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Palm fruits potential for sustainable commercialization in Pando, Bolivia

Master thesis

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Content

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List of abbreviations

ABT	Autoridad de Fiscalización y Control Social de Bosques y Tierra
ACCA	Asociación para la Conservación de la Cuenca Amazónica.
ACCESO	Programa de inclusión Económica para Familias y Comunidades Rural
ACEAA	Asociación Boliviana para la investigación y conservación de ecosistemas Andino Amazónicos
CIPCA	Centro de Investigación y Promoción del Campesinado
FEDAFAP	Federación de Cosechadores de Asaí y Frutos Amazónicos de Pando
IBNORCA	Instituto Boliviano de Normalización y Calidad
INIAF	Instituto Nacional de Innovación Agropecuaria y Forestal
INRA	Instituto Nacional de Reforma Agraria
IPHAE	Instituto Para el Hombre, la Agricultura y Ecología
LEK	Local ecological knowledge
MAP	Madre de Dios (Peru), Acre (Brazil), Pando (Bolivia)
MCDM	Multiple criteria decision making
NTFPs	Non-timber forest products
NGO	Non-Governmental Organization
PICFA	Plataforma Interinstitucional de Articulación de Complejos Productivos de Frutos Amazónicos
PGIBT	Plan de gestión integral de bosque y tierra
PRODIGY	Process-based and Resilience-oriented management of Diversity Generates Sustainability
POGI	Plan Operativo de Gestión Integral
RNVSA	Reserva Nacional de Vida Silvestre Amazónica
TEK	Traditional ecological knowledge
SEDEPRO	Servicio Departamental Productivo
SENASAG	Servicio Nacional de Sanidad Agrícola y Agropecuaria
SERNAP	Servicio Nacional de Áreas Protegidas
SES	Socio-ecological system
SMART	Simple Multi Attribute Rating Technique
SWOT	Strengths, Weaknesses, Opportunities, Threats
UAP	Universidad Amazónica de Pando
WWF	World Wildlife Fund
ZEF	Zentrum für Entwicklungsforschung - Center for Development Research

Abstract

Arancibia Alfaro, Andrea Violeta. 2021. Engl. Palm fruits potential for sustainable commercialization in Pando, Bolivia, Master thesis at the University of Natural Resources and Life Sciences Vienna (Austria)

Palm fruits are important non-timber forest products (NTFPs) for the livelihoods of rural people in the Amazon region, as many are nutritious foods and have potential to generate income. However, in Pando, Bolivia, the conditions for their commercialization are in most cases still underdeveloped. The aim of this master thesis was to assess the potential of four palm fruits for a sustainable commercialization, and to identify the promoting and hindering conditions for that. The palm fruits studied were Asai (*Euterpe precatoria* Mart*),* Majo *(Oenocarpus bataua* Mart*),* Motacu *(Attalea phalerata* Mart. ex Spreng*)* and Palma real *(Mauritia flexuosa* L.f*.)*. I gathered data from 14 key informants, using semi-structured online interviews, and 20 community members, using structured interviews. I analyzed the data with qualitative content analysis and applied a multi criteria decision making tool. Asai was the palm fruit with the highest potential due to its high abundance, high demand and institutional support among others. Followed by Majo, which was benefited by its similarities with Asai regarding harvesting and processing, but still with technical processing deficiencies that limit its commercialization. Palma real and Motacu medium and low potentials, were reduced by a lack of knowledge regarding their harvesting and processing, and reduced consumption. This study demonstrates the importance of considering varied multidisciplinary factors for a sustainable commercialization, and that institutional support is key for its development in rural Bolivia. Furthermore, it served to identify the factors that need further promotion and implementation for each palm fruit studied.

Kurzfassung

Arancibia Alfaro, Andrea Violeta. 2021. Palmfrüchtepotenzial für nachhaltige Vermarktung in Pando, Bolivien, Masterarbeit and der Universität für Bodenkultur Wien

Palmfrüchte, ein Produkt des Regenwaldes, haben für den Lebensunterhalt der ländlichen Bevölkerung im Amazonas-Einzugsgebiet eine große Bedeutung. Denn viele der Palmfrüchte sind nährstoffreich und haben ein großes Vermarktungspotential. Aber für viele der Palmfrüchte gibt es keine Vermarktung. Ziel der Masterarbeit war es vier Palmfrüchten in der Region Pando (Bolivien) hinsichtlich ihres Potentials einer nachhaltigen Vermarktung zu bewerten und sowohl positive als auch negative Faktoren der Vermarktung zu identifizieren. Es wurden folgende Palmfrüchte untersucht: Asai (Euterpe precatoria Mart), Majo (Oenocarpus bataua Mart), Motacu (Attalea phalerata Mart. ex Spreng) und Palma real (Mauritia flexuosa L.f.). Die Datenerhebung basierte auf 14, zum Teil strukturierten, Interviews mit Personen in Schlüsselpositionen und auf 20 strukturierten Interviews mit Gemeindemitgliedern. Die Interviews wurden mittels einer qualitativen Inhaltsanalyse ausgewertet und darauf aufbauend eine multikriterielle Entscheidungsanalyse durchgeführt. Die Palmfrucht mit dem höchsten nachhaltigem Vermarktungspotential war Asai, aufgrund ihrer Häufigkeit, der hohen Nachfrage und der institutionellen Förderung. Danach folgt Majo, mit ähnlichen Charakteristika hinsichtlich Ernte und Produktveredelung wie Asai. Allerdings limitieren Schwächen bei der maschinellen Weiterverarbeitung gegenwärtig die Vermarktung. Zuletzt folgen Palma real und Motacu mit einem mäßig-geringen bzw. geringen Vermarktungspotential. Dies ist fehlender Kenntnisse hinsichtlich Ernte, Weiterverarbeitung und geringem Konsum geschuldet. Diese Studie zeigt die Notwendigkeit einer sektorenübergreifenden Betrachtung und die wichtige Rolle der Institutionen für die Förderung einer nachhaltigen Vermarktung. Zudem wurden für jede der untersuchten Palmfrüchte die Faktoren identifiziert, welche weiter gefördert bzw. angewendet werden müssen.

1. Introduction

Non-timber forest products (NTFPs), are the biological materials other than timber, extracted from forests for human use (de beer and Mcdermott, 1989).They provide different kinds of services and goods like food, materials and medicine, which can be directly consumed by people to satisfy subsistence needs, serving as an alternative to decrease the need for purchasing goods, or sold to generate economic income (Secretariat of the Convention on Biological Diversity, 2001; Stanley et al., 2012). Either way, they offer several paths to improve the livelihood of rural people especially in developing countries, and additionally their use can promote the biodiversity maintenance, carbon sequestration and forest conservation (Avocevou-Ayiso et al. 2009; Pérez et al., 1996).

As these products increase their value, their demand and necessity to harvest them also increases, creating a higher pressure on forests putting them at risk of depletion, especially important when products go from being self-consumed goods to commercialized products (Stockdale, 2005). To avoid this point and to ensure that NTFPs continue offering their benefits over time, it is necessary to manage them responsibly and plan their commercialization sustainably. But, this can be very challenging due to the various ecological, social, economic and governance factors, among others, influencing simultaneously (Shackleton, 2015). Among the ecological aspects, one of the main factors that impact the NTFPs stock, is the intensity of harvesting, i.e., a sporadic gathering of a fruit may be lees detrimental than intensive harvesting (Peters, 1996). Regarding the social and economic dimensions, the contribution to household self-sufficiency, economic income and food security are the most alluded, e.g., working as ´gap fillers´ in case of seasonal income gaps and providing a buffer in times of emergency or economic insecurity (Pérez et al., 1996). Moreover, a good functioning of markets and value chains are essential for a fair distribution of the profits (Marshall et al., 2006; Schreckenberg et al., 2006). All these factors are embedded in a political framework, which provide the setting for all the other elements to work correctly, and ensure their sustainable operation (Cunningham, 2001).

NTFPs, are essential elements of the Amazonian socio-ecological systems (SES), which are defined as complex adaptive systems that integrate biogeophysical and socio-cultural processes with feedbacks among them (Delgado-Serrano et al., 2015). In the Bolivian Amazon, their extraction, mainly of Brazil nut, is considered a critical component of its SES, whose vulnerability and resilience depend on the different pressures and fluctuations that may affect its production, e.g., the forest conservation, climate fluctuations, and its price on the international market (D. Callo-Concha et al, personal communication, February 10, 2020). As the local people depend economically mainly on this product, the effects of these hard-to-predict fluctuations could greatly affect the land use decisions and increase the land pressure to satisfy subsistence needs, this mainly because a sustained economy based on extractivism is only possible if the forest provides higher economic benefits than other land use activities or if very strict regulations prevent land use change (Pacheco et al., 2009). Therefore, it would be advantageous, to explore the potential of other alternative NTFPs, to include them in a diversified economy and buffer the possible negative impacts on Brazil nut.

Numerous studies point out to the high biodiversity of the Bolivian Amazon forest and the large variety of NTFPs that it provides (Araujo-Murakami et al., 2016; Herencia, 2013; Moraes, 2014, 2020; Phillips, 1993). Palm trees are considered the most important group of plants providing them due to their large range of uses and importance in local people's livelihoods (Balslev et al., 2015; Moraes et al., 2015; C. M. Shackleton et al., 2018; Smith, 2014). Their use as food is one of the most common, as they their fruits are constantly consumed by forest population and are a well-known source of nutrients (Moraes, 2014; Smith, 2014). They are also the NTFPs with the highest economical potential in the region (Moraes, 2014), having some of

them even reached international markets (Smith, 2014). Nevertheless, there is still a lack of understanding of the interactions between the ecological, socio-economic, market and political characteristics implied in their use, that underpin a sustainable commercialization and alongside, promote the conservation of the forest and benefits for rural livelihoods. Hence, in this thesis, I aimed to assess their potential for sustainable commercialization of four palm fruits, and identify the promoting and hindering conditions according to an analytical framework and to communities´ characteristics.

2. State of the art

The state of the art gives a review on the conditions that influence the sustainable commercialization of NTFPs in general, but applicable for palm fruits, as specific literature for them is limited concerning this topic.

2.1. Commercialization of NTFPs

There are two main objectives NTFPs commercialization pursues. The first one is related to the livelihoods' improvement due to the income generation and employment opportunities from their trade, especially important for poor people (Belcher & Schreckenberg, 2007; Stanley et al., 2012). The second objective is related to conservation. It is often argued that NTFPs commercialization can create incentives for the conservation of the forests where they grow, assuming that rural people will maintain them to perceive economic benefits that they provide (Belcher & Schreckenberg, 2007; Neumann & Hirsch, 2000). Furthermore, sharing and protecting traditional ecological knowledge is also considered an additional benefit (Alan Pierce, 2010).

However, NTFPs commercialization also has critics, who underline that if sustainability is not considered, livelihoods, as well as the resource base can be negatively impacted (Areki & Cunningham, 2010). This was the case with several NTFPs that were commercialized in the Amazon, characterized by the ´boom and bust´ cycle, described in four characteristic phases (Figure 1). In the first phase, there is an increase in the extraction of the resource, characterized by an abundant resource base and a monopolistic market. In the second, there is a stabilization phase, with a balance between supply and demand, prices start to rise as the demand grows, policies to protect extractivism are adopted and the cultivation of the NTFPs starts. In the third phase there is a decline of the extraction, due to the exhaustion of resources, the growing costs of extraction, substitution by other alternatives and/or quality and trade related problems. In the last phase, the extraction from natural forests declines with the possibility to do it from cultivated plantations. The length of this cycle is determined by the different factors related to NTFPs use, like policies, socio-economic variables, and markets development (Homma 1996; Schreckenberg et al. 2006; Laird, 2010).

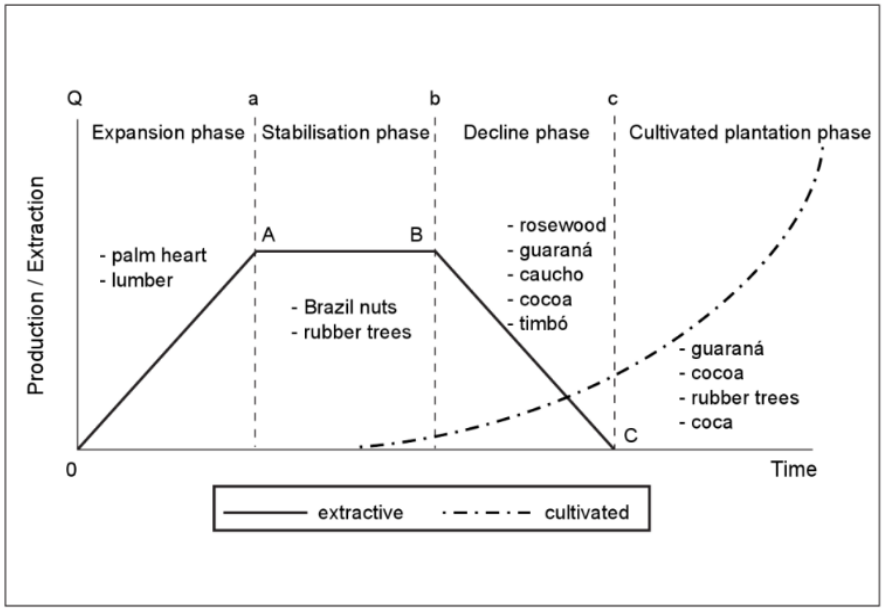

Figure 1: Historical cycle of forest production in the Amazon (Homma, 1996)

This behavior was seen in the case of the palm heart (*Euterpe precatoria*) in Bolivia, which after reaching a high international demand, the bust started at the end of the 90´s with sanctions from the main importer (Brazil) due to bad quality and hygiene conditions (Schreckenberg et al. 2006). But probably the most known experience in the Amazon is with the wild rubber (*Hevea brasiliensis*), extended across Brazil, Bolivia and Peru. When the ´boom´ started, the per capita income in the Amazon raised considerably, population increased due to a colonization program, and urban centers grew with the international market boom. Nevertheless, the benefits were mostly channeled to the big companies and not to the newly settling populations. New, low-cost rubber plantations in Asia at the beginning of the 90´s, caused a sharp drop in the international price, causing an economic shock to the big export houses and all the components of the value chain (Barham & Coomes, 1994).

2.1.1. Sustainable commercialization of NTFPs

Authors that tackle commercialization of NFTPs propose several approaches, dimensions, and methodologies for its assessment. Sustainability is often considered as the basis for its success, including a large range of influencing factors. Among them are mentioned the ecological, social, economic, cultural, institutional, marketing and socio-politic aspects (Avocèvou-Ayisso et al., 2009; Gould et al., 1998; Hernández-Barrios et al., 2015; Marshall, et al., 2006; Wynberg & van Niekerk, 2015). These factors, which also interact among them, account for the complex and multidisciplinary dynamics that NTFPs commercialization pose (Wynberg & van Niekerk, 2015).

For instance, Marshall (2006), offers a methodology used in Mexico and Bolivia for assessing NTFPs trade holistically, based on the natural, financial, material, human and social capital. It starts with a participatory investigation at community level including information from the management and use of the resource, financial capacity, infrastructure, human capacity, and sociocultural and organizational aspects; followed by analysis of the business budget, of the market and its tendency, and of the value chains.

In the following subchapters the most common aspects mentioned for a sustainable commercialization of NTFPs are described.

2.1.1.1. Ecological aspects

As the commercialized products come from a natural basis, their harvesting need to be ecologically sustainable, this meaning that the extracted quantities allow to maintain the stock of the product without exceeding regeneration rates (Hall & Bawa, 1993). There are several indicators that help to assess ecological characteristics of the resources and practices to achieve sustainability. The ones proposed by Wynberg and van Niekerk (2015), can be divided in three groups; the first one is related to the characteristics of the specie and ecosystems, like ecosystem complexity, conservation status of the specie, speed of growth, pollination mechanisms, part of the plant used, ease of propagation. The second group is related to the population size and distribution. And the last one to the human intervention such as harvesting techniques, management, and monitoring.

Among the biological characteristics, the part of the plant used (reproductive parts, vegetative parts or exudates) is the most mentioned**,** as each of them needs different harvesting techniques and considerations for not hindering the abundance of the resource (Chamberlain et al., 2019; Cunningham, 2001; Neumann & Hirsch, 2000; Sunderland & Ndoye, 2004; Ticktin, 2004). NTFPs harvesting that imply killing the plant are more problematic; NTFPs from exudates, fruits or leaves can be harvested many times from the same individual if a correct harvesting method is implemented (Pérez et al., 1996). Fruit and seed harvesting avoid negative impacts, as they are normally collected from what is part of the high seed mortality (Sunderland & Ndoye, 2004).

The integration of NTFPs harvesting into forest research and management, with appropriate inventory and monitoring methods is important for planning a sustainable harvesting (Chamberlain et al., 2019). Among the information collected from forest inventories, are the abundance, density, distribution, population structure, productivity and harvesting quantities (Pérez et al., 1996, Chamberlain et al., 2019). Assessing the current abundance and productivity provides base line information and is the first step to assess and plan harvest management and quantities; the average harvesting quantities must be compared with the productivity to define a sustainable extraction considering a maximum harvest that doesn't exceed the regeneration rate (Chamberlain et al., 2019; Stanley et al., 2012). However, collecting this information from a forest inventory, can be challenging due to the ephemerality of some products and the expensive and time consuming work, but this can be improved integrating traditional and local ecological knowledge (TEK and LEK) or other available data to have preliminary information that can be later updated (Chamberlain et al., 2019; Gould et al., 1998).

Proper harvesting methods are also necessary to ensure a sustained provision of NTFPs. Unsustainable harvesting can affect survival rates, growth, and reproduction of the species, having consequences also in the forest ecology and ecosystem (Chamberlain et al., 2019; Ticktin, 2004). Hence, implementing knowledge-based management approaches to support non-destructive harvesting methods and to prevent the depletion of NTFPs are needed (Pandey, 2016; Wynberg and van Niekerk, 2015). For instance, in Peru, cutting down the palms to harvest *Mauritia flexuosa* fruits, caused a degradation of the state of the swamps where they grow and a decrease in the fruit's availability. This forced local people to adapt their harvesting method to a more sustainable one, preventing the death of female palms (Falen & Honorio, 2018).

Information about changes on the species population due to the ecological impacts of the harvesting is gathered in monitoring activities, and should be provided in a constant flow and with feedbacks to analyze the responses to different degrees of harvesting (Pérez et al., 1996). Changes in the population can also happen due to external factors, such as climatic conditions, which happen at spatial and temporal scales and in different time lapses according to the biophysical conditions of a particular environment. For instance, in more homogenous relative

static environment, long-term analysis may be less crucial than in environments with less predictable climatic events (Dahlberg, 2015).

2.1.1.2. Socio-economic aspects

Sustainable commercialization of NTFPs, also requires of sustainable socio-economic activities, defined as those that generate a self-sustained economy providing an adequate quality of life to population over time (Copus & Crabtree, 1996). Stanley et al. (2012) underlines that NTFPs activities should generate at least sufficient income to workers to purchase a survival basket or match the average day´s work income in the area, to be therefore maintained without needing to shift to a more profitable one. But, income is a straightforward information, that due to limitations in the quality of the data normally accessible, it is often estimated indirectly and finding the importance of the NTFP in the total household income (Neumann & Hirsch, 2000).

