic aspects, but on the contrary, they should raise awareness of the potential benefits of adopting systems that make use of NTFR through models that quantify and communicate the potential risks of adoption and mitigation strategies to help producers understand the benefits of converting from extensive to intensive feeding systems and the potential risks and ways in which they can be minimized and enable farmers to more effectively weigh the benefits and costs of using NTFR. Moreover, the findings indicate that better enabling infrastructure in the form of technical assistance, education and government support for widespread adoption of NTFR is needed in the region.

Bibliographic references

Acuña Encarnación, V. M. (2017). Selección de árboles élite de Copoazu (Theobroma grandiflorum) vereda Agua Dulce del municipio de Belén de los Andaquíes (Caquetá).

Álvarez, C. F., Suárez, S. J. C., & Celis, P. G. A. (2018). Caracterización nutricional y mineral de Boca de Indio Piptocoma discolor (Kunth) Pruski, en dos unidades de paisajes en el Municipio de Florencia, Caquetá.

Anderson, S., & Wadsworth, J. (1995). Procceding of the International Workshop on Dual Purpose Cattle Production Research. *IFS, UADY. Mérida, Yucatán, México*, 368.

Arbuckle, J. G., & Roesch-McNally, G. (2015). Cover crop adoption in Iowa: The role of perceived practice characteristics. *Journal of Soil and Water Conservation*, *70*(6), 418-429.

Argel, P. J., & Lascano, C. E. (1998). Cratylia argentea (Desvaux) O. Kuntze: Una nueva leguminosa arbustiva para suelos ácidos en zonas subhúmedas tropicales.

Asociación Departamental de Productores de Cacao y especies maderables del Caquetá - ACAMAFRUT (2017) *Fortalecimiento Empresarial y adecuación financiera*. Recuperado: https://sinchi.org.co/files/gef/PUBLICACIONES/4.%20Fortalecimiento%20Socioempresarial%20ACAMAFRUT-comprimido.pdf.

Arrieta Rodríguez, D. A., Lora Guzmán, H., & Sánchez González, J. (2018). Análisis de las empresas de Cartagena del sector logístico portuario basado en el modelo de configuración estratégica de Danny Miller. *Aglala*, *9*(1), 62-90. Recuperado de http://revistas.curnvirtual.edu.co/index.php/aglala/article/view/1182

Brenes, O. (1990). Posibilidades de la utilización de los subproductos del beneficio del cacao. In *Seminario Regional sobre Tecnología Poscosecha y Calidad Mejorada del Cacao20-21 Jul 1989Turrialba (Costa Rica)* (No. IICA ICCR-A1/SC 90-005). IICA, San José (Costa Rica). Red Regional de Generación y Transferencia de Tecnología en Cacao-PROCACAO.

Bernal Conde, H., Rodríguez Soto, J. R.., & Ortegón Guzmán, I. C. . (2020). La composición empresarial y la incidencia en el fortalecimiento misional en las Unidades de Salud de Ibagué

USI. *Aglala*, *11*(2), 167–176. Recuperado a partir de https://revistas.curn.edu.co/index.php/aglala/article/view/1707

Canchila, E. R., Soca, M., Ojeda, F., & Machado, R. (2009). Evaluación de la composición bromatológica de 24 accesiones de Brachiaria spp. *Pastos y Forrajes*, *32*(4), 1-1.

Canchila, E. R., Soca, M., Ojeda, F., & Machado, R. (2009). Evaluación de la composición bromatológica de 24 accesiones de Brachiaria spp. *Pastos y Forrajes*, *32*(4), 1-1.

Capper, J. L. (2021). Current issues and controversies in assessing the environmental impacts of livestock production. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources*.

Cardona, M. G., Sorza, J. D., Posada, S. L., Carmona, J. C., Ayala, S. A., & Álvarez, O. L. (2002). Establecimiento de una base de datos para la elaboración de tablas de contenido nutricional de alimentos para animales. *Revista Colombiana de Ciencias Pecuarias*, *15*(2), 240-246.

Carrillo, A. R. Q., Quiroz, J. F. E., & Jiménez, L. M. (2007). Evaluación de especies forrajeras en América tropical, avances o status quo. *Interciencia*, *32*(8), 566-571.

Celis, G. A., Sánchez, H., & Parra, F. A. (2004). Calidad nutritiva de las arbustivas forrajeras Malvaviscus arboreus, Codariocalyx gyroides y Cratylia argentea en la zona de ladera de los Departamentos de Cauca y Valle, Colombia. *Ciencia y Tecnología Agropecuaria*, *5*(1), 56-59.

