SUSTAINABLE COFFEE FOR SAN MARTIN

Reinventing the agricultural value chain through cooperatives and agroforestry

Virtual Field Trip 2020

4550 words

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Abbreviations List

AGROBANCO = Agricultural Bank in Peru
CCSI = Columbia Center on Sustainable Investment
CENAP = Centro Nacional de Administración Pública (Perú)
CEPLAN = Centro Nacional de Planeamiento Estratégico
COCLA = Organic Coffee Cooperative in Peru
CUSAF = Cessions in Use for Agroforestry Systems
ECOALDEAS = Peruvian business focused on local sustainable development
FAO = The Food and Agriculture Organization of the United Nations
GCF = Green Climate Fund
GDP = Gross Domestic Product
GFDRR = Global Facility for Disaster Risk Reduction and Recovery
ICO = International Coffee Organization
ILO = International Labour Organization
NGO = Non-governmental organization
NORAD = Norwegian Agency for Development Cooperation
PRODUCE = Ministerio de la Producción (Perú)
PEN = Peruvian Sol (National currency of Peru)
R&D = Research and Development
SBGF = Sustainable Global Biomass Fund
UED = Urban Economic Development
UNDP = United Nations Development Programme
USD = United States Dollar (Currency)
USAID = United States Agency for International Aid
UTZ = Non-Profit Organization for Sustainable Farming

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1. Introduction

Coffee is an important factor of the economy of Latin America. In Peru, coffee is one of the main export goods, and provides employment for coffee farmers, more than 80% of whom are smallholder plantation owners (Morris et al., 2017). However, the growing global demand of coffee has put a considerable pressure on farmers and the economies that produce it. Due to price fluctuations and limited access to supply chains or markets, smallholder farmers face growing social and economic problems.

In addition to these challenges, environmental problems caused by climate change and urbanisation processes contribute to the growing pressure that coffee farmers experience. The negative consequences include diminishing natural resources, growth of crop plagues, deterioration of the ecosystem. Despite its important value to the economy, unsustainable coffee production also contributes to deforestation and the degradation of soil and water, which perpetuate the damages in biodiversity and the environment.

As an alternative production system that has the capacity to combat both socio-economic and environmental problems, this paper proposes the upgradation of coffee value chains based on Brundtland's (1987) sustainable development model. The research conducted by the authors puts these problems into context in the department of San Martin, one of Peru's primary coffee producer regions that has suffered tremendously from agriculture-led environmental degradation.

The first chapter introduces the socio-economic and environmental context for coffee in Tarapoto, followed by a literature review on cooperatives, agroforestry, sustainable development, regional policy and coffee supply chains. The paper then introduces case studies, one from Nicaragua and one from Guatemala, which will be used as benchmarks to inform our recommendations for San Martin. The report concludes with recommendations from the authors.