Due to their economic benefits and role in poverty reduction, NTFPs activities are reported as ´gap fillers´, ´safety nets´ and ´steppingstones´. NTFPs´ as ´gap fillers´ make poverty more bearable generating supplementary income to other main economic activities normally in non-agricultural season (Laird, 2010; Schreckenberg, Marshall, et al., 2006). ´Safety nets´ are built helping households to reduce their vulnerability to hard times risks, like illness, natural disasters, periods of shortage or other unpredictable events (Laird, 2010; Schreckenberg, Marshall, et al., 2006; C. Shackleton & Shackleton, 2004). The ´steppingstone´ function, refers to the transition of poor people getting out of poverty or becoming less poor thanks to the income generated from NTFPs, usually happening when producers have an adequate specialized commercialization strategy (Schreckenberg, et al., 2006). On the other hand, economic activities related to NTFPs, could also become ´poverty traps´ when they don't provide enough profits for a socioeconomic advancement, or when there is not a fair distribution of the benefits in a value chain (CIFOR, 2003; Schreckenberg, et al., 2006). For instance, this is the case of the peonage systems, where gatherers are paid in advance for the production, being trapped in a repayment circle, as it was often the case of Rubber and Brazil nuts decades ago (Schreckenberg, et al., 2006).

In the Amazon and MAP region, there are cases where NTFPs represented the major source of income for rural people, e.g., in Pando, Bolivia with Brazil nuts (Ministerio de Medio Ambiente y Agua et al., 2013), and in Brazil with Asai juice, which after having a long consumption tradition, became the most important NTFP in its economy (Richards, 1993). However this is not universal, in a Peruvian Amazon community, incomes from NTFPs were lower than the ones from agriculture and timber, although NTFPs were important for the locals' livelihoods, commercialization chains prevented them to generate significant economic profits (Pyhälä et al., 2006).

The socio-economic benefits of NTFPs also relate to the satisfaction they provide to other material human needs, among them food, medicine, raw materials for construction and others, and energy (Cunningham, 2001; de Mello et al., 2020); Pérez et al., 1996). They are an especially important element for the food security in rural areas, as their consumption can prevent hunger in difficult times, e.g. droughts, (Cunningham, 2001), and contribute to their health due to their nutritious quality. This is the case of Amazonian palms, which are consumed in a variety of byproducts, containing beneficial natural oils, starch, proteins and vitamins, important to prevent malnutrition (Balslev et al., 2015; Brokamp et al., 2011).

2.1.1.3. Market related aspects

Value chains are important elements for the development of commercialization. They relate to the activities and the steps carried out in a commercialization process, from the extraction of the resource, processing and transformation, until the delivery to the consumers (Kaplinsky,

2000). They are composed by links, containing each of them another range of activities and actors with specific functions. A good connection, information flow and transparency between the actors is necessary to increase the resilience of the value chain to external market factors like competition or substitution; and to ensure a fair distribution of the profits (Marshall et al., 2006; Schreckenberg et al., 2006).

Many NTFPs, among them food products are usually restricted to the local market and often sold directly from gatherers to consumers. Efforts to expand the market requires special attention to the demand. In the case of an international market, when the access to it is secure, the main constrain is the fulfillment of the supply and achieving the quality and certification requirements. In both cases it is necessary to have a clear view of the potential markets, their trends and characteristics such as prices and substitutes (Belcher & Schreckenberg, 2007; Schreckenberg et al., 2006).

When commercialization expands, different types of organizations arise along the value chain, shifting from informal to formal arrangements. For instance, communal organizations, which are characteristic in communal territories, allow to share costs of investments among the members and improve products quality as well as their bargaining power. Entrepreneurs, other important actors, have an important role in transmitting markets information (Belcher & Schreckenberg, 2007; Marshall, et al., 2006).

Information about the markets, together with the capacity to act according to them is essential to enter and maintain a good position of the product, as well as to ensure a fair and efficient process. Producers need to have information about the quality requirements, as well as an adequate infrastructure to fulfill them, value-added processing could be a plus (Marshall, et al., 2006).

Competition or substitution of the NTFPs by other industrial alternatives or cheaper products, can lead to the inability to commercialize them (Godoy & Bawa, 1993; Marshall et al., 2006). Substitution can also be a danger, when a product has many local similar products, or when the efforts for a sustainable harvesting increases its price (Plotkin & Famolare, 1992). Negative impacts to rural producers, can be tackled creating a diversified portfolio of products harvested and commercialized, or creating specialized niche markets for products with specific quality characteristics. This was the case of wild rubber, which was substituted by synthetic latex, but that nowadays has found a rustic niche market (Marshall et al., 2006).

The technology required to process NTFPs, will depend on the final product and on the target market. The infrastructural conditions required include processing equipment and post-harvesting storage, necessary to avoid losses of perishable products. A proper storage is important for the efficacy of the sale, as it extends the economic life of the harvest and allows the harvesting of big volumes (Belcher & Schreckenberg, 2007). Moreover, communication and transportation systems, often deficient in rural areas, can affect the transportation costs and their accessibility to the markets reducing their competitiveness (Belcher & Schreckenberg, 2007; Plotkin & Famolare, 1992).

2.1.1.4. Political, legal and institutional aspects

Political and legal aspects set a framework that can facilitate or hinder sustainable management and commercialization of NTFPs. Policies and laws related to NTFPs are often complicated and deficient, and a broader policy is hard to set by the diversity of species, ecological niches and harvesting methods involved, as well as the different uses and scale at which NTFPs are traded. But, there are few cases of comprehensive policies for specific high-value species, like it is the case of Brazil nut in Bolivia (Laird et al., 2010).

According to Laird et al. (2010), polices that have a direct influence on NTFPs, focus on their trade and commercialization, among these are: quality and safety control, transportation

system, and taxation. Quality and safety control for food products, relate to the food safety legislation, which sets the sanitary requirements to access markets. These are often seen as an obstacle to reach international markets. A good transportation system, including the road system and transportation law of natural resources, allow the flow of the resources from the forest to the commercialization destiny. Taxation, including 'unofficial taxation' is normally enforced by governments, but in many cases, bribery is normalized due to governance problems, corruption or intricated bureaucracy.

Policies that indirectly impact NTFPs relate to agriculture, land tenure and resource use rights. Agricultural policies can promote or discourage resources management, by subsidizing or incentivizing certain species cultivation. Sometimes, they can set major changes in the rights on land or resources, like in the case of the Agrarian Reform in Bolivia, whose consequences impacted Brazil nuts access in the forest (Laird et al., 2010). Land tenure determines how are the land and resources accessed, who are the users and holders, under what conditions and for how long (McLain & Lawry, 2015). Cleared land tenure and resources rights are key to have guaranteed, equitable and sustainable access to NTFPs (Pierce & Bürgerner, 2010). This is particularly important when there is an overlap between the land rights of communities and the state, like in the case of protected areas (Cunningham, 2001). Tenure security is also important for a good governance and a sustainable use of NTFPs (McLain & Lawry, 2015). Relatedly, Persha et al. (2011), mention that the users' perception of how secure their tenure of land and resources is, determines their engagement and long-term decisions related to sustainability. Moreover, there is evidence that shows that transferring or returning land ownership to poor people, in a secure and long-term manner, is an effective strategy to take them out from poverty (Arnold, 2001).

Schreckenberg et al. (2006) mention that a country´s legislation and the inclusion of NTFPs commercialization in it, is key for the process of shifting from informal to formal markets. This is usually not a constrain for small local markets, but it is when the markets are expanded. Other relevant legislation refers to collec

tion permits, export requirements, restrictions in protected areas, and formalization requirements. Several institutions are normally involved in setting this legal framework, and in the Amazonian context, collective agreements and negotiations among them is key (Pyhälä et al., 2006). Among the institutions involved are the forestry and agricultural superintendencies and ministries, and the protected area services when it's the case. Moreover, NGOs, are institutions that play a key role in promoting NTFPs commercialization in rural communities, providing information and tools to fulfill legal requirements, support related to production and processing, marketing, and funding (Schreckenberg et al., 2006).

Other two important factors mentioned by McLain & Lawry (2015), are the institutional fit, and the rules for an effective monitoring and enforcement. Institutional fit refers to the consideration of the biophysical characteristics of the resources as well as users´ cultural values, traditions, and knowledge, in institutional arrangements; how properly set institutional arrangements are, and how they help to implement the equity and fairness between the actors of the NTFPs value chains. An effective monitoring and enforcement system requires an assessment not only of the resource behavior and ecological conditions at different levels, but also of the good functioning of the governance system.

3. Research questions

This master thesis aims to assess the sustainable commercialization of four selected palm fruits in Pando, Bolivia from the perception of key informants and community members. The research questions are:

- Research question 1: Which ecological, socio-economic, political and institutional, and market and value chain framework conditions promote or hinder the sustainable commercialization of the palm fruits?
- Research question 2: Which community characteristics influence palms fruits sustainable commercialization?
- Research question 3: What potential for sustainable commercialization do palm fruits have?

4. Methods

4.1. PRODIGY project and research partners

This M.Sc. thesis was carried out as part of the Working group 2 of the project Process- Based and Resilience-oriented Management of Diversity Generates Sustainability (PRODIGY), financed by the German Federal Ministry of Education and Research. This working group's main collaborator in Germany was the University of Koblenz-Landau and had and main objectives the evaluation of the socio-ecological resilience and the identification of the tipping points in rural tropical systems in the Madre de Dios, Acre and Pando (MAP) region. Partner institutions of the PRODIGY project in the study area were: Centro de Investigación y Promoción del Campesinado (CIPCA), Asociación Boliviana para la Investigación y Conservación de Ecosistemas Andino Amazónicos (ACEAA) and Universidad Amazónica de Pando (UAP).

4.2. Study area

The study area of the PRODIGY project in Pando and of this thesis is located in the district of Filadelfia, west part of the province Manuripi, along the main road that crosses the protected area *Reserva Nacional de Vida Silvestre Amazónica* (RNVSA Manuripi), including part inside of it and part and part outside of it (Figure 2).

RNVSA Manuripi has a total area of 747 000 ha, 67% belongs to the zoning "Area for harvesting of Non-timber forest products", whose function is to ensure a sustained harvest of the resources by the local people and promote the conservation by sustained use. In the area outside the RNVSA Manuripi, an important increase of human settlements promoted by the government has occurred, and therefore more intense and widespread land use change in comparison to inside of it (Ministerio de Medio Ambiente y Agua et al., 2013).

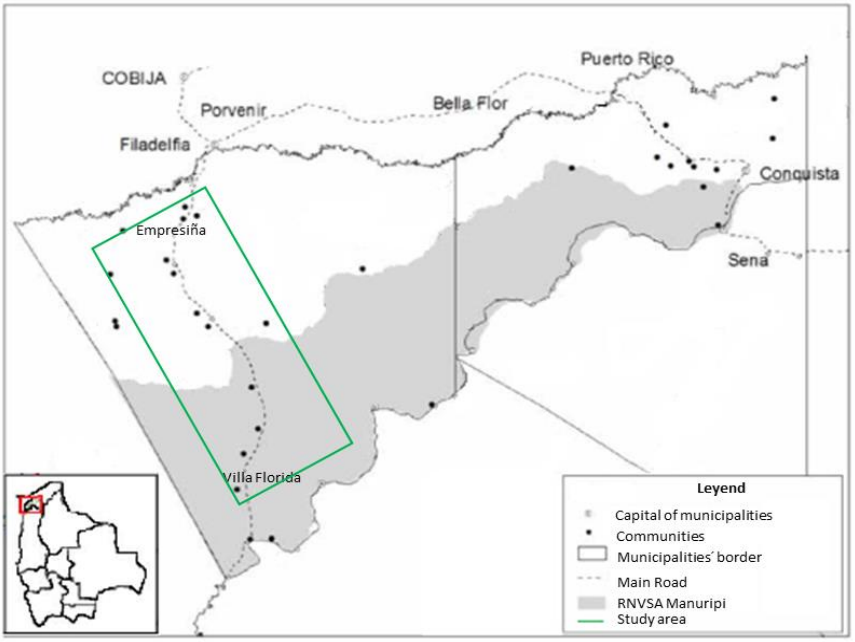

Figure 2: Study area in Pando, Bolivia (Modified after Ministerio de Medio Ambiente y Agua et al. (2013)).

4.2.1. Non-timber forest products in Pando

NTFPs extractivism history in the Bolivian Amazon, started with the rubber extraction from rubber trees in the late XIX (Vallori, 2012), but after its collapse in mid XX, locals found other sources of income like Brazil nut (Ministerio del Medio Ambiente y Agua et al., 2013), which is now the main export product and base of the economy of the department (Araujo-Murakami et al., 2016). Other NTFPs are important element of rural livelihoods, among them several palm trees species producing edible palms fruits; nevertheless, their commercialization was not yet explored, except for Asai (*Euterpe precatoria* Mart), whose market and value chain has started developing in the last few years (ACEAA, 2016).

4.2.2. Population description

The district of Filadelfia, had a population of 5 756 inhabitants in 2012, people's main spoken language are spanish (89,5%), foreign languages (5,1%), quechua (2.8%), aymara (2,2%) and other native languages (0,5%) (INE, 2015). In the RNVSA Manuripi, 82.85% of its total population is living in communities with 306 families, and 17,15% in *barracas* with 68 families (Ministerio de Medio Ambiente y Agua et al., 2013).

Indigenous groups in Pando, disappeared with the migration of people from other regions of the country like Santa Cruz and Beni that arrived as colonizers for the rubber rush, and later for Brazil nut activities (Antezana Guerrero et al., 2001; Ministerio de Medio Ambiente y Agua et al., 2013). After the fall in the rubber 'boom', some people moved to the urban areas, mainly Riberalta and Cobija, while the rest remained and established communities close to rivers and to Brazil nut trees (Antezana Guerrero et al., 2001).

This land ocupation trend, allowed the two types of setlements seen now: the *barracas* and communities, in the RNVSA Manuripi, Brazil nuts generate around 80% of the household income in both of them (Ministerio de Medio Ambiente y Agua et al., 2013). The *barracas* are centers of natural resources gathering of private ownerships and of variable size that were the dominant type of settlement until not so long ago. In them live families, not always settled but working as Brazil nut gatherers that during the off-season do subsistance agriculture, hunting

and fishing. (Ministerio de Medio Ambiente y Agua et al., 2013; Cronkleton & Albornoz, 2009). The communities, have comunal porperty rights on the land, and an economy based in an integral management system, including Brazil nuts collection, other forest resources collection and activities like hunting, fishing and agriculture (Araujo-Murakami et al., 2016; Ministerio de Medio Ambiente y Agua et al., 2013). In general, communities that have more access to the forest have higher incomes than the ones oriented only to agricultural activities (Pacheco, et a., 2009). Agricultural activities are mainly for subsistance and in a smaller scale for commercialization as soils are not suitable for an intensive agriculture, the system is based on the clear cut and with annual or biannual crops like rice, corn, casava or banana. (Antezana Guerrero et al., 2001). Other important source of income is the labor force, one or more family members usually offer their manpower inside or outside the RNVSA Manuripi (Ministerio de Medio Ambiente y Agua et al., 2013).

4.3. Analytical framework

This study held an interdisciplinary approach, combining ecological, socio-economic, political and institutional, and market and value chain aspects, used as criteria in an analytical framework with a set of indicators selected based on literature review, according to their contextual importance and the feasibility to collect local data in the current conditions (Table 1). This framework was the basis for data collection and analysis methodologies (Figure 3).

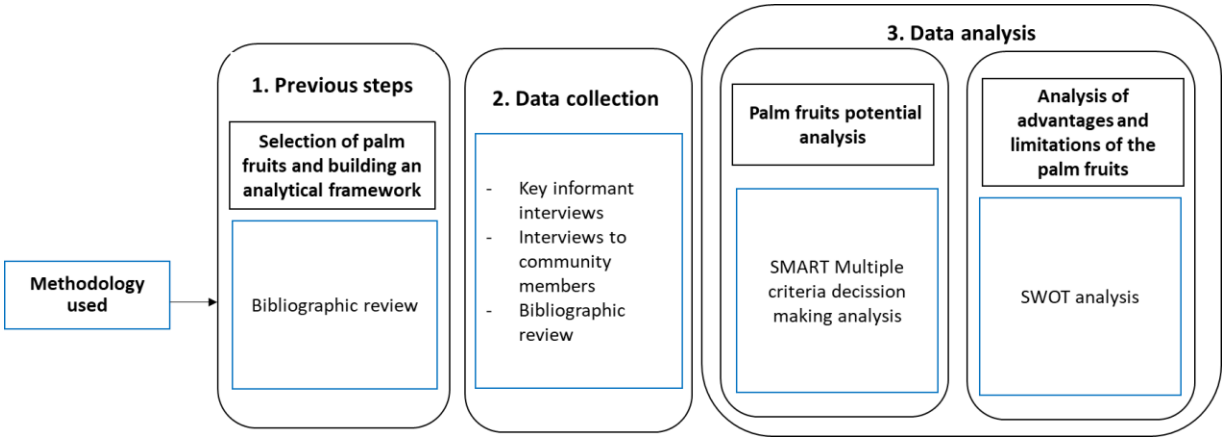

Figure 3: Methodology chart

Table 1: Analytical framework

Criteria and indicators	Description
Ecological criteria	
Abundance	Metric that gives information about the presence of a particular specie in certain forest area (Chamberlain et al., 2019). Was defined using the parameter species density, which is the number of individuals of a specie per unit area and allows to compare values across different forest inventories.
Estimated extraction relative to the harvesting potential	Assesses the people´s perception of the extracted percentages of a palm fruit in relation to the total production of the forest, it serves to estimate the remaining harvesting potential.
Harvesting methods impact	Defines if the harvesting methods and criteria used are knowledge-based and if they could cause negative impact on the individuals or population.
Harvesting level of difficulty	Defines how difficult the harvesting methods are according to characteristics of the palm.

Resource availability trend	Describes the availability trend of the resources (increase, stability or decrease) in the last decades. Relevant to understand the dynamics of the production due to internal, external, or environmental drivers.
Competitive use	Assesses if the palm fruits have other important local uses that could hinder the abundance of the specie or be in conflict with the extraction of fruits (e.g., the consumption of palm hearts or use of the stem as wood).
Socio-economic criteria	
Income generation	Assesses if the income from a day of work with a palm fruit, gives a return to the household that is enough to purchase a survival basket (Stanley et al., 2012).
Importance for household´s economy	Assesses how important rural householders perceive the income they get from the commercialization of the palm fruits.
Consumption in households	Assesses how often rural householders consume the palm fruits
Policies and institutional support criteria	
Policies and regulations	Describes how the current policies and regulations related to access to land, access to the resources, manufacturing, and sanitation support or hinder palm fruits use.
Technical support for harvesting	Refers to the technical support provided by governmental or non-governmental institutions to rural householders and producers associations, regarding adequate harvesting methods and species management.
Technical support for fruit processing	Refers to the technical support provided by governmental or non-governmental institutions to rural householders and producers associations, related to the adequate processing methods and equipment needed to maintain the quality of the product necessary for commercialization.
Financial support instruments	Assesses the financial support given to producers, that allows them to have a financial or material capital to facilitate their economic development, through financial instruments like such as reduction of taxes, subsidies, credits, loans, or provision of infrastructure.
Support for organization	Assesses the support from governmental or non-governmental institutions to the formation of rural organizations dedicated to palm fruits production, like producers' associations or federations.
Market and value chain criteria	
Competition and substitution	Determines if the palm fruits are vulnerable to compete or be substituted by other products in the market with the same or better characteristics
Local demand	Defines if the palm fruits have a current local market and its demand trend (increase, stability or decrease).
International market	Defines if the palm fruits have a current established or potential international market.
Producer's associations	Determines the existence of producers' associations for specific palm fruits.
Value chain	Determines how is the connection between the links of the production chain perceived, important to facilitate the arrival of the product to the market efficiently and minimizing losses.
Road conditions	Describes the conditions of the roads used to transport the products.
Infrastructure	Relates to the existence and actual state of the infrastructure needed for processing, to achieve quality standards for commercialization.
Processing level of difficulty	Defines how difficult the processing methods are according to characteristics of the fruits.