Chandrasekharan, C., Frisk, T., & Roasio, J. C. (1996). *Desarrollo de productos forestales no madereros en América Latina y el Caribe* (pp. 484-484). Dirección de Productos Forestales, FAO.

Cipagauta, M., Velásquez, J., & Pulido, J. I. (1998). Producción de leche en tres pasturas del piedemonte amazónico del Caquetá, Colombia. *Pasturas tropicales*, *20*(3), 2-9.

Colciencias. Ministerio de Agricultura y Desarrollo rural – Minagricultura & Corpoica (2016). *Plan Estratégico de Ciencia, Tecnología e innovación del Sector Agropecuario Colombiano (2017-2027)*. Recuperado de: https://minciencias.gov.co/sites/default/files/upload/noticias/pectia-2017-actualizado.pdf.

Contreras León, A. L., & Rodríguez Lozano, G. I. (2017). Medición de la eficiencia relativa de fincas ganaderas con servicio de asistencia técnica. *Revista Facultad de Ciencias Económicas: Investigación y Reflexión*, *25*(1), 117-128.

CORPOAMAZONIA. (2018). *Sistema Económico*. Disponible en: https://www.corpoamazonia.gov.co/region/Caqueta/Caq_Economico.htm

Corredor, Y. A. V., & Pérez, L. I. P. (2018). Aprovechamiento de residuos agroindustriales en el mejoramiento de la calidad del ambiente. *Revista Facultad de Ciencias Básicas*, 59-72.

Cortner, O., Garrett, R. D., Valentim, J. F., Ferreira, J., Niles, M. T., Reis, J., & Gil, J. (2019). Perceptions of integrated crop-livestock systems for sustainable intensification in the Brazilian Amazon. *Land use policy*, *82*, 841-853.

Cury, K., Aguas, Y., Martinez, A., Olivero, R., & Ch, L. C. (2017). Residuos agroindustriales su impacto, manejo y aprovechamiento. *Revista Colombiana de Ciencia Animal-RECIA*, *9*(S1), 122-132.

De Beer, J. H., & McDermott, M. D. (1996). The economic value of non-timber forest products in. Southeast Asia. *Netherlands Committee for IUCN*, Amsterdam. Recuperado de: https://portals.iucn.org/library/sites/library/files/documents/1996-020.pdf

De Beer, J. H., & McDermott, M. J. (1989). The economic value of non-timber forest products in Southeast Asia: with emphasis on Indonesia, Malaysia and Thailand. *The economic value of non-timber forest products in Southeast Asia: with emphasis on Indonesia, Malaysia and Thailand.*

Delgado-Ospina, J., Lucas-González, R., Viuda-Martos, M., Fernández-López, J., Pérez-Álvarez, J. Á., Martuscelli, M., & Chaves-López, C. (2021). Bioactive compounds and techno-functional properties of high-fiber co-products of the cacao agro-industrial chain. *Heliyon*, *7*(4), e06799.

Departamento Administrativo Nacional de Estadística - DANE (2014). Aspectos sociodemográficos: 3er censo nacional agropecuario 2014. (Consultado en línea el 18 de enero de 2019). Recuperado de: https://desarrollomedellin.files.wordpress.com/2018/03/censo-nacional-agropecuario-20141.pdf

Duarte Rey, D. M., Barrientos Rosales, M. de los Ángeles, & Castro Alfaro, D. (2019). La subutilización del neuromarketing en Colombia como herramienta de posicionamiento de marca. *Enfoque Disciplinario*, *4*(1), 28-36. Recuperado a partir de http://enfoquedisciplinario.org/revista/index.php/enfoque/article/view/17

Erazo, G., Izurieta, J. C., Cronkleton, P., Larson, A., & Putzel, L. (2014). *El uso de pigüe (Piptocoma discolor) por los pequeños productores de Napo, Ecuador: Manejo sostenible de una especie pionera de madera para los medios de vida locales* (Vol. 26). CIFOR.

Estrella, M. Á. E., & Flores, K. I. M. (2020). Análisis de caso del modelo de gestión asociativo a nivel rural en acopio de fréjol, en la comuna Las Rocas cantón Alausí, provincia de Chimborazo. *Economía y Negocios*, *11*(1), 34-46.