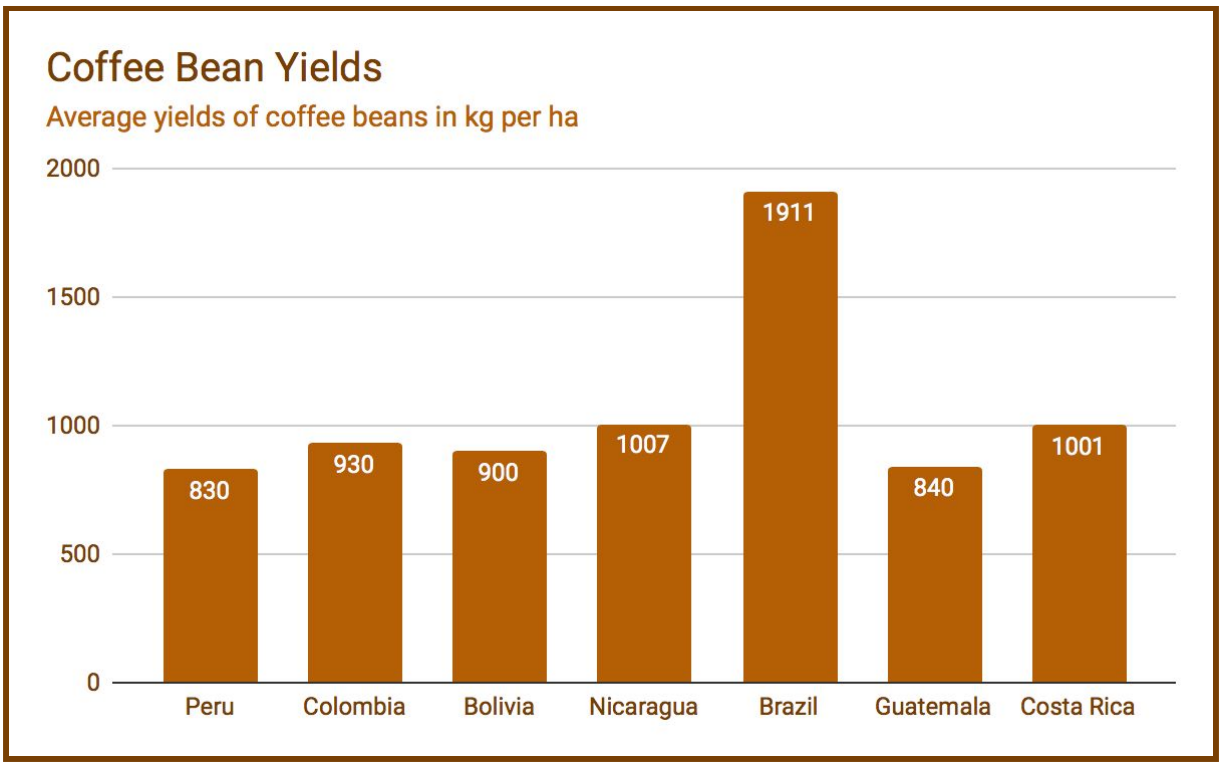
2. Context

The Department of San Martin accounts for 22.2% of the national Peruvian coffee production, of which San Martin province produces 1.4% (Morris et al., 2017). Tarapoto is located in the northern Peruvian Selva region, in which farmers grow coffee and cocoa, making up San Martin's two major export commodities. Typically produced is the Arabica coffee bean, which can be harvested in the summer months, bringing in an alternative source of income for farmers who produce cocoa in the spring and fall months (World of Coffee, 2019). While cocoa is being increasingly processed locally, coffee largely functions as a cash crop export product for Tarapoto's farmers.

2.1 Economy

80% of the world's coffee is being produced by 25mn smallholder farmers (Fair Trade, 2019). In the San Martin region, coffee is expected to create an additional 18,553 jobs in the next ten years. The added value of producing coffee will be 378mn PEN, which is close to 117mn USD. Under the national policy plan of 2018, coffee is expected to have a promising future in San Martin. An 80,000 hectare expansion of plantation will guarantee new opportunities for smallholder farmers, agri-businesses and coffee traders. An investment fund of 70mn USD has been ensured by the Agrobanco (Oxford Business Group, n.d.). Yet, challenges for the coffee industry remain. The average crop yield production is only 830kg per hectare, compared to the Brazilian average of 1911kg per hectare as seen in Figure 1 below (Oxford Business Group, 2018). 24% of the Peruvian labour market is dependent on coffee farming and export, as the agricultural sector makes up 5.3% of the Peruvian GDP. According to the ICO, Peru is the 9th largest coffee producer worldwide with 223,902 families involved (World of Coffee, 2018). Domestic coffee consumption remains at 10%, mainly purchased as a lifestyle product by the younger population, however increasing as income per capita grows (Morris et al., 2017).

Figure 1. Crop Yield Productivity of Coffee Beans in Latin American Countries



Data retrieved from Oxford Business Group (2018)

2.2 Society

There are large inequalities between agri-business landowners and smallholder coffee farmers. As 80% of the Peruvian economy is informal, smallholder coffee farmers are not issued credits by private Peruvian banks (Morris et al., 2017). No access to rural credit and limited right to the farming land leaves the existence of many coffee families fragile and dependent on cash crop farming. 47,000 farmers have limited means to use farming technology and earn between 1.30 and 3.90 USD a day on the brink of the absolute poverty line as seen in Table 1. (Carto, 2019). During an interview with agricultural engineer Ginsberg Rodriguez, he explained that Tarapoto is in need of rural workers as many young people migrate to the city to conduct mototaxi jobs, gaining more income (2020).