4.4. Sampling

The sampling strategy consisted in a first step, to identify the palm fruits to work with, and later in the selection of the interviewees.

4.4.1. Identification the Palm fruits

I reviewed previous studies and documentation to identify the most common palm fruits according to the following general criteria:

- Abundance of the specie: I searched for species mentioned as abundant in the literature and data from forest inventories specifically from the most abundant vegetation units describing *terra firme* forests.
- Use in the Bolivian Amazon: I looked for species that were mentioned as commonly used in Pando and in the MAP region and mentioned as promissory or very important species consumed in the area by Araujo-Murakami et al. (2016) and/or Antezana Guerrero et al. (2001).
- Potential local or international markets: I searched for species that showed evidence of market development.

The species selected were: Asai (*Euterpe precatoria* Mart*),* Majo *(Oenocarpus bataua* Mart*)* also known with its synonym *Jesennia bataua* (Mart.) Burret*,* Motacú *(Attalea phalerata* Mart. ex Spreng*)* and Palma real *(Mauritia flexuosa* L.f*.).*

Asai palms had a high economic importance in the 70's-90's because of its palm heart, nevertheless, the extraction of that product put in risk its sustainability because of the need of cutting the whole palm (Moraes, 2014). Nowadays, Asai´s fruits have open an interesting increasing regional an international market due to its high nutritional qualities and different final uses, being Brazil the main producer and exporter Araujo-Murakami et al. (2016). Majo and Motacú*,* are both used as edible fruits regionally. Their seed´s oil, have potential as edible oil and for cosmetic products (Miller, 2002; Moraes, 2014; Moraes et al., 1996), but an international market for them has not been developed yet. Palma real has several uses registered and a high economic importance in the Amazon region e.g., in Peru and Brazil. It was registered as used in Pando but is still subtilized compared to other neighbor countries, and with limited information available from Bolivia (Herencia, 2013; Moraes, 2014).

Several studies relate to the high nutritional quality of the different subproducts of these palm fruits, highlighting their content of proteins, carbohydrates, and unsaturated fatty acids. For instance, Majo´s drink composition was found to be comparable to breastmilk and considered superior to cow's milk (Collazos, 1988), and Majo´s and Motacu´s oil composition was comparable with olive oil, even with higher amount of some Omegas (Coimbra et al., 2020; Rendón P. et al., 2013). Other nutritional benefits are the potential in preventing vitamin A deficiency of Palma real, which is the richest natural source of beta carotene (Santos, 2005), and the anti-inflammatory effects of Asai and Motacu (Xie et al., 2012; Freitas de Lima et al., 2018)

All species have a high antioxidant activity, the Oxygen radical absorbance capacity (ORAC) values of Asai, Majo and Palma real are much higher than the values of other fruits like blueberries and pomegranates. Antioxidant benefits are specially studied in Asai, but mostly for the variety *E. oleracea* Mart, though, antioxidant characteristics of *E. precatoria* are higher (Table 2).

Table 2: Antioxidant activity of the palm fruits through 2,2-diphenyl-1-picrylhydrazyl (DPPH) and Oxygen radical absorbance capacity (ORAC) methodologies

Metho-dology	**Asai (*E. precatoria*) pulp and skin; pulp** (Sotero et al., 2013; Kang et al., 2012)	**Asai (*E. oleracea*) pulp** (Kang et al., 2012)	**Majo fruit without seed** (Tauchen et al., 2016)	**Motacu oil** (Lizarbe, 2018)	**Palma real epicarp** (Tauchen et al., 2016)	**Blueberries** USDA (2010)	**Pomagranate** USDA (2010)
DPPH	1350 µg/ml		903.8 µg/mg	51,2 µg/mL	1062 µg/mg		
ORAC	1828.4 µmol TE/g DW	1014.0 µmol TE/g DW	1024 µmol TE/g DW	-	645.9 µmol TE/g DW	59.23 µmol TE/g DW	48.48 µmol TE/g DW

Figure 4: Fruits of Asai (*Euterpe precatoria Mart*) (Source: Huamán. Copyright: MBG. Licensed under CC BY-NC-SA 3.0. <http://www.tropicos.org/Image/100766466>)

Figure 5: Fruits of Majo (*Oenocarpus bataua Mart*) (Source: Salomon. Copyright: J. Solomon. Licensed under CC BY-NC-SA 3.0. <http://www.tropicos.org/Image/33529>)

Figure 6: Fruits of Motacú (*Attalea phalerata Mart. ex Spreng*) (Source: Stang. Copyright: MBG. Licensed under CC BY-NC-SA 3.0. <http://www.tropicos.org/Image/100108021>)

Figure 7: Fruits of Palma real (*Mauritia flexuosa L.f.*) (Source: Huamán. Copyright: MBG. Licensed under CC BY-NC-SA 3.0. <http://www.tropicos.org/Image/100448425>)

4.4.2. Interviews

4.4.2.1. Key informant interviews

To identify key informants, I used a nonprobability sampling method, which is recommended when the data collection intends to collect information about attributes rather than estimating parameters (Bernard, 2011). I started selecting PRODIGY partners in the region and doing a web research of institutions and stakeholders related to palm fruits, then I used the snowball method asking the first key informants to recommend other people to whom I could interview, until no new names were mentioned (Bernard, 2011).

From a total number of 23 possible key informants identified, 14 agreed to participate in the interview. They belonged to the following groups of stakeholders:

- Five officers of NGOs related to research, conservation, sustainable development, and rural support.
- Four representatives of governmental institutions, from the ministerial level, departmental level and sanitary service.
- Two retailers of Asai and NTFPs
- One member of the federation of producer's associations
- Two research consultants and former workers of NGOs

Detailed information of the key informants' organizations in Annex 12.1.

4.4.2.2. Interviews in rural communities

For the interviews in rural communities I used the nonprobability convenience sampling method, which is recommended when the only possibility is to interview people who is available and willing to be interviewed (Bernard, 2011). This was the case, because communities´ population in the region is rather low, and because the period when the interviews were made coincided with the period of Brazil nut collection, in which community members go deep into the forest for long periods of time, and therefore it is more difficult to find them.

I chose two communities inside the study area to scout differences between them, community Villa Florida inside the RNVSA Manuripi and community Empresiña outside of it. The selection was made with the help of a field assistant, who had contacts in these communities. The target interviewees were community members with experience harvesting or processing palm fruits for commercialization or self-consumption. The total number of interviews in each community was 20, 10 in each community.

4.5. Data collection

Due to the COVID-19 Pandemic, the methodology of this master thesis had to be continuously adapted. Originally, I planned a field work to the study area to collect first-hand information through different methods, including a forest inventory and an extensive socio-economic household survey planned by the PRODIGY project. Nevertheless, due to travel restrictions and safety measures, the field work was postponed and finally canceled, this led to plan a second scenario to collect data from bibliographic review and through online interviews and via hired local field assistants.

4.5.1. Key informant interviews

Key informants were an important data source, as they can provide information not only about themselves but also about others and about situations in an specific area, which allows to

identify factors and relationships difficult to determine by other methods (Narayanasamy, 2009; Casley & Kumar, 1988). I applied semi-structured interviews considering the ecological, policies and institutional support, and market and value chain criteria defined in the analytical framework (Chapter 4.3). I formulated open-ended questions, to allow key informants to compose their responses (Wildemuth, 2016), I chose this type of questions to avoid to limit the interviewees from mentioning possible important information for the analysis and due to the complexity that posed including four different products in one questionnaire with a high number of multiple choices that could make of an interview confusing and exhausting (Wildemuth, 2016). Before conducting the interviews, I did pre-test interviews with field assistants from the area with experience working with some of the palm fruits, these interviews had the objective to test the comprehensibility, the order and duration of the interview, being also open to suggestions form the participants. I also tested the software functioning to simulate real interview conditions (Bernard, 2011).

I contacted the key informants via e-mail, but most of them via WhatsApp, as it is the main media used in the region, also for work activities. When contacting them, I sent an information sheet with detailed information about the topic of the interview, presentation of the PRODIGY project, description of the objectives and duration. For each interview, I prioritized the group of questions relevant to the background and expertise of the key informant. e.g., in interviews to retailers I started with questions regarding the market and value chain criteria, and if identified also some experience in harvesting I added question regarding the ecological criteria. During the interviews I kept certain flexibility to change the order of the questions during the interview, the wording, or to include new questions if an important aspect not considered before came up (Adams, 2015). I conducted the interviews via online using the platform Zoom (12 interviews), WhatsApp call (1 interview) and one participant filled the questionnaire on a word document. I took notes of the answers and recorded the interviews to have an archive of primary data, always asking for permission to the interviewee beforehand.

4.5.2. Interviews in rural communities

As people from rural communities have limited access to internet, I couldn´t conduct online interviews with them. Therefore, the interviews were done by a field assistant, partner from the PRODIGY project. I formulated structured interviews, in which the interviewer formulated the questions stated in the questionnaire, explained them more in detail if the interviewees didn't understand them completely and probed in case they didn´t answer the questions directly.

The questionnaire included questions from the ecological, socio-economic, and policies and institutional support criteria. For questions regarding the socio-economic aspects, I included closed-ended questions with multiple choices, this was decided after pretesting the interviews done on the field weeks before. To store the information, the assistant took notes in a questionnaire form, and recorded the interviews with a mobile phone, except for two of them in Villa Florida and three in Empresiña, in which participants preferred not to be recorded.

Figure 8: Interviews to community members in Villa Florida (source: Oliva)

Figure 9: Interviews to community members in Empresiña (source: Oliva)

4.5.3. Bibliographic review

Data from bibliographic review was used to assess the indicators: Abundance, Policies and regulations and road conditions in the communities. For the abundance, as data from forest inventories from the specific study area was not available, I used data from forest inventories of Pando, the Bolivian Amazon, and the MAP region as an estimation.

4.6. Data analysis

4.6.1. Key informants and community members' interview

I did the transcription of the interviews using a selective protocol, I selected the parts of the interview that were relevant to answer the research questions, omitting introductory parts and

parts of the answers that were not related to the topic. I transcribed the remaining parts, following a smooth verbatim transcript, I literally transcribed the answers leaving out utterances, aiming to build a coherent text keeping the original wording and grammatical structure (Mayring, 2014). For the analysis, I carried out a qualitative structured content analytical method, described as a deductive category assignment, where the analytical categories were established before the coding according to the defined framework in chapter 4.3 (Mayring, 2014).

I created a codebook according to a hierarchical tree, where codes were grouped in *themes,* which broadly describe what a unit of data is about in a coherent narrative (Saldaña, 2013), these were the four criteria defined i.e., ecological, socio-economic, policies and institutional support, and market and value chains criteria. The *codes* were directly related to the indicators of each criteria; subsequently followed by the first level of *subcodes,* which quoted information related to the *codes* with specific information for each palm fruit.

I did the coding using the software Atlas.ti[1]. After a first round of coding, I updated the codebook, creating a second level of *subcodes* when possible, they were used when the codes needed more extensive categorization for further analysis (Saldaña, 2013), these *subcodes* were created in an ordinal category system, creating a simple scale adapted to the possible answers of each question (e.g. decreasing, stable, increasing) (Mayring, 2014) (Figure 10).

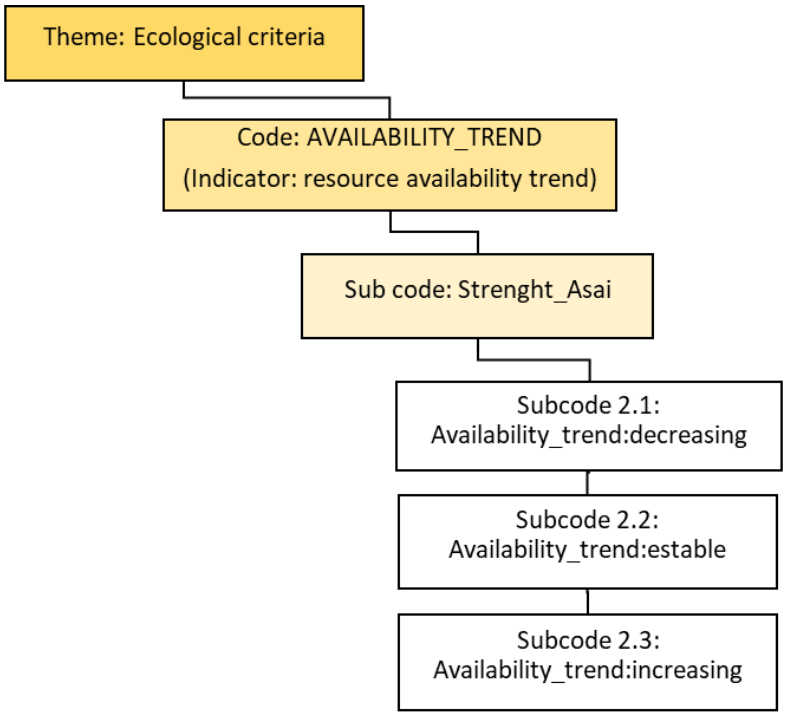

Figure 10: Example of hierarchical coding for the indicator ´resource availability trend´ (source: own elaboration)

Simultaneously, a second group of codes and subcodes was created to be later used in the SWOT analysis, the codes described the aspects of the SWOT analysis (strengths, weaknesses, opportunities, and threats) and the subcodes the palm fruit related (e.g., Strength_asai).

[1] License provided by the Centre of Development Research (ZEF)

4.6.2. Potential of palm fruits analysis

To compare the potentials between palm fruits I used a Multiple Criteria Decision Making (MCDM) analysis, which allows to select the most preferred choice according to different criteria simultaneously (Mendoza & Prabhu, 2000)**.** This analysis is often used in natural resources management, as it facilitates to deal with complex problems**;** it can use mixed sets of data, both, quantitative and qualitative, and when no quantitative data is available, qualitative or semi-quantitative data such as linguistic variables can be used. Hence, it can also be complemented with experts' opinions or knowledge, what is advantageous when information is not fully understood or complete (Mendoza & Martins, 2006 & Niekamp et al., 2015).

The MCDM method I used, was the Simple Multi Attribute Rating Technique (SMART). In this method the different criteria and indicators are valued by their importance in the decision making, which requires to see the objective with an structured hierarchy (Figure 11) (Taylor & Love, 2014; Mendoza & Prabhu, 2000).

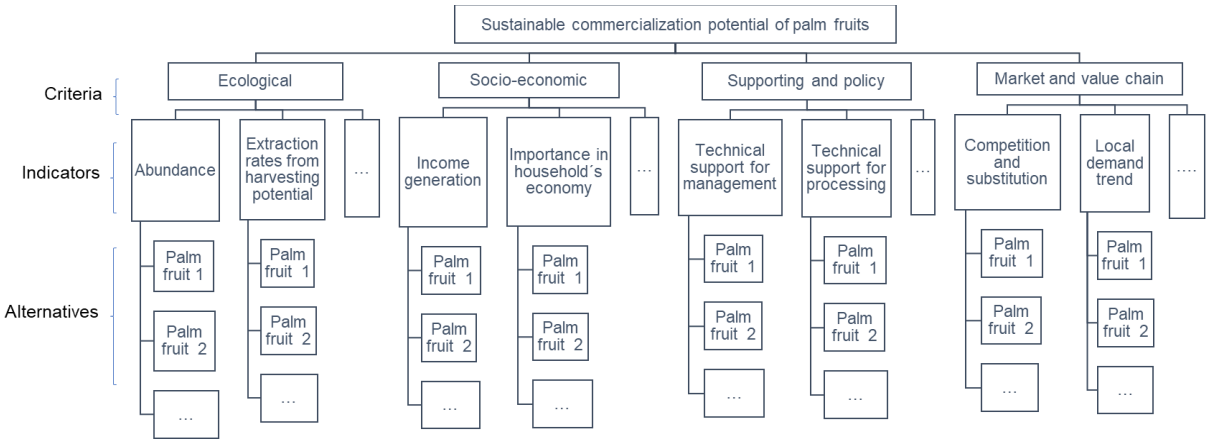

Figure 11: Hierarchical structure of the Decision Making

I did the SMART analysis for each respondent group, one to key informants' and one for each community. The data source used for each analysis was mainly the data gathered from interviews for each group and complemented with literature review. In some cases, data from the different respondent groups complemented to each other e.g., for most market and value chain indicators in the communities, data from key informants was used, as many of them are common for the region and key informants may have more experience and knowledge in that regard.

The calculations were made in a scoring table (Annex 12.5) according to the following steps (modified from Fahlepi (2020) and Taylor & Love (2014)):

a) I determined the number of criteria and indicators corresponding to each respondent group.

b) I weighted each criteria equally, being the sum of them 1, and calculated the weight value for each indicator also equally.

   E.g.:

Number of criteria = 4

Weight for each criteria = $\frac{1}{Number\ of\ criteria} = \frac{1}{4} = 0.25$

Number of indicators of the criteria = 5

Weight for each indicator = $\frac{Weight\ of\ criteria}{Number\ of\ indicators} = \frac{0.25}{5} = 0.05$

c) I created an indicators' scoring table with rating values from 1 to 3 according to the obtained answers and the subcodes defined during the coding process (Annex 12.8 and Annex 12.9). I defined the rating values in an objective way, trying to find differences between scale categories contextually to each indicator.

d) I rated each palm fruit according to the indicators scoring table.

e) I calculated the utility values multiplying the weight of each indicator with the rate value of each palm fruit.

f) I calculated the final rating value of each palm fruit adding up their utility values.

g) I classified the results in potential categories:

Table 3: Categories of assessment results

Value range	Potential Category
1 - 1.66	Low potential
1.67 - 2.32	Medium potential
2.33 - 3	High potential

4.6.3. SWOT analysis

A strengths, weaknesses, opportunities and threats (SWOT) analysis comprises the most important internal and external strategic factors for the future planning process and developing of a strategy (Kajanus et al., 2012). I did a SWOT analysis for the sustainable commercialization of each palm fruit, based on the rating of the indicators in the MCDM analysis and complemented it with the codes and subcodes defined for this purpose.

4.7. Ethical issues

The methodology of this thesis followed the ethical requirements for a qualitative research. Those included: self-determination, I repeatedly emphasized that respondents are free to participate and withdraw at any moment; privacy, I kept the anonymity of the participants, being not possible to link their identities with the data; avoiding harm, I didn't include sensitive questions that could potentially harm interviewees or interviewers; and I asked for an informed consent giving the participants information of the scope of the study, for which purposes the data was going to be used and the type of questions to be asked (Allmark et al., 2009; Byrne, 2001).