FAO (1999). Directrices para la ordenación de los bosques tropicales: 1 producción de madera (No. 634.9 F3Y v. 135). FAO. Recuperado de: http://www.fao.org/3/a-w8212s.pdf

FAO. 2010 . Evaluación de los recursos forestales mundiales, 2010 – Informe principal. Estudio FAO Montes 163. Roma Italia . Disponible también Recuperado de: http://www.fao.org/3/i1757s/i1757s.pdf. Consulta: 02 de septiembre 2021

Farias Machado, N. A., de Oliveira Maia Parente, M., Parente, H. N., de Moura Zanine, A., Moreira Filho, M. A., da Cunha, I. A. L., ... & Santos Araujo, J. D. (2020). The physiological response, feeding behaviour and water intake of feedlot lambs supplemented with babassu oil or buriti oil. *Biological Rhythm Research*, *51*(2), 213-224.

FEDEGAN – Federación Colombiana de Ganaderos (2017). Balance y Perspectivas del Sector Ganadero Colombiano 2016-2017. Recuperado de: https://static.contextoganadero.com/Publicaciones/Balance_Perspectivas_2016_2017.pdf

FEDEGAN - Federación Colombiana de Ganaderos. (2006). Plan Estratégico de la Ganadería Colombiana 2019 . Recuperado de: https://www.fedegan.org.co/plan-estrategico-de-la-ganaderia-colombiana-2019

Ferreira, R., Bezerra, L., Edvan, R., Araújo, M., Marques, C., Torreão, J. & Parente, H. (2016). Physicochemical composition and ruminal degradability of leucaena ensiled with different levels of buriti fruit peel. *Grassland science*, *62*(3), 160-166.

García, C., & Polanía, J. (2007). Marco conceptual para productos no maderables del bosque en manglares de Colombia. *Gestión y Ambiente*, *10*(2), 169-178.

Gasco, L., Acuti, G., Bani, P., Dalle Zotte, A., Danieli, P. P., De Angelis, A. & Roncarati, A. (2020). Insect and fish by-products as sustainable alternatives to conventional animal proteins in animal nutrition. *Italian Journal of Animal Science*, *19*(1), 360-372.

Gerez, P., & Purata, S. E. (2008). *Guía Práctica Forestal de Silvicultura Comunitaria. México*. SEMARNAT/CONAFOR/CCMSS. Recuperado de http://www. ccmss. org. mx/descargas/Guia_ Practica_Forestal_de_Silvicultura_Comunitaria. pdf.

Gobernación del Caquetá. (2007). Plan de desarrollo del Caquetá 2004-2007: Todos Por Un Caquetá Mejor. Recuperado

de:https://repositoriocdim.esap.edu.co/bitstream/handle/123456789/344/36561.pdf?sequence=1&isAllowed=y

Godoy, D., Gonzales, J., Roque, R., Fernández, M., Gamarra, S., Hidalgo, V., & Gómez, C. (2021). Use of unconventional agro-industrial by-products for supplementation of grazing dairy cattle in the Peruvian Amazon region. *Tropical Animal Health and Production*, *53*(2), 1-6.

Gómez Wilches, D. A., & Ospina Rodríguez, J. S. (2016). Análisis de la competitividad del eslabón de transformación de la agro-cadena de palma africana en Colombia.

Gómez, A. G., Tabares, J. A. G., & Patiño, G. R. (2012). COMPORTAMIENTO DE COPOAZÚ [Theobroma grandiflorum (Willd. ex. Spreng.) K. Schum.] EN AGROECOSISTEMAS DISEÑADOS A PARTIR DE BOSQUE SECUNDARIO (CAQUETÁ, COLOMBIA). *Ingenierías & Amazonia*, *5*(2).

Gómez-Cortés, P., Juárez, M., & de la Fuente, M. A. (2018). Milk fatty acids and potential health benefits: An updated vision. *Trends in Food Science & Technology*, *81*, 1-9.

Guayara, A. Gamboa, J. & Velásquez, J. (2009). Manual de ganadería con enfoque silvopastoril en la Amazonia colombiana. ISBN: 978-958-91787-85-2. pp 138. Recuperado de: https://www.uniamazonia.edu.co/v10/index.php/vicerrectorias/vicerrectoria-de investigaciones-y-posgrados/40-libros-resultados-de-investigacion/120-manual-de-ganaderia-con-enfoque-silvopastoril-en-la-amazonia-colombiana.html

Hess, H. D., Beuret, R. A., Lötscher, M., Hindrichsen, I. K., Machmüller, A., Carulla, J. E., ... & Kreuzer, M. (2004). Ruminal fermentation, methanogenesis and nitrogen utilization of sheep receiving tropical grass hay-concentrate diets offered with Sapindus saponaria fruits and Cratylia argentea foliage. *Animal Science*, *79*(1), 177-189.