5. Results

5.1. Indicator's assessment

5.1.1. Ecological criteria

- **Abundance**

All four species; Asai (*Euterpe precatoria* Mart*),* Majo *(Oenocarpus bataua* Mart*),* Motacú *(Attalea phalerata* Mart. ex Spreng*)* and Palma real *(Mauritia flexuosa* L.f*.)*, are abundant in the RNVSA Manuripi (Herencia, 2003). Antezana et al. (2001) mentioned Asai among the most abundant palm species in Pando; and Rodriguez & Montero (2002) highlighted Asai and Majo by their ecological importance. Forest inventories in the Bolivian Amazon (Araujo-Murakami et al., 2005; Mostacedo et al., 2006) and in the MAP region (Selaya et al., 2017), recall alike species densities for all species. However, the single record of abundance inside the study area correspond to Asai in the community Villa Florida (Table 4). It is important to mention, that these data come from evaluations in *terra firme* forest, which is the most abundant in the study area, and that Palma real is mainly found in specific flooded areas/swamps, normally not considered in forest inventories (Mostacedo et al. 2006). Inventories of Palma real stands in Beni, Bolivia, outputted densities between 55 and 65 palms/ha (Mendieta-Aguilar et al., 2015), and in the Peruvian Amazon between 19 and 138 palms/ha (Kahn 1988), which suggests that although focalized, the species abundance could be significant; what was confirmed in the case of the study site by key informants.

Table 4: Palm species density

Palm fruit	**Scientific name**	**Abundance (palms/ha)**			
		Araujo-Murakami et al. (2005) (Sample size = 35 ha)	**Mostacedo et al. (2006) (Sample size = 16 ha)**	**Selaya et al. (2017) (Sample size = 41 ha)**	**ACEAA (2016) (Sample size= aprox. 11 ha)**
Asai	*Euterpe precatoria*	15.9	28.3	16	66
Majo	*Oenocarpus bataua / Jesennia bataua*	12.7	14.1	4.1	-
Motacú	*Attalea phalerata*	1.6	1.4	1.2	-
Palma real	*Mauritia flexuosa*	-	-	0.1	-

- **Estimated extraction relative to the harvesting potential**

The species with the highest estimated extraction relative to its full harvesting potential was Asai. Key informants estimated that between 1% and 50% of the existing Asai is harvested. For the other species, no estimations were given, aside than saying that the extracted amounts were minimal or that there is not enough information. Exceptionally, two key informants gave similar values for all four species: Asai (30%), Majo (5% and 10%), and Motacu and Palma real (up to 1%). In general, key informants, stated that the actual extraction of all species is quite low compared to their productivity. In communities, Asai and Majo estimated extractions were higher than 50% and higher in Villa Florida than in Empresiña. Different is the case of Motacu and Palma real, for which only few community members gave estimations and with lower percentages (Table 5).

Table 5: Estimated extraction from harvesting potential in communities (Villa Florida (n=10), Empresiña (n=10))

	Asai		Majo		Motacu		Palma real	
Community	**Freq.**	**Average**	**Freq.**	**Average**	**Freq.**	**Average**	**Freq.**	**Average**
Villa Florida	10	61%	10	57%	2	30%	1	1%
Empresiña	10	29%	10	25%	1	20%	1	20%

- **Harvesting methods impact**

In the case of Asai, all interviewees reported climbing the palm to collect the fruits, and only one said that in some cases Brazil nut collectors might cut some palms for self-consumption. However, climbing palms is hard work and only done by trained people, mostly young men. The technique was learned from Brazilians, who had a longer tradition collecting and consuming Asai. It requires of minimum equipment, i.e. a harness made out of ropes, security belts, machete and bags. It was also reported the existence of more sophisticated security equipment like the harnesses designed by the NGO ACEAA, used together with a protocol of good practices.

Although Majo palms are anyhow different from Asai (wider diameters), the harvesting techniques are the same, nevertheless it was reported that cutting down the palm is still sometimes practiced. It was also said that the product is not harvested in commercial quantities as in the case of Asai, and therefore only the minimum equipment is used. In the case of Motacu and Palma real, there were very few answers, but all asserted the use of non-destructive methods (Table 6). For Palma real specifically, the need of training was mentioned by two key informants, and two community members from Villa Florida mentioned not having the knowledge and equipment necessary.

Table 6: Harvesting methods for each palm fruit (Key informants (n=12), Villa Florida (n=10), Empresiña (=10))

Group of respondents	**Harvesting method**	**Frequency of responses**			
		Asai	**Majo**	**Motacu**	**Palma real**
Key informants	Climbing the palm	11	8	1	4
	Sometimes cutting the palm	-	3	-	-
	Using a stick to drop the fruits	-	-	1	1
	Using a ladder to reach the fruits	-	-	2	-
	Not specified	1	1	8	7
Villa Florida	Climbing the palm	10	10	-	-
	Not detailed	-	-	10	10
Empresiña	Climbing the palm	10	10	-	1
	Not detailed	-	-	10	9

For the selection of the palms to harvest, no technical guidelines were reported. Farmers only harvest ripe fruits, recognized by looking at fallen fruits or dropping some using a slingshot. Other harvesting criteria were the strength and straightness of the palm for the safety of climbers, proximity to communities, and the number of fruits per palm. For Asai, one key informant mentioned that in the *Plan de Gestion Integral de Bosque y Tierra* (PGIBT) management guidelines, 20% of the palms are defined as ´seed trees´ and should not be harvested, but that in practice, that rule is ignored.

Regarding the perception of sustainable use, all key informants considered that palm fruits are harvested sustainably, as the harvesting methods are harmless, and the quantities collected are still low.

- **Harvesting level of difficulty**

Regarding the harvesting difficulty, key informants mentioned that Motacu is easier to harvest because of its smaller height. Asai is easier to climb than Majo and with a more homogeneous distribution than the rest of the palms. Palma real is the most difficult to harvest by its height, width and preference for swampy lands.

In Empresiña most of the community members said that there was no difference between Asai and Majo harvesting. While in Villa Florida, the majority mentioned that Asai was easier to harvest, as it is thinner, nevertheless few mentioned that for Asai one needs to climb more palms than for Majo, because of the lower number of fruits per palm.

- **Resource availability trend**

According to key informants' responses, there was no clear trend in the availability of the palm fruits in the last years. For Asai, it was often mentioned how harmful palm heart harvesting was some decades ago, whose consequences are still visible. Others mentioned that Asai population is now constant or even increasing, due to the proper harvesting, its natural regeneration, the promotion for its cultivation, and the controlling normative in the RNVSA Manuripi. For the other species, reasons for a decrease were inadequate harvesting techniques or deforestation, and reasons for an increase were the low harvesting quantities and a higher consciousness regarding their conservation. There were also some key informants mentioning that there is not available data about these trends (Figure 12).

On the other hand, communities showed more clear but also contradictory trends. In Villa Florida, it is mostly believed that the Asai and Majo availability tend to increase by their proper management and harvesting methods regulated by the RNVSA Manuripi. While in Empresiña, there is a general belief that Majo populations remain constant but Asai is decreasing, because of climatic fluctuations, imbalances in the forest, consequences of palm heart extraction or others (Figure 13).

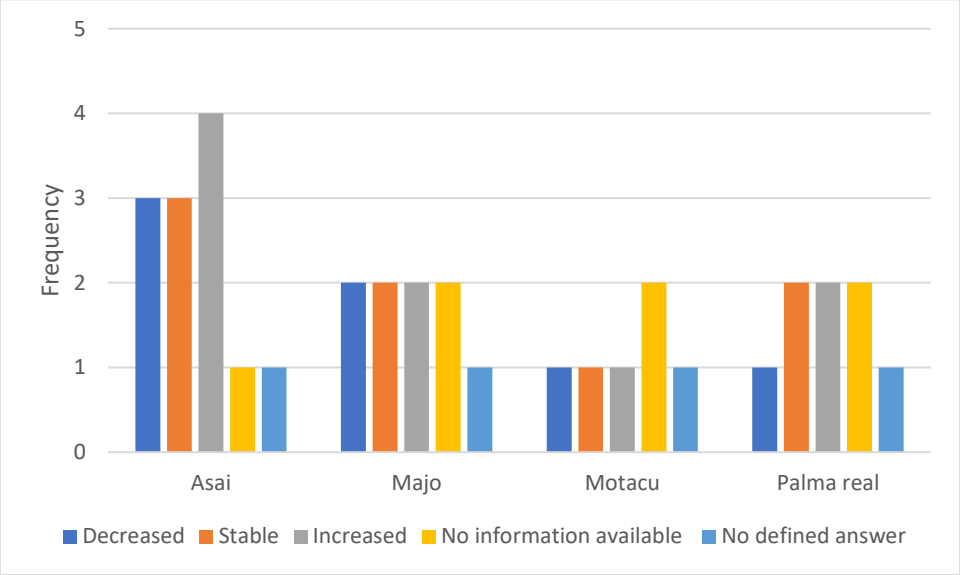

Figure 12: Key informants' responses regarding palm fruits availability trend (n=11)

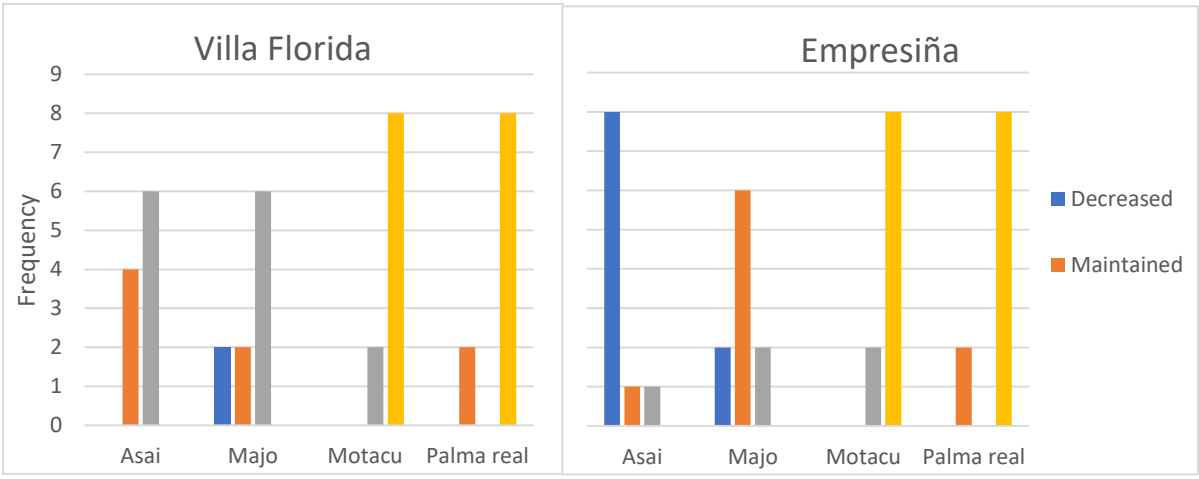

Figure 13: Community members´ responses regarding palm fruits availability trend (Villa Florida (n=10), Empresiña (n=10))

- **Competitive use**

All key informants mentioned that there are no other competitive uses for any of the palm fruits; and that the extraction of palm heart, which implied cutting down the palm is not practiced anymore. Nevertheless, in Empresiña, more than half of the community members reported other uses for Asai, as the extraction of palm heart and wood; for Majo, some mentioned the extraction of *suri* (edible larva), wood and leaves for roofing, and in Villa Florida, one community member mentioned the use of palm heart from Asai.

5.1.2. Socio-economic criteria

- **Income generation**

All interviewed community members from Villa Florida mentioned to earn an average of 137.5Bs (19.9$/16.5€) and 120.5Bs (17.4$/14.4€) from the harvesting of Asai and Majo per day respectively. Fruits' harvesting is seasonal, about 3 to 7 months between March and September for Asai, and 3 to 6 months between September to March for Majo. During those

times, community members work about 2 – 3 days in a week, depending on the capacity of processing plants and the demand.

In Empresiña, community members mentioned that in general, palm fruits are self-consumed and not commercialized, only one community member mentioned earning 100Bs (14.6$/12.1€) harvesting Asai.

- **Importance for households´ economy**

The economic importance of Asai and Majo for households differed between communities. Asai was important or very important for most of community members in Villa Florida, and only important for around a third of the community members in Empresiña. Motacu and Palma real were not economically important for any community (Figure 14).

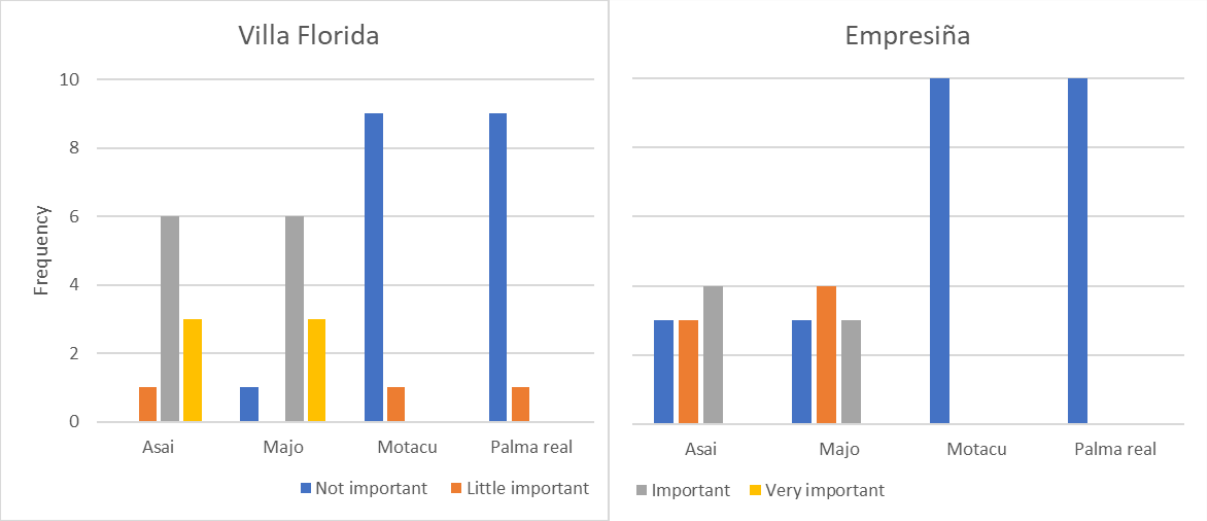

Figure 14: Importance of palm fruits in household economy in communities (Villa Florida (n=10), Empresiña (n=10))

- **Consumption in households**

Consumption of all palm fruits was higher in Villa Florida than in Empresiña. Asai and Majo were the fruits more consumed in both communities, in Villa Florida, most of community members consumed them constantly. Motacu and Palma real were in most of the cases not consumed or very little consumed in both communities (Figure 15).

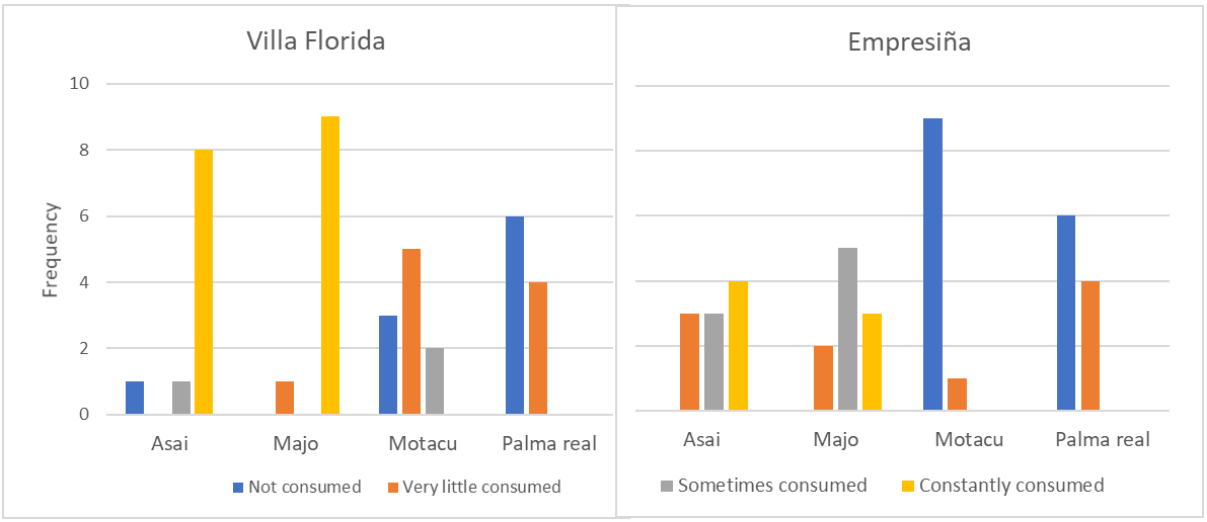

Figure 15: Consumption of palm fruits in communities (Villa Florida (n=10), Empresiña (n=10))

5.1.3. Policies and institutional support criteria

- **Policies and regulation**

In 2008, a land redistribution process took place in Pando, as part of an agrarian reform, in which a large part of land, passed from private ownership (e.g., *barracas)* to peasant and indigenous communities. Communities received a *título ejecutorial* issued by the *Instituto Nacional de Reforma Agraria* (INRA), that granted legal security to the owners (INRA, 2008). In the RNVSA Manuripi, land was divided in plots of 500ha that were distributed to families (Coronel & Solorzano, 2017). Currently, 23 % of the RNVSA Manuripi area is allocated in favor of 10 communities and 2% to 37 *barracas* (Ministerio de Medio Ambiente y Agua et al., 2013). This communal property of land, was considered an opportunity to strengthen a development model based on the community forest management (Murakami et al., 2016). Nevertheless there are still land ownership conflicts between and within communities and *barracas*, with reference to boundary delimitations, land ownership, and the increasing population (Coronel & Solorzano, 2017; Pacheco, 2009).

The RNVSA Manuripi, has a shared governance scheme, involving the state and the communities, which is coordinated by the *Servicio Nacional de Áreas Protegidas* (SERNAP), a local representation of the Ministry of Sustainable Development and Planification (Coronel & Solorzano, 2017).

To have access to the resources, each community must elaborate a management plan (*Plan de Gestión Integral de Bosques y Tierra* (PGIBT)), based on the normative and land use restrictions in the community. PGIBTs are done participatorily to identify potential productivity, productive systems and internal normative for the sustainable use of natural resources and land. Later, an Operative management plan (*Plan Operativo de Gestión Integral* (POGI)), details more specific management activities. These two documents have to be approved by the *Autoridad de Fiscalización y Control Social de Bosques y Tierra* (ABT) to exploit the resources legally (FAO, 2017).

For the commercialization of NTFPs, enterprises need a registration by the ABT, the municipality and the *Servicio Nacional de Sanidad Agrícola y Agropecuaria* (SENASAG) regarding the safety for processing and commercialization of food products (de la Torre et al., 2011). These requirements are often an obstacle for producers organizations, as the conditions in rural areas like electricity and drinking water are often poor (Tonore et al., 2019).

- **Technical support for harvesting**

Technical support related to harvesting, was provided by different organizations (Table 7). According to key informants, most of the support targeted Asai. The NGOs support consisted mostly of trainings on harvesting techniques and palms management (also useful for Majo), evaluations of the productive potential, and provision of equipment for climbing to ensure harvesters safety. It was also mentioned that the NGOs ACEAA and CIPCA, are currently assessing the abundance and productive potential of Palma real in the region, as theirs and producer associations´ interest on this fruit is increasing.

Support from the government was related to normative, national programs creation, training, and technical assistance. Key informants also mentioned that a Protocol of good harvesting practices, was elaborated within the *Plataforma Interinstitucional de Articulación de Complejos Productivos de Frutos Amazónicos* (PICFA).

In Villa Florida, most community members received some equipment and training on Asai and Majo harvesting from different institutions (Table 7). A couple of community members mentioned a recent similar initiative for Palma real. In Empresiña, no community member mentioned having received technical support for any palm tree, only one mentioned the intervention of local authorities in the installation of Asai plantations but without success. No support was reported for Motacu.

Table 7: Institutions and programs providing management technical support

Group of respondents	**Institution/program mentioned**	
	Asai and Majo	**Palma real**
Key informants (n=8)	**- NGOs:** CIPCA, WWF, ACEAA, IPHAE and Herencia. **- Governmental institutions or programs**: departmental, local, and municipal government, Ministry of Productive Development, Ministry of Rural and Land Development, national programs *Programa de inclusión Económica para Familias y Comunidades Rural* (ACCESO), Empoderar, and the Platform PICFA.	**NGOs:** CIPCA, ACEAA
Community Villa Florida (n=10)	**- NGOs**: WWF, ACEAA, FAUTAPO, **- Governmental institutions or programs:** ACCESO and Empoderar **- Private enterprise**: Acailandia	**NGO:** ACEAA

- **Technical support for fruit processing**

Support for processing also mainly targeted Asai and was provided through different institutions (Table 8); still, a couple of interviewees mentioned that the support is limited. The government mainly provided processing plants with pulping machinery and supplies, also useful to process Majo, but that at the moment not all of them are working due to certain limitations. It was also mentioned that recently, the *Instituto Boliviano de Normalización y Calidad* (IBNORCA) through the platform PICFA, elaborated a new ´Bolivian norm for Asai pulp´ to contribute to strengthen Asai pulp production, standardizing the product quality and innocuity at a national level. NGOs intervened with trainings on processing techniques, sanitary conditions, infrastructure, and technology. Key informants underlined that the collaboration between governmental institutions and NGOs is important for the success of processing initiatives.

Regarding other palms, it was mentioned that WWF plans to set a pilot processing plant to produce Palma real pulp, to verify if the available infrastructure for Asai could be also used to this fruit. No specific initiatives were mentioned for Motacu.

Table 8: Institutions and programs providing processing technical support

	Institution/program mentioned	
Group of respondents	**Asai and Majo**	**Palma real**
Key informants (n=9)	**NGOs:** CIPCA, WWF, FAO, ACEAA. **Governmental institutions or programs**: PICFA, IBNORCA.	**NGO:** WWF
Community Villa Florida (n=10)	**NGOs**: WWF, ACEAA, FAUTAPO, INIAF **Governmental institutions or programs:** SENASAG, ACCESO and Empoderar **Private enterprise**: Acailandia, Ventana amazónica	**NGO:** ACEAA

- **Financial support instruments**

Most key informants mentioned a deficient financial support with no specific instruments or mechanisms to promote financial independence of producer associations. The existing support comes instead, mostly from NGOs and international cooperation with direct founding. The government support restricted to equipment and infrastructure mainly for the processing of Asai and Majo. Nevertheless, this seems to be changing with the increasing interest from the government to promote palm fruits, specially Asai, with the new related national programs emerging.

It was also mentioned that rural producers often have difficulties to deal with the tax system, as it is not designed to support rural production. To sell the products legally, rural organizations must fulfill formalities required for taxation, which requires of financial knowledge that very often they lack. Thereby, the government has reduced or eliminated the sales taxes for rural organizations, which is not possible to enforce when big amounts are sold to enterprises.

Key informants also recalled the limitations and difficulties to access bank credits, due mainly to the guaranties requested by banks. Rural organizations usually do not have enough economic assets that may serve as guaranties, and future income from NTFPs is not accepted as one. Moreover, previous failures in paying by the associations, created skepticism in both sides.

Some government initiatives to promote financial support existed, but their success was rather limited. Among them, the creation of a fund that is transferrable to banks to finance credits for NTFPs businesses, the possibility to consider NTFPs trade contracts as a guarantee for credits, and the creation of organizations that could have the possibility to sell the products directly to the government. Recently the platform PICFA, has considered a new financial support mechanisms with non-repayable financing.

- **Organizational support**

Most key informants mentioned that there is support for the organization of rural associations, by NGOs, governmental institutions, or a coordination from both. The support is on the conformation, strengthening and administration of the organizations, and commercialization strategies. They also mentioned that rural organizations decide which NTFP they want to work

with, according to their potential. On the other hand, all community members from both communities mentioned that they did not receive any support for the formation of producer associations.

5.1.4. Market and value chain criteria

- **Competition and substitution**

Most key informants stand that there are other products that can compete or substitute the palm fruits in general, most of them were other NTFPs with a popular consumption. Among them were mentioned: Brazil nut (*Bertholletia excelsa*), Copoasú (*Theobroma grandiflorum (Willd. ex Spreng*.), Achachairú (*Garcinia brasiliensis Mart*.), Cedrillo (*Spondias mombin L*.), Sinini (*Annona muricata L*.), Camu Camu (*Myrciaria dubia (Kunth) McVaugh*), Pitahaya (*Stenocereus thurberi*), coffee (*Coffea arabica*), medicinal plants, blueberries and Totaí (*Acrocomia aculeata (Jacq.) Lodd*), as the only palm fruit mentioned.

- **Local demand**

Key informants agreed that the local demand for Asai has increased in the last years, as people are more informed of its high nutritional quality. They also mentioned an increase in businesses selling Asai in Cobija, the closest city to the study area, as well as an increase in the variety of sold by-products. Besides the local demand, they mentioned that the national demand also increased significantly in cities like Cochabamba, La Paz and Santa Cruz. Anecdotally, it is thought that the COVID-19 pandemic has helped to its positioning in the market, as some perceive it as a healthy product that helps to prevent and overcome an infection.

For the rest of the palm fruits, a few informants mentioned that there is no information available about their demand trends, but that they have probably been stable. Majo, is self-consumed or consumed locally; it is harvested in small quantities and therefore harder to find in local markets. However, some key informants said that its demand also increased as happened to Asai. In the case of Motacu and Palma real, the demands are inexistent, as they are only self-consumed locally and not in larger markets.

- **International market**

The only palm product exported from Bolivia is Asai. There is only one company, in Santa Cruz, exporting small quantities of freeze-dried Asai (Asai pulp converted into powder) and with an unsatisfied demand of pulp. No direct exports were reported from the study area, but small quantities of pulp are sent to Santa Cruz to be later exported. Still, it is known that an increasing international demand for Asai exists, which is so far covered by Brazil. Exports from Pando are still not possible by the lack of a freeze-drying equipment and low quantities harvested. Anecdotally, key informants mentioned that fruit production from the province Abuna in Pando is transported to Brazil to be processed but without the legal requirements.

It was also said that the other palms could be potentially exported in the future. Although this is disputed, since Majo and Motacu are harvested in low amounts and still don´t have an international market. For Palma real, it was acknowledged a higher potential for exports as it is already known internationally, being Peru, where it is significantly consumed, a potential buyer.

- **Producer's associations**

Currently there are six associations of Asai producers in Pando, some of which work also with Majo in a small scale, and none dealing with Palma real and Motacu. Still, some associations label themselves as producers of Amazonian fruits in general, opening the possibility to include other palm fruits in the future. These associations are part of the Federation of Asai and

Amazonian fruits of Pando (FEDAFAP), which objective is to facilitate a joint work between associations and be better represented in the sector.

- **Value chain connection**

Asai was the only product with an identified value chain, but that could also be used for Majo when commercialized. The main value chain links identified were the harvesters, processors, and traders. A few key informants mentioned a good connection between them, while most of them mentioned that it has deficiencies. They mentioned a good relation between harvesters and processors as they are normally of the same association or closely related, therefore, considered sometimes as part of the same link. On the other hand, they mentioned that there was no clear connection between processors and traders, this mainly because commercialization has an unstable dynamic without formal contracts and with occasional sales dependent on the current demand. Only in some cases, private traders in Cobija have a close relation with some communities.

- **Infrastructure**

The infrastructure for processing, transport and storage was built for Asai but is also used for Majo when needed. There is no infrastructure for Motacú and Palma real, as they are not processed or traded.

All and all, infrastructural conditions vary among organizations. There are few existing plants in rural communities, that set with the support from NGOs and the government could reach good infrastructure conditions with the sanitary and structural requirements from the sanitary service. On the other hand, other plants lack of the adequate technology and conditions. A major problem mentioned was the lack of a cold chain, necessary to conserve the pulp until the selling points. Currently, the transportation of pulp is made using Styrofoam boxes, and only one organization counts with a cold chamber truck. It was also mentioned the need of a freeze drier machine, which could ease the trade regional and internationally.

- **Road conditions**

There is a consensus on the poor conditions of roads, highlighting that most of them are not paved, which makes transportation difficult especially in the rainy season. This hinders transportation logistics, as the quality of the products is affected by long transportations and as producers often have difficulties to reach the main road that connects to Cobija to commercialize their products.

- **Processing level of difficulty**

The main steps for processing Asai pulp are: the classification and sifting of the fruits; the *sancochado,* which is a disinfection at high temperatures; and the crushing of the fruits. Key informants mentioned that for Majo's pulp, the process and machinery are the same as for Asai. Nevertheless, few differences were pointed out. Majo's fruits need more time of *sancochado* controlling the temperature more precisely; by its higher content of oils, Majo poses more difficulties in cleaning the used machinery; and, the fruits are also more perishable, after harvested, they need to be processed in the next 20 hours before getting rotten (compared to the 48 hours for Asai). Once processed, they do not last for long, and when defrosted, the pulp goes bad easily. Due to these complications, in some communities Majo´s beverage or *leche* is preferred over the pulp, as the method to obtain it is simpler.

In the case of Motacu and Palma real, they are only processed using traditional methods and in small scale. Motacu's pulp is difficult to extract by the characteristics of the fruits, which are bigger than Asai and Majo but with less flesh. Also, Motacu oil was mentioned as a promising subproduct, but the processing methods are unknown. For Palma real, it was mentioned that

there is not yet the knowledge to produce pulp, but maybe the Asai infrastructure could be adapted to produce it.

In Empresiña, the obtained products from Asai and Majo were beverages, and most community members mentioned that there was no difference between their processing. While in Villa Florida, Asai's main product was the pulp and Majo´s, the beverage.

5.2. MCDM analysis

The SMART analysis results show the total potential for each palm fruit detailing the shares of each criteria per respondent group (Figure 16). Socio-economic criteria were only included for the analysis made in communities, as it deals with the importance of palm fruits at a household level. The analysis on key informants', gives us scouts on the potential of the palm fruits according to experts' knowledge on the study area in general, while the other two, on the specific communities. According to the key informants' analysis, Asai was the only fruit with a high potential for sustainable commercialization, with similar high rating values for all criteria. Follows Majo with a medium potential, and Motacu and Palma real with similar low potentials. In Villa Florida, high potentials were reported for Asai and Majo, which were influenced by their high values in all criteria. Palma real got a medium potential surpassing Motacu´s due to its higher rating values in the policies and institutional support, and market and value chain criteria. On the other hand, results from Empresiña were less promising, being Asai the only species with a medium potential. (Figure 16 and Table 9).

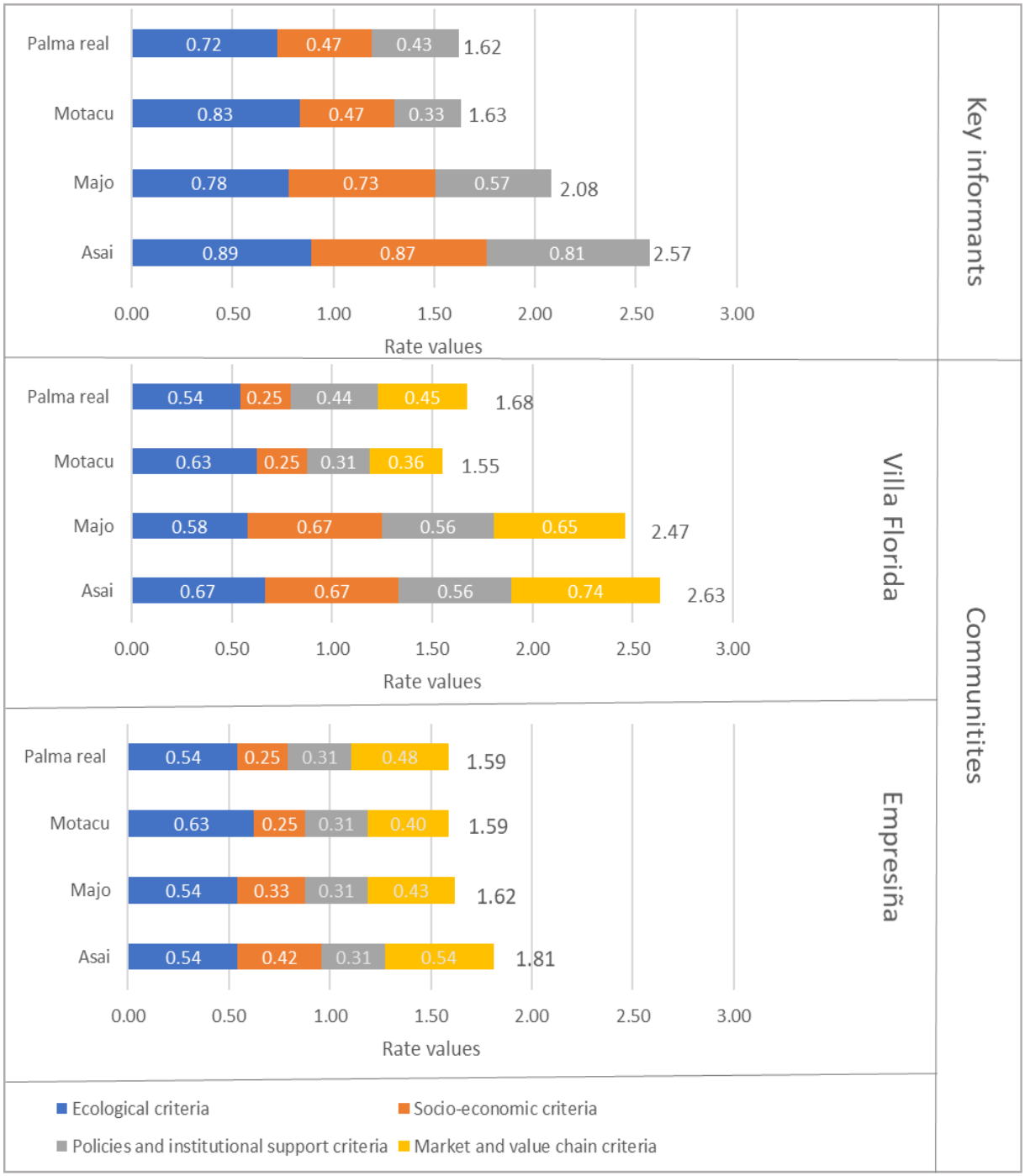

Figure 16: SMART results for each respondent group (maximum total rate value = 3.0, maximum rate value for each criteria for key informants = 1, for communities = 0.75)

Table 9: Palm fruits assessment results

Respondents group	Asai	Majo	Motacu	Palma real
Key informants	High potential	Medium potential	Low potential	Low potential
Community members in Villa Florida	High potential	High potential	Low potential	Medium potential
Community members in Empresiña	Medium potential	Low potential	Low potential	Low potential

5.3. SWOT analysis

Some extra strengths mentioned by key informants, besides the ones directly related to indicators were: the appreciated taste of Majo, several key informants said the Majo taste is even better than that of Asai; the link between Palma real and water resources, as it grows in swamps, which are important on the water cycle in Amazonian forests; a higher antioxidant capacity than Brazilian Asai, could be an asset to enter in the international market, as current international is covered mainly by Brazil.

Among weaknesses, specific infrastructural need to deal with perishability and a lack of standardization between communities' production, were identified for Asai and Majo as they are the only fruits processed, while for Motacu and Palma real weaknesses are still related to the lack of knowledge.

More opportunities were identified for Asai, highlighting among them technical support, existing normative, and more developed markets, mostly lacking for the rest of palm fruits. Nevertheless, an opportunity for others palm fruits is the use of experiences of Asai as a spearhead. Asai shares with Palma real the advantage of the existence of technologies developed by other countries, from which Asai was already benefited. Asai and Majo shared socio-economic opportunities related to the income and seasonal complementarity.

Threats common for Asai and Majo, were related to the deficiencies of the markets and value chain, while for Motacu and Palma real, they were related to the lack of them.