Hernández Royett, J., Hernández, Y. F., Gil, M. de los A., & Cárdenas Barboza, E. (2018). Evaluación del modelo integrado de planeación y gestión (MIPG) en las entidades territoriales del estado colombiano. *Aglala*, *9*(1), 444-463. http://revistas.curnvirtual.edu.co/index.php/aglala/article/view/1255

Hurtado, E., Tafur, O., Calle, Z., Ortiz, L. H., Zambrano, F., Gacharná, N., ... & Murgueitio, E. (2011). El árbol boca de indio o cenizo: este árbol es forrajero, maderable y de rápido crecimiento para la ganadería del trópico húmedo. *Carta Fedegán*, *126*, 64-70.

Ibrahim, M., Franco, M., Pezo, D. A., Camero, A., & Araya, J. L. (2001). Promoting intake of Cratylia argentea as a dry season supplement for cattle grazing Hyparrhenia rufa in the subhumid tropics. *Agroforestry systems*, *51*(2), 167-175.

IDEAM. (2018). Sistema de Monitoreo de bosques y carbono. Recuperado: http://smbyc.ideam.gov.co/MonitoreoBCWEB/pub/reporteGeoproceso.jsp?id_reporte=7123

Ledesma, L. M., Gallego, L. A., & Peláez, F. J. (2002). Situación actual de la ganadería de carne en Colombia y alternativas para impulsar su competitividad y sostenibilidad. *Revista Colombiana de Ciencias Pecuarias*, *15*(2), 213-225.

Lima, L. A., Silva, A. M. D. A., Bezerra, L. R., Morais, J. S. D., Araújo, M. J. D., Oliveira, R. L. & Pereira, E. S. (2018). Effects of the buriti (Mauritia flexuosa L.) oil supplementation on crossbred lactating goats: behavioral, physiological, and hematological responses. *Revista Brasileira de Zootecnia*, *47*.

Maass, B. L., & Pengelly, B. C. (2021). Tropical Forage Genetic Resources--Will Any Be Left for Future Generations?.

Mahecha, L. (2003). Importancia de los sistemas silvopastoriles y principales limitantes para su implementación en la ganadería colombiana. *Revista Colombiana de Ciencias Pecuarias*, *16*(1), 11-18.

Martínez Amado, W. E., Barbosa Guerrero, L. M., Amaya Cocunubo, I. F., & Guzmán Ramos, H. F. (2020). ¿Son los momentos de crisis, una oportunidad para las marcas?. *Enfoque Disciplinario*, *5*(2), 19-23. Recuperado a partir de http://enfoquedisciplinario.org/revista/index.php/enfoque/article/view/22

Martín, P. C. (2009). El uso de residuales agroindustriales en la alimentación animal en Cuba: pasado, presente y futuro. *Avances en Investigación Agropecuaria*, *13*(3), 3-10.

Mercado León, L. (2018). Impacto de la revaluación del peso frente al dólar en las exportaciones de atún por el puerto de Cartagena de Indias en el periodo 2008-2012. *Conocimiento Global*, *3*(1), 30-49. Recuperado a partir de http://conocimientoglobal.org/revista/index.php/cglobal/article/view/6

Mirabella, N., Castellani, V., & Sala, S. (2014). Current options for the valorization of food manufacturing waste: a review. *Journal of Cleaner Production*, *65*, 28-41.

Mukerji, A. K. (1997). La importancia de los productos forestales no madereros (PFNM) y las estrategias para el desarrollo sostenible. In *Congresso Forestal Mundial, XI. Antalya, 1997. Proceedings. Antalya, FAO. p* (pp. 217-227).

Orús, A. (2021, Abril 2021). Principales países productores de carne de vacuno a nivel mundial en 2021. Statista. https://es.statista.com/estadisticas/635290/carne-de-vacuno-principales-paises-productores/

Otero, E. Mosquera, L. Silva, G. & Guzmán, J. (2008). La Amazonia de Colombia. ISBN 978-958-95504-2-7. Recuperado de: https://www.imeditores.com/banocc/amazonia/creditos.htm

Pazla, R., Zain, M., Ryanto, I., & Dona, A. (2018). Supplementation of minerals (phosphorus and sulfur) and Saccharomyces cerevisiae in a sheep diet based on a cocoa by-product. *Pakistan Journal of Nutrition*, *17*(7), 329-335.

Palacios Rozo, J., Ortiz Quevedo, J., Nuñez Uribe, J., & Porras Rojas, I. (2019). Competencias sociales en docentes universitarios en la ciudad de Bogotá. *Conocimiento Global*, *4*(2), 57-68. Recuperado a partir de https://conocimientoglobal.org/revista/index.php/cglobal/article/view/45

Ponguillo Lucín, L. E. (2018). *Estudio del aprovechamiento de los residuos de cacao en el Cantón Balao, Provincia del Guayas* (Bachelor's thesis, Universidad de Guayaquil. Facultad de Ciencias Económicas).