Table 10: Strengths and weaknesses for a sustainable commercialization of the palm fruits (in bold are the factors only found in that palm fruit, and in parenthesis the criteria they belong to when they are related to an indicator from analytical framework i.e. EC= Ecological, SE= socio-economic, PI= Political and institutional, MV= Market and value chain, O= others)

	Asai	Majo	Motacu	Palma real
Strengths	- High abundance and **homogeneous distribution (EC)** **- Highly consumed in urban and rural areas (SE)** **- Existence of producers' associations / federation (MV)** - High nutritional quality (O) **- Higher antioxidant capacity than Brazilian Asai (*Euterpe oleracea*) (O)**	- High abundance (EC) **- Consumed in rural areas (SE)** - High nutritional quality (O) **- Appreciated taste (O)**	**- Easy to harvest (low height) (EC)** - Low consumption (SE) **- Known for its good oil quality (O)** - High nutritional quality (O)	- Low consumption (SE) - **Linked to water resources (O)** - High nutritional quality and **Vitamin A content (O)**
Weaknesses	- Work intensive harvesting (EC) - Requirement of cold chain (MV) - Lack of financial capacity (PI) **- Lack of standardization of the product quality (O)** - Perishable fruits (need to be processed within 48 hours) (O)	- Work intensive harvesting (EC) **- Lack of knowledge about defrosting techniques to preserve the pulp quality (MV)** - Requirement of cold chain (MV) - Lack of financial capacity (PI) - Perishable fruits (needs to be processed within 20 hours) (O)	- Lack of knowledge about harvesting and processing (EC, MV) - Low consumption (SE) - Lack of financial capacity (PI) **- Fruits with little flesh** (O)	- Work intensive harvesting **(very tall and wide palms) (EC)** **- Difficult harvesting conditions (swamps) (EC)** - Lack of knowledge about harvesting and processing (EC, MV) - Lack of consumption habit (SE) - Lack of financial capacity (PI) **- Lack of information about its abundance (O)**

Table 11: Opportunities for a sustainable commercialization of the palm fruits (in bold are the factors only found in that palm fruit, and in parenthesis the criteria they belong to when they are related to an indicator from analytical framework i.e. EC= Ecological, SE= socio-economic, PI= Political and institutional, MV= Market and value chain, O= others)

	Asai	**Majo**	**Motacu**	**Palma real**
Opportunities	- Complements the agricultural calendar (harvesting after Brazil nuts season) (EC, SE) - Generates income in communities with processing infrastructure (SE) - Increasing demand and interest for natural nutritious products (MV) - Harvesting and processing knowledge already developed in Brazil (EC, MV) **- International market (MV)** **- Increasing local, national, and international market (MV)** - Technical support from institutions (PI) **- Included in national programs and platforms (PI)** **- Existence of a protocol of good harvesting practices and a Bolivian norm for Asai pulp (PI)** - Increasing interest from producers and institutions (O) **- Promoted as beneficial against Covid-19 (O)**	- Complements the agricultural calendar (harvesting after Asai season) (EC, SE) - Generate income in communities with processing infrastructure (SE) - Increasing demand for natural nutritious products (MV) **- Harvesting and processing methods similar to Asai (EC, MV)** - Could be nested in Asai producers' associations and value chain (MV) - Technical support from institutions (PI)	- Increasing demand for natural nutritious products (MV) - Could be nested in Asai producers' associations and value chain (MV)	- Increasing demand for natural nutritious products (MV) **- Processing could possibly be adaptable to Asai and Majo's infrastructure (MV)** - Harvesting and processing knowledge already developed in Peru (EC, MV) - Potential international market (MV) - Could be nested in Asai producers' associations and value chain (MV) - Increasing interest from producers and institutions (PI)

Table 12: Threats for a sustainable commercialization of the palm fruits (in bold are the factors only found in that palm fruit, and in parenthesis the criteria they belong to when they are related to an indicator from analytical framework i.e. EC= Ecological, SE= socio-economic, PI= Political and institutional, MV= Market and value chain, O= others)

	Asai	**Majo**	**Motacu**	**Palma real**
Threats	- Possible competitive uses outside protected areas (EC) - Deficient condition of roads (MV) - Lack of financial mechanisms to promote rural entrepreneurships (PI) - Deficient connection between processors and traders (MV) - Lack of well stablished sales contracts (MV) - Lack of freezing technologies and cold chain (MV) - Bureaucratic barriers for formalization (PI)	- Possible competitive uses outside protected areas (EC) - Deficient condition of roads (MV) - Lack of financial mechanisms to promote rural entrepreneurships (PI) - Deficient connection between processors and traders (MV) - Lack of well stablished sales contracts (MV) - Lack of freezing technologies and cold chain (MV) - Bureaucratic barriers for formalization (PI)	- Deficient condition of roads (MV) - Lack of financial mechanisms to promote rural entrepreneurships (PI) **- No local nor international market established (MV)** - No value chain stablished (MV) - Bureaucratic barriers for formalization (PI)	- Deficient condition of roads (MV) - Lack of financial mechanisms to promote rural entrepreneurships (PI) **- No local market established (MV)** **- Rumor of the link between its consumption and homosexuality (O)** - No value chain stablished (MV) - Bureaucratic barriers for formalization (PI)

6. Discussion

6.1. Conditions that promote or hinder sustainable commercialization of palm fruits (RQ1)

6.1.1. Ecological conditions

The high abundance of Asai and Majo, are an asset for developing an economic activity based on their products, as it ensures the availability of the basic resource without extra efforts for cultivation. However, abundance only, is a static factor, which needs to be evaluated over time and assessed together with the harvesting quantities (Hall & Bawa, 1993; Chamberlain et al., 2019; Stanley et al., 2012). In this regard, the only palm fruit that was included in inventories and with a track of the harvesting quantities was Asai in Villa Florida, with an estimated potential production between 5.3 and 10.9 thousand tons (ACEAA, 2016), and a reported extracted amount of 88 ton (Gabarini, 2020). Therefore, the calculated extraction percentage was around barely 1%, much lower than most of the estimated extraction percentages by respondents. As it remains hard to estimate the total full harvesting potential of the forest, responses may have referred mostly to current harvested areas, which are the more accessible and closer to communities. Therefore, it is probable that extraction rates are higher in more accessible forests, but still far from overexploitation, as community members also mentioned that the quantity of fruits in the last years increased.

Accordingly, the harvesting amounts in Villa Florida are sustainable, and they are very probable to be similar or inferior in other communities, as Villa Florida is among the few communities commercializing Asai. For the other palm fruits, which are less commercialized, and at times self-consumed only, their current extraction percentages are likely to be sustainable too, as confirmed by key informants, and by Vos et al. (2016) for Majo.

An ecological factor that favors sustainability, is the fact that the part of the plant extracted are the fruits, which compared to others, facilitate a harmless and sustainable harvesting (Moraes, 2014; Sunderland & Ndoye, 2004). The reported harvesting methods for all palm fruits in both communities, are aligned with the recommendations for a sustainable harvesting for Asai and Majo by Rocha & Viana (2004) and Peralta (2007), who suggest to climb the palms. Nevertheless, there is lack of information about effects of higher harvesting rates, and future risks of overexploitation. Studies on regeneration rates and recommended harvesting quantities are based on harmful harvesting techniques like palm heart or fruit extraction cutting down the palm, but not on others (Peña-Claros & Zuidema, 2000; Avalos et al., 2013; Rocha & Viana, 2004).

6.1.2. Socio-economic conditions

The high income per day of harvesting Asai and Majo in Villa Florida, give them a big potential for contributing to household's economy. They reported incomes that surpassed by far the poverty lines (1.8$ and 1.9$, rural Bolivian and international extreme daily poverty lines respectively (INE, 2020; The World Bank, 2011)), which means that they are enough for meeting basic food needs. However, the main limitation to meet sustained socio-economic benefits, is its discontinuity. Respondents mentioned that they only work a few days a week during fructification times, confirmed by Lorini (2017), this was because of the insecure contracts with buyers, low capacities of the processing plants and difficulties to deal with the perishability. What is different, for example, in the case of Brazil nut, where gatherers can store the nuts for long time, having an economic buffer for non-harvesting periods. Therefore, the potential of these two fruits relays on their complementarity to other activities generating supplementary income, common characteristic of many NTFPs (Ruiz-Pérez et al., 2004;

Schreckenberg et al., 2006; Belcher & Schreckenberg, 2007). After the Brazil nuts season, the Asai fructification period starts, later followed by Majo's, complementing the agricultural calendar. Key informants mentioned this as an advantage for harvesters, who collect all the fruits in the same forest area, allowing them to base their economic income on NTFPs during the whole year.

A different situation can be seen in Empresiña, outside the RNVSA Manuripi, where any palm fruit generated an economic income. Nevertheless, Asai and Majo reported in some cases some importance in household´s economy (Figure 14), probably because of the indirect economic benefit at a household level, like being part of their diet and reducing the necessity to purchase other products.

The high nutritional quality of all palm fruits, give them the potential to contribute to consumer´s well-being and rural population´s food security, an important role of NTFPs (Pandey et al. 2016). Nevertheless, this was not exploited yet for Motacú and Palma real, as people in this region don't consume it regularly, which is also a constrain to develop local markets.

6.1.3. Policies and institutional support conditions

Political decisions, like the land reform in Bolivia to provide rural communities access to land, is considered a step ahead to favor rural communities with a fair access to resources. However, as argued by Mallik (2000), resource access alone doesn't secure a sustainable use, but an enabling political framework that give rural population the conditions to develop fair economic activities.

Key informants, confirmed by Tonore et al. (2019), stated that palm fruits commercialization is a relatively new economic activity, but with a recent increasing interest from the government and non-governmental institutions, suffering a slowly transition to a more favorable legal framework, especially for Asai. This can be confirmed looking at the normative related to it. Cronkleton & Pacheco (2010) and Schreckenberg et al. (2006) mentioned that in the Bolivian Amazon context, forestry regulations have been historically directed to timber production and biodiversity conservation, but generally not including NTFPs. Only in 2006, the Technical Standard for Sustainable Commercial Use of NTFPs was published, aiming at regulating and setting the normative for NTFPs harvesting. There, palm fruits production was only mentioned generally, and Asai, Majo and Motacu were suggested as palm heart producers. Different situation now, that there are new normative, protocols and programs released by the government related to harvesting, production and commercialization of Asai (PICFA, 2020).

A constrain for NTFPs commercialization often mentioned by key informants, which still confirms the situation described by Shackleton et al. (2007), Schreckenberg et al. (2006) and Belcher & Schreckenberg (2007) more than a decade ago, was the tedious bureaucracy. For commercializing at big scales, formality is required, and as Belcher & Schreckenberg (2007) mention, the transition towards it is critical due to the hard to understand legal issues that it entails, specially constraining for rural entrepreneurs. For that reason, some sellers often prefer to remain informal and even diverge into illegality, like in the case of the transportation of Asai from Pando to Brazil. In addition to this, are the difficulties to obtain a sanitary permit, also argued by Bojanic (2002) and Tonore et al. (2019), being some of the major causes for that the lack of infrastructure and basic conditions like the access to drinking water.

The numerous institutions providing support for Asai and Majo, are essential for the development of the local economies related to their production (Pandey et al., 2016; Alexiades and Shanley, 2004). NGOs were constantly mentioned by key informants as important actors promoting their use; confirmed by community members in Villa Florida. This is in line with Schreckenberg et al. (2006) and Jong (2004), asserting that NGOs are often the most effective institutions supporting communities. Another important factor mentioned was the interaction of

NGOs in Bolivia with others abroad, like the WWF also present in several Amazonian neighbor countries, and ACEAA that holds a bond with ACCA in Peru. These connections could facilitate the transfer and sharing of information and technologies between countries, as happened in the case of Asai and experiences from Brazil and could also happen with Palma real and Peru.

Besides the regulatory functions, the government support was mentioned as important by key informants, but still leaving space for improvements. For instance, governmental institutions implemented some Asai processing plants in Pando, being some of them not active at the moment, what demonstrates the need of a better planning and strengthening of communities' technical and management capabilities, generally lacking in Bolivian communities (Schreckenberg et al., 2006).

The private sector´s intervention, was less often mentioned, which agrees with the situation described by Ruiz-Pérez et al. (2004) in the Latin-American context, where the economic capacities are in general low to promote it. One of the private enterprises mentioned was Ventana Amazónica in Villa Florida, dedicated to process and commercialize Asai pulp among other NTFPs. This enterprise connects producer associations from Pando with high demand markets in La Paz (Lorini, 2017). This intermediary function of enterprises was argued as important in rural value chains by Schreckenberg et al. (2006) and would be advantageous to be reinforced in the study area.

These variety of institutions identified, can also pose some challenges regarding coordination and administrative boundaries (Schreckenberg et al., 2006). However, the recent creation of the platform PICFA, opens an important opportunity for the integration and joint work among institutional actors, making easier the identification of duties and a clearer transference of information. Among the outcomes already generated are the strengthening of the producers federation, trainings according to technical standards, a protocol of good harvesting practices and the norm for Asai production (PICFA, 2020).

A very important obstacle to develop palm fruits production, is the lack of financial capabilities of small producers, identified by key informants and confirmed by (Tonore et al., 2019). As the actual financial system doesn't offer clear incentives or mechanisms to promote entrepreneurships related to NTFPs, e.g., access to credits; rural producers might be developing an economic dependency on direct financial support e.g., with the provision of materials and infrastructure. Therefore, the initiatives to develop small producers' financial and managerial capacities should be specially reinforced.

6.1.4. Market and value chain conditions

A high demand is essential for promoting commercialization, this was only clearly reported for Asai, and confirmed by ACEAA (2016) and Lorini (2016), who mentioned an expanding market to neighboring municipalities and Cobija capital city of the department, and as potential long-term markets Cochabamba, La Paz and Santa Cruz. An international market was also identified but mentioned as still hard to reach, which lines up with Peralta (2009) arguments, relating that for Bolivian communities, local markets are priority and of special importance, due to the less legal requirements, easy accessibility, and more information compared to national and international markets. To help rural organizations to reach stable local markets, the stimulation of the demand through governmental decisions is suggested (Schreckenberg et al., 2006). Key informants mentioned some of these possible strategies, such as the inclusion of palm fruits as part of the subsidized school breakfast, also mentioned by Lorini (2017) for Asai, but discontinued.

Regarding value chains, the deficient communication between processors and intermediaries in Asai´s, creates difficulties to reach markets, as intermediaries play a key role by providing market information about the quantities and qualities required, organizing transportation and

setting prices (Schreckenberg et al., 2006; Belcher & Schreckenberg, 2007). The close communication and friendship/familiar relationships between harvesters and processors, also suggested as a good strategy by Schreckenberg et al. (2006), were advantageous for strengthening that section of the value chain and would be beneficial to be replicated with intermediaries too.

One point in favor of Asai, is the existence of producer's associations, located in most cases in communities with processing plants implemented by NGOs (Tonore et al., 2019). These associations are affiliated to a producers federation, to improve the value chain dynamics (Tonore et al., 2019), and as key informants mentioned, to have a better institutional representation. The formation of these organizations are advantageous to promote a coordinated production, and if potentiated, can make a positive impact in the standardization of qualities, promotion of the product and negotiation capacities (Schreckenberg et al., 2006), factors mentioned in the study area as lacking.

The limited number of processing plants and the limited infrastructural conditions of many of them, agree with the general situation described for NTFPs in Bolivian communities and in the Amazon region (Bojanic, 2002; et al., 2006; Brokamp et al., 2011). They are also considered as serious constrains for NTFPs economic development, as they are obstacles to meet phytosanitary requirements, expand trades, increase income, etc (Schreckenberg et al., 2006). The better equipped processing plants are the ones supported by NGOs, enterprises, or the government, like in the case of the one in Villa Florida, which count with proper infrastructure and permissions, which highlights again the importance of institutional support.

An increase in the number and capacity of processing plants, added by the inclusion of Majo and possibly Palma real in the future, could be a good strategy to increase profits, since the flexibility and adaptation to different products, could avoid economic loses compared to using the infrastructure only during one fruit season (Brokamp et al., 2011).

Palms fruits pose an extra challenge, due to their perishability they require a special handling to avoid product and economic losses (Brokamp et al., 2011; Belcher & Schreckenberg, 2007). The lack of a cold chain, needed to keep the products quality is a crucial obstacle for expanding their production and trade, added to this, the bad road conditions delay transportation. Therefore, cold chain technologies and infrastructure, should be also considered as important elements of processing plants.

6.2. Community characteristics influencing palms fruits commercialization (RQ2)

By comparing the community's conditions, some of the differences in the potential for palm fruits trade can be explained. Villa Florida key advantage for sustainable commercialization is its location inside the RNVSA Manuripi. This protected area has a long tradition in generating sustainable strategies, especially regarding NTFPs, such as Brazil nut and natural rubber (ACEEA, 2016). Its management plan, focus on the resources preservation, contribution to the socio-economic benefits of the population, and the promotion of local participation in the management (Ministerio de Medio Ambiente y Agua et al., 2013), factors that are beneficial for sustainable commercialization too. Its normative which includes the prohibition of cutting down palm trees and limiting agricultural activities (Coronel, 2017), also influenced people's behavior, as it prevented other competitive uses of the palms and of land and created awareness towards the conservation of the resources. This can also be seen when looking at the occupation of the respondents (Annex 12.2). More than half of the community members interviewed in Villa Florida, reported as their single economic activity harvesting and collection of NTFPs, while in Empresiña, most respondents mentioned a more diversified economy,

including Brazil nuts collection, livestock raising and opening new agricultural lands, activity not mentioned in Villa Florida.

The several reports of intervention and institutional support in Villa Florida was also facilitated by its protected area condition. Institutions might find easier to work in communities with a coordinated management with the SERNAP, as they share institutional objectives. Some of those are the NGO ACEAA, that carried out a coordinated study on the productive potential of Asai (ACEAA, 2016) and WWF that promotes commercialization through harvesting and processing support (WWF, 2016). Moreover, RNVSA Manuripi is also part of PICFA, which is also an opportunity to continue this joint work with institutions.

Both communities, Villa Florida and Empresiña, have a PGIBT, which describes the management activities and objectives for each productive activity. In both cases, the only NTFP considered as a productive activity was Brazil nut, while Asai and Majo were only considered for self-consumption. However, in Villa Florida, Asai and Majo were already identified as potential economic activities, describing management objectives to be accomplished in the next years, which included the obtention of infrastructure for processing and increasing extracted volumes for commercialization (Baldivieso, 2015; Peñaranda, 2015), fulfilled in the last years.

Another important factor for the recent development of Asai production in Villa Florida, was the existence of the processing plant *Ventana Amazónica*. As mentioned before, processing infrastructure is essential for developing commercialization, and a processing plant close to the harvesting areas is crucial to avoid loses and ease logistics, reason why in Empresiña, palm fruits are only manually processed and self-consumed. To develop commercialization activities in Empresiña, fruits would need to be transported to a processing plant, requiring a cold chain, organization form the community to harvest enough, technical support for improving harvesting methods and handling of the products, and the interventions of intermediaries.

6.3. Potential of the palm fruits (RQ3)

Asai, the palm fruit with the highest potential due to the numerous favoring conditions, is also the specie with more recent research and documents mentioning it as one of the NTFPs most important for rural people livelihood and economy (ACEAA, 2016; CIPCA, 2020; Paniagua-Zambrana et al., 2020; Tonore et al., 2019). Its high abundance and productivity, together with its high demand in Bolivia, confirmed by market studies (ACEAA, 2020; Lorini, 2016), gives it the potential to develop an economy based on its production, being the pulp the main product processed for commercialization. Also, the information generated, and support provided, has been essential to introduce and educate population about its use, which has resulted in being one of the main targeted NTFP from producers' associations and institutions. Nevertheless, it is a recent developing activity, as key informants argued, it is still necessary to pay special attention to the obstacles that need to be removed and the capacities needed to be potentiated to create a fair and fluent value chain prioritizing the local level first.

Majo, the palm fruit with the second highest potential, has been beneficiated by its similarities with Asai regarding processing and harvesting, which made possible to include it in the technical support, and to use the existing infrastructure. Nevertheless, it is still confronting some technical difficulties, like the high perishability of the fruits and pulp, which limits the reach to further markets. Hence, its juice is more often consumed (Miranda et al., 2008; Peñaranda, 2015) but can only be sold locally or self-consumed. This explains key informants' arguments, saying that Majo is a fruit consumed locally and important for rural people's livelihoods. Several authors also highlight this characteristic together with its traditional use but, in other regions of Bolivia (Griffiths, 2008; Miranda et al., 2008; Peralta et al., 2020). In this context, Majo has the potential to be promoted for both local consumption and commercialization, exploiting its identified advantages. And, at the same time promote

research to develop the technologies for a better management of the perishability of its pulp, with the aim of promoting its commercialization to reach further markets in the mid/long-term.

Motacu and Palma real, with low potentials in most cases, share many of the hindering and less beneficial conditions, like the lack of knowledge regarding its harvesting and processing, lack of technical support, consumption habit and lower abundance. Nevertheless, in other regions these two fruits, are well known for their long consumption tradition and economic importance for rural population, which confirms that Pando has still not developed the knowledge nor the conditions to exploit their potential. For instance, Motacu fruit products were mentioned by key informants and in literature, as commonly consumed and traded in other regions of Bolivia like Beni, La Paz and Santa Cruz (Peralta, 2009; Miranda et al., 2008; Moraes et al., 1996). Palma real, often mentioned by key informants as commonly used in Peru, is one of the most popular Amazonian palm tree mentioned in the literature, and mentioned as emblematic due to its ecological, social and mentioned economic benefits (Moraes et al., 2020; Rojas-Ruiz et al., 2006; Trujillo et al., 2011).

Palma real showed some potential in Villa Florida and several respondents mentioned an increasing interest on it, as they have identified its untapped economic potential. Nevertheless, the know-how on its harvesting and processing methods, is just been developed by some NGOs. On the other hand, Motacu didn't show any special interest for increasing its consumption or production, even though Motacu´s harvesting is much easier than the other palm fruits, population didn't develop a consumption habit. One of the reasons might be the less fleshy pulp compared to other fruits and to Motacu varieties in other regions, which could make of the oil a more promissory subproduct.

A special characteristic of Palma real is its location in flooded areas, this condition brings some logistic difficulties in the harvesting, but could also be an advantage to stimulate its promotion as an important specie for conservation. They are considered as a key stone species of Amazonian ecosystems (van der Hoek et al., 2019), they are important for the conservation of water bodies (Moraes et al., 2020), and also for the carbon sink function of swamps (Draper et al., 2014). Nevertheless, its promotion needs to be in line with knowledge based technical support, as other experiences have shown that this specie requires special attention regarding its harvesting methods due to its dioic characteristic (Falen & Honorio, 2018).

6.4. Methodological challenges

The biggest challenge of the methodology used in this thesis, was the remote data collection. A forest inventory, as it was intended to be carried out, would have provided comparable information about the abundance and harvesting potential of the palms selected in the study area. However, these data had to be collected from secondary sources, and it was not available for all palms.

Methodologies to carry out interviews, the main source of data, had both strengths and limitations. As for key informants' interviews, potential participants had to be contacted online, and in some cases, it was difficult to arrange an appointment. On the other side, many of them were easy to reach and agreed willingly to participate. Using an online software was not a problem for any of the participants as they had already some experience using it and a good internet connection. Doing the interview in person, would have been much beneficial to get a closer contact with the participants and reduce the time limitation that some participants had. Nevertheless, I consider that online interviews were a very useful tool, as the openness of the participants helped to have a fluent interview.

Regarding interviews to community members, the big limitation was that I couldn't carry out the interviews on my own, therefore I didn't have the possibility to do semi structured interviews to include extra questions in case some interesting topic came out. Nevertheless, the support

from the field assistant was very helpful, as he knew the study area well, as well as the local people and the topic.

Another methodological limitation was the small sample size of community members, as the time of the year when interviews were carried out was not the optimal. Nevertheless, answers didn't show a big variation, being able to find a tendency and probably catching a good representation of the population. Also, interviews to processors would have added interesting inputs, to confirm key informants' information about the processing, but I was not able to contact them.

The use of the SMART analysis was useful given the conditions and availability of data, as it allowed me to use both, quantitative and qualitative information, combine and analyze them. I chose the indicators from the literature about the topic, however, a presential focus group to discuss about their importance, as it was planned in a first instance, would have enriched the analysis and the selection of indicators.

7. Conclusion and outlook

In this master thesis, I assessed the potential of four palm fruits for sustainable commercialization in Pando, Bolivia, using a multi-criteria analysis framework, which considered ecological, socio-economic, policies and institutional support, and market and value chain criteria. Data collection relied mostly on interviews with key informants and community members from one community inside and one community outside the protected area RNVSA Manuripi. Results revealed differences among the fruits potentials, as well as differences between the communities studied.

Asai high potential and recent advances in commercialization, may continue favorably in the next years as there exists an increasing interest from rural organizations and supporting institutions. This development may have an important role in the commercialization development of the rest of the fruits too, as they may benefit from several of the promoting factors, such as value chains, infrastructure, and producers' associations, which is already happening with Majo. Furthermore, the results for Asai and Majo in Villa Florida, community inside the RNVSA Manuripi, show that they have the promising conditions to benefit rural population economically as an important supplementary income, and additionally favor forest conservation due to their sustainable harvesting. Motacu and Palma real, despite their high nutritional quality, still have a lower potential in Pando, and will require of a strong promotion and development of technologies for its future development.

Results showed that it is necessary to continue reinforcing rural people's capacities and to tackle the identified obstacles. Future interventions should target: the development of technologies and infrastructure to deal with perishability, the increase of processing capacities, the promotion of more stable sales contracts creating better links between associations and buyers, the promotion of organizational and financial capacities of rural associations, more helpful financial instruments, easing the bureaucratic requirements, the implementation of inventories and monitoring systems, and the reinforcement of the importance of the management plans.

Several identified constrains that affect all palm fruits like the ones related to legal procedures, lack of financial and managerial capacities and deficiencies in infrastructure, reflect the common situation described by several authors, not only in the study area, but in Bolivia and the Amazon region. On the other hand, the results of this study contrasted with other more successful experiences in other Amazonian regions, demonstrate that the use and commercialization development of NTFPs is context dependent, and that it is also influenced by the population habits and knowledge. Moreover, the differences between the two communities exposed that the location inside a protected area, provides more favorable conditions for a sustainable commercialization than outside of it, as the co-management between SERNAP and the communities facilitated intervention and support from different institutions. This confirms what is often underlined in literature: that the intervention from institutions is key, as rural people normally lack the capacities to deal with complicated logistics and managerial issues.

The multidisciplinary approach used in this study, demonstrates the importance of considering a broad perspective regarding the dimensions and factors that influence sustainable commercialization, existing interrelations between them. Become equally important the understanding of the householders´ context, and the ecological and economic dynamics, in order to prevent failures, like in previous NTFPs Boom and Bust cycles in the Amazon. Nevertheless, this multifactorial approach, required a high number of indicators, which also pose some limitations, since the timeframe and logistics didn't allow their thorough implementation. However, the SMART methodology proved useful by its flexibility, and the analysis could be updated when more detailed information is obtained.

The devised methodology also serves as a diagnostic tool to identify needed further research and supportive intervention and can be replicated with other NTFPs/communities. It can also be used as a monitoring tool, by tracking the changes over time, seeking sustainable commercialization objectives, and assisting stakeholders in decision making processes.

8. Summary

Non-timber forest products (NTFPs) play a key role in improving rural communities´ livelihoods by providing valuable goods and services, and generating economic income when commercialized (Belcher & Schreckenberg, 2007; Secretariat of the Convention on Biological Diversity, 2001; Stanley et al., 2012). The NTFPs commercialization is promoted as a forest conservation strategy, as it is bonded with the need to maintain forests for their continue provision (Belcher & Schreckenberg, 2007). In Pando, Bolivia, NTFPs were identified as critical components of its SES (Callo-Concha et al, internal comm), as the local populations depend economically on one product (Brazil nut), bringing up the necessity to diversify their economic activities with sustainable alternatives. Palm trees have promising characteristics for this diversification, as they generate varied and important NTFPs, being the fruits the part of the plant most commonly used by their nutritional value (Balslev et al., 2015; Brokamp et al., 2011) and also the ones with a higher potential for trading (Moraes, 2014).

In that context, this master thesis aims to set a baseline to assess the potential of four palm fruits species for sustainable commercialization applying a multi-criteria analytical framework. The criteria were: ecological, related to the species´ characteristics that influence their harvesting; socio-economic, especially important in terms of how rural populations are benefitted; market and value chain, referring to the factors needed to take into account when products go beyond self-consumption and start being commercialized; and political and institutional supporting criteria, which set the framework and support for the well-functioning of the rest of the factors (Shackleton, 2015; Cunningham, 2001; Wynberg and van Niekerk, 2015; Stanley et al., 2012). Each criteria was split in several indicators selected according to the literature and the possibility to assess them remotely.

To define the potentiality of each palm fruit, I used a Multi-criteria decision making (MCDM) analysis with a Simple Multi Attribute Rating Technique (SMART) methodology, which allowed me to rate each indicator according to its specific context and to the data obtained. I identified differences between the potentials among palm fruits, and additionally among communities, detecting the conditions that enabled or hindered their commercialization. Moreover I used a SWOT analysis to identify the internal and external factors affecting a sustainable commercialization.

The species selected by their reports on use and importance in Pando and the Madre de Dios, Acre, Pando (MAP) region, were Asaí (*Euterpe precatoria Mart*), Majo (*Oenocarpus bataua Mart*), Motacú (*Attalea phalerata Mart. ex Spreng*) and Palma real (*Mauritia flexuosa L.f.*). Due to the Covid-19 pandemic limitations, data was collected remotely, and secondary data sources were privileged. I conducted semi-structured interviews with key informants using online platforms. Key informants were stakeholders experienced on palm fruits: officers from NGOs, representatives of governmental institutions, retailers, private consultants, and a member from a producer's federation. Aside, structured interviews were conducted by a field assistant to community members in two communities, Villa Florida located inside the RNVSA Manuripi and Empresiña outside of it, both located in the district of Filadelfia in Pando. I analyzed the interviews coding the transcripts with a structured content analysis software ATLAS.ti.

Results showed that Asai, was the palm fruit of highest potential for sustainable commercialization. Among the main advantages were its high abundance and productive potential, its increasing demand, the existence of processing infrastructure, and the supportive intervention from different institutions, all resulting in the recent development of its trading, but still limited. Majo, was the species ranking the second in trade potential, benefited by its many similarities with Asai concerning harvesting and processing methods, but still posing some extra technical difficulties like the dealing with its high perishability.

The higher potentials for Asai and Majo were found in the community Villa Florida, benefitted by the favorable conditions given inside the RNVSA Manuripi, related to the co-management of the area between SERNAP and the communities, which facilitates the intervention and support from different institutions. Also, in this community, Asai and Majo were the only palm fruits that generated economic income at a household level. This finding together with their seasonal production, suggests them as an interesting source of complementary income to Brazil nuts collection.

Palma real had a medium potential only in Villa Florida. Several respondents think that it has good potential in the region and mentioned their interest in starting to work with it. Nevertheless, there is still a lack of knowledge about its productive potential, harvesting and processing methods, which are just starting to be addressed by some NGOs. Motacu was the palm fruit with the lowest potential, with no reported interest for commercial use, and only self-consumed in a small scale.

Several promoting and hindering conditions were shared by all palm fruits, among the most mentioned obstacles were the bureaucratic requirements to become formal traders; the lack of financial capacities; and the deficient conditions of roads and infrastructure, key to maintain the quality of perishable goods. This demonstrate that institutional intervention is still required to remove obstacles and promote the trading capacities of rural entrepreneurships. Regarding the favoring conditions, due to the biological characteristics of the palms, quantities and harvesting methods used, all palm fruits are sustainably harvested. However, more information about their abundance and productive potential are needed to continue ensuring it.

The results of this thesis confirm the necessity of considering broadly the factors affecting sustainable commercialization, as well as the interrelations between them. Nevertheless, the use of this multidisciplinary methodology also presented some limitations, since the time frame and logistical limitations didn't allow a thorough assessment of some of them. However, the SMART tool was useful, and due to its flexibility, it can be complemented and adapted when more detailed information is obtained. This methodology can serve as a diagnostic tool to identify specific aspects of the studied palm fruits that may need improvement or further research, and the use of indicators, can also be used also as a monitoring tool, to track changes over time. Also, it can be replicated in other NTFPs and communities, and serve a tool for different stakeholders in decision-making.

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12. Annex

12.1. List of key informants

Table 13: Key informants' information

Interviewee	Sex	Type of organization / occupation	Organization
KI01	Male	NGO	Centro de Investigación y Promoción del Campesinado (CIPCA)
KI02	Male	NGO	Centro de Investigación y Promoción del Campesinado (CIPCA)
KI03	Male	NGO	Asociación Boliviana para la Investigación y Conservación de Ecosistemas Andino-Amazónicos (ACEAA)
KI04	Male	NGO	World Wildlife Fund (WWF)
KI05	Male	NGO	Herencia
KI06	Male	Governmental institution	Ministerio de Desarrollo Rural y Tierra
KI07	Male	Governmental institution	Servicio Nacional de Sanidad Agrícola (SENASAG)
KI08	Male	Governmental institution	Servicio Nacional de Sanidad Agrícola (SENASAG)
KI09	Female	Governmental institution	Former worker of Servicio Departamental Productivo (SEDEPRO)
KI10	Male	Retailer	Retailer of Asai products
KI11	Male	Retailer	Retailer of Asai products
KI12	Male	Federation of producers associations	Federación de Cosechadores de Asaí y Frutos Amazónicos de Pando (FEDAFAP)
KI13	Male	Consultant	Private consultant
KI14	Female	Consultant	Private consultant

12.2. List of community members

Table 14: Community members´ information

Interviewee	Community	Age	Sex	Occupation
VILLA01	Villa Florida	52	Male	NTFPs extraction
VILLA02	Villa Florida	36	Female	NTFPs extraction
VILLA03	Villa Florida	31	Male	Agriculture and NTFPs extraction
VILLA04	Villa Florida	26	Male	NTFPs extraction
VILLA05	Villa Florida	33	Male	NTFPs extraction
VILLA06	Villa Florida	58	Male	NTFPs extraction, general secretary of the community
VILLA07	Villa Florida	21	Female	Housewife
VILLA08	Villa Florida	48	Female	NTFPs extraction
VILLA09	Villa Florida	42	Male	Agriculture and NTFPs extraction
VILLA10	Villa Florida	44	Male	NTFPs extraction
EMP01	Empresiña	28	Male	Brazil nut recollection, opening new agricultural fields, livestock
EMP02	Empresiña	67	Female	Housewife
EMP03	Empresiña	34	Female	Housewife
EMP04	Empresiña	46	Male	Opening new agricultural fields, agriculture, Brazil nut recollection, raising chickens
EMP05	Empresiña	43	Female	Housewife, opening new agricultural fields
EMP06	Empresiña	28	Male	Brazil nut recollection, opening new agriculture fields, taxi driver
EMP07	Empresiña	67	Male	Opening new agricultural fields, agriculture, Brazil nut recollection, livestock
EMP08	Empresiña	33	Male	Brazil nut recollection, opening new agricultural fields
EMP09	Empresiña	44	Female	Brazil nut recollection, livestock, agriculture
EMP10	Empresiña	49	Female	Timber, fishery, Brazil nut recollection, Asai harvesting for self-consumption

12.3. Interview guideline for Key informants

1. ¿A qué se dedica?
2. ¿Su trabajo estuvo o está relacionado a PFNM como los frutos del asaí, motacú, majo o palma real?

ASPECTOS ECOLÓGICOS

3. ¿Qué método se usa para aprovechar los productos?
4. ¿Hay algún criterio para seleccionar a las palmeras que se van a aprovechar?
5. ¿Considera que esa forma de aprovechamiento de estas palmeras es sostenible y permite mantener la abundancia de la especie en el bosque?
6. ¿De la cantidad de producto disponible en el bosque para ser aprovechado, cuanto cree que es realmente aprovechado aproximadamente en porcentaje?
7. ¿Considera que la tendencia de la cantidad de producto en el bosque en los últimos 20 años ha disminuido, se ha mantenido o ha aumentado?
8. Si ha disminuido o aumentado:
   ¿A cree qué se debe el cambio?
9. ¿Hay algún otro uso que se le dé a la especie que afecte o que esté en conflicto con la producción de frutos? (ej. palmito o madera)

SOPORTE Y ASPECTOS LEGALES

10. ¿Alguna institución ofrece o ha ofrecido algún tipo de soporte técnico en relación a los métodos de aprovechamiento o manejo de las especies en el bosque para alguno de los productos?
11. ¿En qué consiste este soporte?
12. ¿Y respecto al procesamiento y cómo mantener la calidad del producto una vez cosechado?
13. ¿Cómo considera que ha sido el apoyo financiero para las actividades relacionadas a los productos, ha habido por ejemplo algún tipo de incentivo como reducción de impuestos, subsidios, acceso a créditos o préstamos?

MERCADO Y CADENAS DE VALOR

14. ¿Cómo ha sido la tendencia del mercado local de los productos en Pando en los últimos años? ¿Ha aumentado, disminuido o se ha mantenido estable?
15. ¿Alguno de estos productos se exporta?
16. Si se exporta, ¿La demanda ha aumentado, disminuido o se ha mantenido estable? ¿Cuál ha sido el motivo?
17. ¿Cree que los frutos de motacú, majo o palma real podrían tener potencial para la exportación? ¿Porqué?
18. ¿Qué otros productos existen en el mercado que puedan competir o sustituir a los productos?
19. ¿Existen organizaciones o asociaciones de colectores o procesadores para los frutos de motacú, majo o palma real?
20. ¿Considera que existe una buena conexión en las cadenas productivas (entre colectores, procesadores y comercializadores) que permitan al producto llegar fácilmente al mercado?
21. ¿Cómo considera que ha sido el apoyo del gobierno u otras instituciones en la formación de estas asociaciones?

22. ¿Los productos necesitan de algún tipo de proceso antes de ser comercializados? ¿En qué consiste ese proceso?
23. ¿Cómo considera que es el estado de la infraestructura, como instalaciones o maquinaria necesaria para dicho procesamiento?
24. ¿Cómo considera el estado de los medios para transportar el producto del bosque al lugar de venta? (Ej. Carreteras, caminos, vehículos)
25. ¿Qué tan intensa es la mano de obra requerida para el aprovechamiento y procesamiento de los productos? ¿Cuál de los productos requiere una mano de obra más intensa?

DATOS DEL ENTREVISTADO:

Nombre:

Sexo: F / M

Lugar de trabajo:

12.4. Community members survey questionnaire

1. ¿A qué se dedica?
2. ¿Ha trabajado o tiene experiencia con alguno de estos frutos?

ASPECTOS ECOLÓGICOS

3. ¿Qué método se usa para aprovechar los productos?
4. ¿En qué época del año se aprovechan?
5. ¿Hay algún criterio para seleccionar a las palmeras que se van a aprovechar?
6. ¿Qué cantidad se aprovecha aproximadamente por día?
7. ¿De la cantidad de fruto que hay disponible en el bosque para ser recolectado, cuanto cree que realmente se recolecta aproximadamente?
8. ¿Considera que la cantidad de frutos en el bosque en los últimos 20 años ha disminuido, se ha mantenido o ha aumentado?
9. Si ha disminuido o aumentado:
   ¿A qué cree que se debe el cambio?
10. ¿Hay algún otro uso que se le dé a la especie que afecte la producción de frutos? (ej. palmito o madera)

ASPECTOS SOCIOECONÓMICOS

11. ¿Qué tan importante es el consumo de estos frutos en su alimentación?

Asaí:
Se consume constantemente ☐ Se consume a veces ☐ Se consume muy poc ☐
No se consume ☐

Majo:
Se consume constantemente ☐ Se consume a veces ☐ Se consume muy poc ☐
No se consume ☐

Motacú:
Se consume constantemente ☐ Se consume a veces ☐ Se consume muy poc ☐
No se consume ☐

Palma real:
Se consume constantemente ☐ Se consume a veces ☐ Se consume muy poc ☐
No se consume ☐

12. ¿Qué tan importante es el ingreso que recibe trabajando con estos frutos para su ingreso familiar?

Asaí:
Muy importante ☐ Importante ☐ Poco importante ☐ No es importante ☐

Majo:
Muy importante ☐ Importante ☐ Poco importante ☐ No es importante ☐

Motacú:
Muy importante ☐ Importante ☐ Poco importante ☐ No es importante ☐

Palma real:
Muy importante ☐ Importante ☐ Poco importante ☐ No es importante ☐

13. ¿Cuánto gana por día aproximadamente por el trabajo realizado con los productos?
14. ¿Cuántos días al año aproximadamente trabaja en actividades relacionadas a los productos?