Queiroz, A. C. M. D., Santos, W. M. D., Mendonça, R. D. C. A. D., Santos, R. I. R. D., Silva, T. C. D., Domingues, F. N., & Rêgo, A. C. D. (2020). Effects of inclusion of patauá, Oenocarpus bataua meal on elephant grass silage. *Acta Amazonica*, *50*, 101-107.

Quispe Jacobo, F., Ayala Rojas, M., Ingunza Reyes, G., Landeo Pino, E., & Pascual Chagman, G. (2009). Caracterización de aceites, tortas y harinas de frutos de Ungurahui (Jessenia polycarpa) y Aguaje (Mauritia flexuosa L.) de la Amazonía Peruana. *Revista de la Sociedad Química del Perú*, *75*(2), 243-253.

Ramírez Elias, G., & Pérez Paredes, A. (2021). Las finanzas personales bajo el impacto de la Covid-19 en México. *Enfoque Disciplinario*, *6*(1), 32-41. Recuperado a partir de http://enfoquedisciplinario.org/revista/index.php/enfoque/article/view/25

Restrepo Sierra, L. (2019). Potencialidades de la comercialización de flores exóticas tropicales en el municipio de Aguachica-Cesar. *Conocimiento Global*, *4*(1), 1-11. Recuperado a partir de https://conocimientoglobal.org/revista/index.php/cglobal/article/view/30

Rodríguez-Villanueva, H., Puch-Rodríguez, J., Muñoz-González, J., Sanginés-García, J., Aguilar-Urquizo, E., Chay-Canul, A. & Piñeiro-Vázquez, A. (2020). Intake, digestibility, and nitrogen balance in hair sheep fed Pennisetum purpureum supplemented with tropical tree foliage. *Agroforestry Systems*, *94*(3), 665-674.

Saval, S. (2012). Aprovechamiento de residuos agroindustriales: pasado, presente y futuro. *BioTecnología*, *16*(2), 14-46.

Tejeda, G. C., Zamora-Martínez, M. C., & Sánchez, L. (1998). Recursos forestales no maderables, situación actual y perspectivas. *Memorias Reunión de la Comisión Forestal para América del Norte, Mérida, Yucatán, México*, 35-49.

Tergas, Luis Eduardo; Sánchez, Pedro A. (eds.). 1979. Seminario sobre Producción de Pastos en Suelos Ácidos de los Trópicos (1978, Cali, Colombia). Producción de pastos en suelos ácidos de los trópicos: Trabajos presentados. Centro Internacional de Agricultura Tropical (CIAT), Programa de Producción de Ganado de Carne, Cali, CO. 524 p. (Serie O3SG-5) (Cambiar cita Garza TR 1978).

UNICEF. (2018). El estado de la seguridad alimentaria y la nutrición en el mundo: fomentando la resiliencia climática en aras de la seguridad alimentaria y la nutrición.

Vargas, E., & Zumbado, M. (2003). Composición de los subproductos de la industrialización de la palma africana utilizados en la alimentación animal en Costa Rica. *Agronomía Costarricense*, *27*(1), 7-18.

Velásquez, J., OCAÑA, H. E., Rodríguez, G., VILLANUEVA, O., Ramírez, B., & Lavelle, P. (2012). Caracterización socio-económica y productiva de tres tipos de sistemas de producción con bovinos en el piedemontc amazónico colombiano. *Revista Facultad de Ciencias Agropecuarias-FAGROPEC*, *4*(1), 13-19.

Vergara, W. (2010). La ganadería extensiva y el problema agrario. El reto de un modelo de desarrollo rural sustentable para Colombia. *Revista Ciencia Animal*, *1*(3), 17-26.

Vicenssuto, G. M., & de Castro, R. J. S. (2020). Development of a novel probiotic milk product with enhanced antioxidant properties using mango peel as a fermentation substrate. *Biocatalysis and Agricultural Biotechnology*, *24*, 101564.

Villa, R., Rodriguez, L. O., Fenech, C., & Anika, O. C. (2020). Ensiling for anaerobic digestion: A review of key considerations to maximise methane yields. *Renewable and Sustainable Energy Reviews*, *134*, 110401.

Wang, Z., Bui, Q., & Zhang, B. (2020). The relationship between biomass energy consumption and human development: Empirical evidence from BRICS countries. *Energy*, *194*, 116906.