SOPORTE, ASPECTOS LEGALES Y CADENA DE VALOR

15. ¿Ha habido algún soporte técnico por parte del estado u otras instituciones con relación a métodos de aprovechamiento o manejo de las especies en el bosque para alguno de los productos?
16. ¿Ha habido algún soporte técnico por parte del estado u otras instituciones con relación a cómo mantener la calidad del producto una vez cosechado?
17. ¿Cómo considera que es la conexión entre los recolectores, procesadores y comercializadores de los frutos?
18. ¿Cómo considera que ha sido el apoyo del gobierno u otras instituciones en la formación de las asociaciones de productores?
19. ¿Qué tan trabajoso es recolectar estos frutos? ¿Hay diferencia entre ellos?
20. ¿Qué tan trabajoso es procesar estos productos? ¿Hay diferencias entre ellos?

DATOS DEL ENTREVISTADO:

Nombre:

Sexo: F / M

Edad:

Comunidad:

12.5. SMART analysis of palm fruits according to key informants' and community members assessment

Table 15: SMART analysis of palm fruits according to key informants' assessment

Criteria and indicators	Weight	Asai		Majo		Motacu		Palma real	
		Rating value	Utility value	Rating value	Utility value	Rating value	Utility value	Rating value	Utility value
Ecological aspect	**0.33**	**15**	**0.89**	**14**	**0.78**	**15**	**0.83**	**13**	**0.72**
Abundance	0.06	3	0.17	2	0.11	1	0.06	1	0.06
Estimated extraction relative to the harvesting potential	0.06	3	0.17	3	0.17	3	0.17	3	0.17
Harvesting methods impact	0.06	3	0.17	2	0.11	3	0.17	3	0.17
Harvesting level of difficulty	0.06	2	0.11	2	0.11	3	0.17	1	0.06
Resource availability trend	0.06	2	0.11	2	0.11	2	0.11	2	0.11
Competitive use	0.06	3	0.17	3	0.17	3	0.17	3	0.17
Supporting and policy instruments	**0.33**	**13**	**0.87**	**11**	**0.73**	**7**	**0.47**	**7**	**0.47**
Policies and regulations	0.07	2	0.13	2	0.13	2	0.13	2	0.13
Technical support for harvesting	0.07	3	0.20	2	0.13	1	0.07	1	0.07
Technical support for processing	0.07	3	0.20	2	0.13	1	0.07	1	0.07
Financial support	0.07	2	0.13	2	0.13	1	0.07	1	0.07
Support for organization	0.07	3	0.20	3	0.20	2	0.13	2	0.13
Commercialization	**0.33**	**17**	**0.81**	**12**	**0.57**	**7**	**0.33**	**9**	**0.43**
Local demand	0.05	3	0.14	2	0.10	1	0.05	1	0.05
International market	0.05	3	0.14	1	0.05	1	0.05	3	0.14
Existence of producer's associations	0.05	3	0.14	2	0.10	1	0.05	1	0.05
Value chain connection	0.05	2	0.10	2	0.10	1	0.05	1	0.05
Infrastructure	0.05	2	0.10	2	0.10	1	0.05	1	0.05
Roads conditions	0.05	1	0.05	1	0.05	1	0.05	1	0.05
Processing level of difficulty	0.05	3	0.14	2	0.10	1	0.05	1	0.05
Final value		**2.57**		**2.08**		**1.63**		**1.62**	

Table 16: SMART analysis of palm fruits according to community members from Villa Florida assessment

Indicator	Weight	Asai		Majo		Motacu		Palma real	
		Rating value	Utility value	Rating value	Utility value	Rating value	Utility value	Rating value	Utility value
Ecological aspect	**0.25**	**16**	**0.67**	**13**	**0.58**	**15**	**0.63**	**13**	**0.54**
Abundance	0.04	3	0.13	2	0.08	1	0.04	1	0.04
Estimated extraction relative to the harvesting potential	0.04	1	0.04	1	0.04	3	0.13	3	0.13
Harvesting methods impact	0.04	3	0.13	3	0.13	3	0.13	3	0.13
Harvesting level of difficulty	0.04	3	0.13	2	0.08	3	0.13	1	0.04
Resource availability trend	0.04	3	0.13	3	0.13	2	0.08	2	0.08
Competitive use	0.04	3	0.13	3	0.13	3	0.13	3	0.13
Socio-economic aspect	**0.25**	**8**	**0.67**	**8**	**0.67**	**3**	**0.25**	**3**	**0.25**
Income generation	0.08	3	0.25	3	0.25	1	0.08	1	0.08
Importance for household´s economy	0.08	2	0.17	2	0.17	1	0.08	1	0.08
Consumption in households	0.08	3	0.25	3	0.25	1	0.08	1	0.08
Policies and institutional support aspects	**0.25**	**9**	**0.56**	**9**	**0.56**	**5**	**0.31**	**7**	**0.44**
Policies and regulations	0.06	2	0.13	2	0.13	2	0.13	2	0.13
Technical support for harvesting	0.06	3	0.19	3	0.19	1	0.06	2	0.13
Technical support for fruit processing	0.06	3	0.19	3	0.19	1	0.06	2	0.13
Organizational support	0.06	1	0.06	1	0.06	1	0.06	1	0.06
Market and value chain	**0.25**	**18**	**0.74**	**16**	**0.65**	**9**	**0.36**	**11**	**0.45**
Local demand	0.04	3	0.13	2	0.08	2	0.08	2	0.08
International market	0.04	3	0.13	1	0.04	1	0.04	3	0.13
Producer’s associations	0.04	3	0.13	3	0.13	1	0.04	1	0.04
Value chain	0.04	2	0.08	2	0.08	1	0.04	1	0.04
Infrastructure	0.04	3	0.13	3	0.13	1	0.04	1	0.04
Road conditions	0.04	2	0.07	2	0.07	2	0.07	2	0.07
Processing level of difficulty	0.04	2	0.08	3	0.13	1	0.04	1	0.04
Final value		**2.63**		**2.47**		**1.55**		**1.68**	

Table 17: SMART analysis of palm fruits according to community members from Empresiña assessment

Indicator	Weight	Asai		Majo		Motacu		Palma real	
		Rating value	Utility value	Rating value	Utility value	Rating value	Utility value	Rating value	Utility value
Ecological aspect	**0.25**	**13**	**0.54**	**13**	**0.54**	**15**	**0.63**	**13**	**0.54**
Abundance	0.04	3	0.13	2	0.08	1	0.04	1	0.04
Estimated extraction relative to the harvesting potential	0.04	2	0.08	2	0.08	3	0.13	3	0.13
Harvesting methods impact	0.04	3	0.13	3	0.13	3	0.13	3	0.13
Harvesting level of difficulty	0.04	2	0.08	2	0.08	3	0.13	1	0.04
Resource availability trend	0.04	1	0.04	2	0.08	2	0.08	2	0.08
Competitive use	0.04	2	0.08	2	0.08	3	0.13	3	0.13
Socio-economic aspect	**0.25**	**5**	**0.42**	**4**	**0.33**	**3**	**0.25**	**3**	**0.25**
Income generation	0.08	1	0.08	1	0.08	1	0.08	1	0.08
Importance for household´s economy	0.08	1	0.08	1	0.08	1	0.08	1	0.08
Consumption in households	0.08	3	0.25	2	0.17	1	0.08	1	0.08
Policies and institutional support aspects	**0.25**	**5**	**0.31**	**5**	**0.31**	**5**	**0.31**	**5**	**0.31**
Policies and regulations	0.06	2	0.13	2	0.13	2	0.13	2	0.13
Technical support for harvesting	0.06	1	0.06	1	0.06	1	0.06	1	0.06
Technical support for fruit processing	0.06	1	0.06	1	0.06	1	0.06	1	0.06
Organizational support	0.06	1	0.06	1	0.06	1	0.06	1	0.06
Market and value chain	**0.25**	**15**	**0.54**	**12**	**0.43**	**10**	**0.40**	**12**	**0.48**
Local demand	0.04	3	0.11	2	0.07	2	0.08	2	0.08
International market	0.04	3	0.11	1	0.04	1	0.04	3	0.13
Producer's associations	0.04	1	0.04	1	0.04	1	0.04	1	0.04
Value chain	0.04	1	0.04	1	0.04	1	0.04	1	0.04
Infrastructure	0.04	1	0.04	1	0.04	1	0.04	1	0.04
Road conditions	0.04	3	0.11	3	0.11	3	0.11	3	0.11
Processing level of difficulty	0.04	3	0.11	3	0.11	1	0.04	1	0.04
Final value		**1.81**		**1.62**		**1.59**		**1.59**	

12.6. Scoring tables

Table 18: Indicators scoring table for key informants' assessment

Criteria and indicators	Indicators scoring scale		
	1	2	3
Ecological aspect			
Abundance	0 - 5 palms/ha	>5 - 15 palms/ha	> 15 palms/ha
Estimated extraction relative to the harvesting potential	>50% in most of the answers	25% - 50% in most of the answers	<25% in most of the answers
Harvesting methods impact	Several reports of harvesting methods with negative impacts on the plant	Some reports of harvesting methods with negative impacts on the plant	Only harvesting methods without negative impacts on the plant reported
Harvesting level of difficulty	Difficult harvesting	Medium harvesting	Easier harvesting
Resource availability trend	Decreased	Stable or not defined	Increased
Competitive use	Competitive uses reported	-	No competitive uses reported
Policies and institutional support aspects			
Policies and regulations	Policies and regulations create conditions that hinder NTFPs commercialization	Policies and regulations create conditions that promote NTFPs commercialization but with limitations	Policies and regulations create conditions that promote NTFPs commercialization
Technical support for harvesting	Little or no harvesting technical support	Harvesting technical support reported	Specialized harvesting technical support
Technical support for fruit processing	Little or no processing technical support	Processing technical support reported	Specialized processing technical support
Financial support instruments	No financial support identified	Financial support with material capital	Financial support with material capital and financial instruments
Support for organization	No support for the organization of associations provided	-	Support for the organization of associations provided

Market and value chain			
Competition and substitution	No specific value for each palm fruit was possible		
Local demand	High local demand	Medium demand	Low demand
International market	No consolidated international market	-	Existence of an international market
Producer's associations	No producers' associations	Product can be easily included in producers' associations for Asai	Existence of producers' associations
Value chain	No value chain identified	Value chain with deficient connection	Value chain well connected
Road conditions	Bad roads conditions all the year	Bad roads conditions during raining season	Good roads conditions
Infrastructure	No infrastructure	Infrastructure with deficiencies	Infrastructure in good conditions
Processing level of difficulty	Very difficult or unknown processing methods	Known processing methods with difficulties	Processing methods without difficulties

Table 19: Indicators scoring table for communities' assessment

Criteria and indicators	Indicator value		
	1	2	3
Ecological aspect			
Abundance	0 - 5 palms/ha	>5 - 15 palms/ha	> 15 palms/ha
Estimated extraction relative to the harvesting potential	>50% average	25% - 50% average	<25% average or only few responses
Harvesting methods impact	Several reports of harvesting methods with negative impacts on the plant	Some reports of harvesting methods with negative impacts on the plant	Only harvesting methods without negative impacts on the plant reported
Harvesting level of difficulty	Difficult harvesting	Medium harvesting	Easier harvesting
Resource availability trend	Decreased	Stable or mostly not defined	Increased
Competitive use	>50% of respondents reported competitive use	25% - 50% of respondents reported competitive use	<25% of respondents reported competitive use
Socio-economic aspect			
Income generation	No income generated for most of the respondents	Generated income lower than poverty line for most of the respondents	Generated income higher than poverty line for most of the respondents
Importance for household´s economy	Not or little important for most of the respondents	Important for most of the respondents	Very important for most of the respondents
Consumption in households	Not or very little consumed for most of the respondents	Sometimes consumed for most of the respondents	Constantly consumed for most of the respondents
Policies and institutional support aspects			
Policies and regulations	Policies and regulations create conditions that hinder NTFPs sustainable use	Policies and regulations create conditions that promote NTFPs sustainable use but with limitations	Policies and regulations create conditions that promote NTFPs sustainable use
Technical support for harvesting	No technical support reported	Some respondents reported technical support	Most of the respondents reported technical support
Technical support for fruit processing	No technical support reported	Some respondents reported technical support	Most of the respondents reported technical support
Support for organization	No support reported	Some respondents reported support	Most of the respondents reported support

Market and value chain			
Competition and substitution	-	-	-
Local demand	High local demand	Medium demand	Low demand
International market	No consolidated international market	-	Existence of an international market
Producer's associations	No producers' associations	-	Existence of producers' associations
Value chain	No value chain identified	Value chain with deficient connection	Value chain well connected
Road conditions	Bad roads conditions all the year	Bad roads conditions during raining season	Good roads conditions
Infrastructure	No infrastructure	Infrastructure with some deficiencies	Infrastructure in good conditions
Processing level of difficulty	Unknown	More complex for most of the respondents / same complexity	Easier for most of the respondents

12.7. Codebook

Table 20: Codebook

Category / Indicator	**Code**	**Sudcode 1**	**Subcode 2**	**Data example**
Estimated extraction relative to the harvesting potential	ESTIMATED_ EXTRACTION	Estimated_extraction:asai	Estimated_extraction:<25%	
		Estimated_extraction:majo	Estimated_extraction:25-50%	*en majo no debe ser ni el 10% ni el 5%*
		Estimated_extraction:motacu	Estimated_extraction:>50%	
		Estimated_extraction:palma_ real	Estimated_extraction:unkown	
Harvesting methods impact	HARVESTING_ METHODS	Harvesting_methods:asai	Harvesting_methods:negative_ impact	
		Harvesting_methods:majo	Harvesting_methods:no_negativ e_ impact	
		Harvesting_methods:motacu		*El motacú es bajo, abajo se cosecha, hay que subir con una pequeña escalera no hay ningún problema*
		Harvesting_methods:palma_ real		
	HARVESTING_ CRITERIA	Harvesting_criteria:asai		*que sean palmeras rectas y con fruto maduro, caídos en el suelo.*
		Harvesting_criteria:majo		
		Harvesting_criteria:motacu		
		Harveasing_criteria:palma_ real		

	SUSTAINABILITY_ PRECEPTION	Sustainability:asai		*entonces aún así yo creo que no hay una presión sobre la especie, posiblemente estamos hablando de condiciones de equilibrio bastante sostenibles.*
		Sustainability:majo		
		Sustainability:motacu		
		Sustainability:palma_real		
Harvesting level of difficulty	HARVESTING_ DIFFICULTY	Harvesting_difficulty:asai	Harvesting_difficulty:difficult	*Es más fácil por ser delgada la palmera*
		Harvesting_difficulty:majo	Harvesting_difficulty:medium	
		Harvesting_difficulty:motacu	Harvesting_difficulty:easier	
		Harvesting_difficulty:palma_real		
Resource availability trend	AVAILABILITY_ TREND	Availability_trend:asai	Availability_trend:decreasing	
		Availability_trend:majo	Availability_trend:stable	*Para el asaí y Majo, con las técnicas que se vienen aplicando ahora del cuidado del medio ambiente creo que se viene manteniendo las cantidades porque primero se tumbaban los árboles...*
		Availability_trend:motacu	Availability_trend:increasing	
		Availability_trend:palma_real	Availability_trend:no_info	
Competitive use	COMPETITIVE_USE	Competitive_use:asai	Competitive_use:yes	
		Competitive_use:majo	Competitive_use:no	*aquí no porque es prohibida la tala*
		Competitive_use:motacu		
		Competitive_use:palma_real		

Income generation	INCOME_ GENERATION	Income_generation:asai		
		Income_generation:majo		*150 bs*
		Income_generation:motacu		
		Income_generation:palma_real		
Importance in households' economy	ECONOMIC_ IMPORTANCE	Economic_importance:asai	Economic_importance:not_ important	
		Economic_importance:majo	Economic_importance:little_ important	
		Economic_importance:motacu	Economic_importance:important	
		Economic_importance:palma_re al	Economic_importance:very_imp ortant	
Consumption in households	CONSUMPTION	Consumption:asai	Consumption:not_consumed	
		Consumption:majo	Consumption:very_little_consum ed	
		Consumption:motacu	Consumption:sometimes_consu med	
		Consumption:palma_real	Consumption:constantly_consu med	
Technical support for harvesting	SUPPORT_ HARVESTING	Support_harvesting:asai		*Del estado no, de las ONGs si, FAUTAPO y WWF son las que nos han estado apoyando, para asaí y majo*
		Support_harvesting:majo		
		Support_harvesting:motacu		
		Support_harvesting:palma_real		

Technical support for processing	SUPPORT_ PROCESSING	Support_processing:asai		*el asesoramiento va más en el tema de transformación, como hacer la planta procesadora, cómo organizarte,*
		Support_processing:majo		
		Support_processing:motacu		
		Support_processing:palma_ real		
Financial support instruments	FINANCIAL_ SUPPORT			Para palmeras no hay nada de incentivos, el estado ha puesto muy poca atención en temas de actores productivos de esta región del país
Organizational support	ORGANIZATIONAL_ SUPPORT			*la gobernación ayuda un montón en crear un montón de asociaciones*
Competition and substitution	COMPETITION_ SUBSTITUTION			*El sinini tiene propiedades anticancerígenas; el Camu camu tiene vitamina C*
Local demand	LOCAL_DEMAND	Local_demand:asai	Local_demand:increasing	*En el asaí ha aumentado, hay muchas tiendas que se han inaugurado, hay ahora 10 en Cobija, antes no había nada*
		Local_demand:majo	Local_demand:stable	
		Local_demand:motacu	Local_demand:decreasing	
		Local_demand:palma_real	Local_demand:high	
			Local_demand:medium	

			Local_demand:low	*aquí pocos consumen, es sorprendente que en el Perú lo consuman tanto y aquí ni se lo conozca*
International market	INTERNATIONAL_ MARKET	International_market:asai		
		International_market:majo		*El majo no, son pequeños volumen, sería interesante atender la demanda de mercado nacional, para exportación no lo veo.*
		International_market:motacu		
		International_market:palma_ real		
Existence of producers associations	PRODUCERS_ ASSOCIATIONS	Producers_associations:asai		*hay asociaciones de asaiseros, de castañeros ... , pero de los demás no hay.*
		Producers_associations:majo		
		Producers_associations:motacu		
		Producers_associations:palma_ real		
Value chain connection	VALUE_CHAIN	Value_chain:asai	Value_chain:deficient_connectio n	

		Value_chain:majo	Value_chain:good_connection	*No hay buena conexión entre procesadores y comercializadores, son aventureros, no hay un mercado nacional que se haya identificado y que venga y diga que compra toda la producción de Pando, hay comerciantes esporádicos*
		Value_chain:motacu		
		Value_chain:palma_real		
Road conditions	ROAD_CONDITIONS			*En Pando 90% de las carreteras son de tierra, incluso las que nos une con otros departamentos están en construcción todavía*
Infrastructure	INFRASTRUCTURE	Infrastructure:asai	Infraestructure_defficient_conditions	
		Infrastructure:majo	Infraestructure_good_conditions	*Varía por organización, muchas de ellas como la nuestra tiene ya las condiciones adecuadas desde un área de recepción de repente hasta una cámara de almacenamiento en la cámara de frío para el congelado*
		Infrastructure:motacu		
		Infrastructure:palma_real		
Processing level of difficulty	PROCESSING_ METHODS	Processing_methods:asai		*Es principalmente ablandar las frutas y después se lo despulpa, entonces es lo que le llaman sancochar*
		Processing_methods:majo		
		Processing_methods:motacu		

		Processing_methods:palma_real		
	PROCESSING_DIFFICULTY	Processing_difficulty:asai		
		Processing_difficulty:majo		
		Processing_difficulty:motacu		
		Processing_difficulty:palma_real		