Table 1. Coffee Farmers living in Relative or Absolute Poverty

Country / (No. of Coffee Farmers)	Living under 3.10 USD a day	Living under 1.90 USD a day	Farmers living in relative poverty
Peru (202,000)	**47,000**	**16,400**	**21%**
Colombia (554,000)	**67,000**	**33,000**	**12%**
Nicaragua (43,200)	**3,700**	**943**	**9%**
Guatemala (175,000)	**54,000**	**19,400**	**33%**

Data Retrieved from Carto (2019)

2.3 Environment

As a consequence of cutting down 8 million hectares of tropical rainforest, which has contributed to an increase in global temperatures by 1.5 degrees Celsius, severe consequences can be identified for the future of the coffee industry (Conservation, 2019). Thus, deforestation in San Martin has been identified as one of the crucial issues to solve (see Deforestation Map in Appendix 3). The Arabica bean grows at an optimum temperature of 20 to 35 degrees Celsius, thus maintaining the humid and tropical Amazonian habitat is important to ensure Tarapoto's future coffee production (Plantopedia, n.d.). In the CCSI Report of 2019, the fraction of Arabica bean land lost by 2050 will amount to 2.69mn hectares in Peru alone, reducing suitable land by 50%. Therefore, it is crucial to increase land productivity. In San Martin, 6943 hectares of coffee plantations are currently productive, bringing in more than 20% crop returns. In line with the national policy plan, an additional 9739 hectares of coffee land have been renewed estimated to bring in only 10% crop returns (Unlocking Forest Finance, 2016). Several arguments can be pointed out as challenges in present coffee farming: 1. The usage of chemical fertilisers often seen in conventional coffee farming has led to an overconcentration of nitrates in the farmed soil, leading to erosion and acidification. 2. Only 20% of Peruvian agriculture uses drip irrigation, while traditional irrigation techniques allow coffee wastewaters to pollute rivers. 3. An increase in coffee leaf rust disease has affected crop returns in Latin American coffee industries. 4. Conventional coffee farming and supply chains lead to an increase in greenhouse gas emissions (Hivos et al., 2018). 5. Existing coffee plantations are prone to disasters such as landslides, acid rain, heavy El Niño rains and desertification of degraded tropical land (GFDRR, 2020).

3. Literature Review

3.1 Sustainable Development

The Coffee Barometer (Hivos et al., 2018) identifies sustainable coffee production as a crucial element for the preservation of the industry. Climate change undermines the suitability of coffee practices, bean quality and increases of plant diseases (Hivos et al., 2018). As our proposal focuses on sustainable coffee supply chains, one needs to define sustainable development. In reference to the Brundtland Report published in 1987, sustainable development is defined as meeting the needs of the present population without compromising the future generation. The report features a sustainability model that is made up of three categories: The economy, society and the environment.

3.2 Coffee Supply Chain

Our study needs to investigate the differentiation between traditional, export-based coffee supply chains and localized agro-processing. On a traditional basis, the farmer harvests the coffee bean which then will be sold to a private trader, a middleman who delivers it to the processing plant. After the coffee beans have been processed, a local exporter sells the beans to a foreign roasting company, usually larger conglomerates such as Nestlé and Lavazza (Hivos et al., 2018). The roasted beans are finally sold to a retailer who sets the final price point for consumers. In the traditional supply chain, smallholder farmers make between 30 and 50% returns from the export price, depending on the coffee bean quality. However, if the farmer processes the beans himself, he can cut the middlemen costs and sell directly to the trader, retailer or catering services, which can generate up to 90% returns for him (UK GOV, 2008). Alternative ways for farmers to increase returns and integrate into the supply chain include being part of a Fairtrade initiative, receiving Rainforest Alliance certifications and selling specialty coffee. Nevertheless, such Fairtrade coffee initiatives are rare compared to conventional coffee supply chains. In fact, only 20bn of 200bn USD export value worldwide is generated using green coffee initiatives (Hivos et al, 2018).

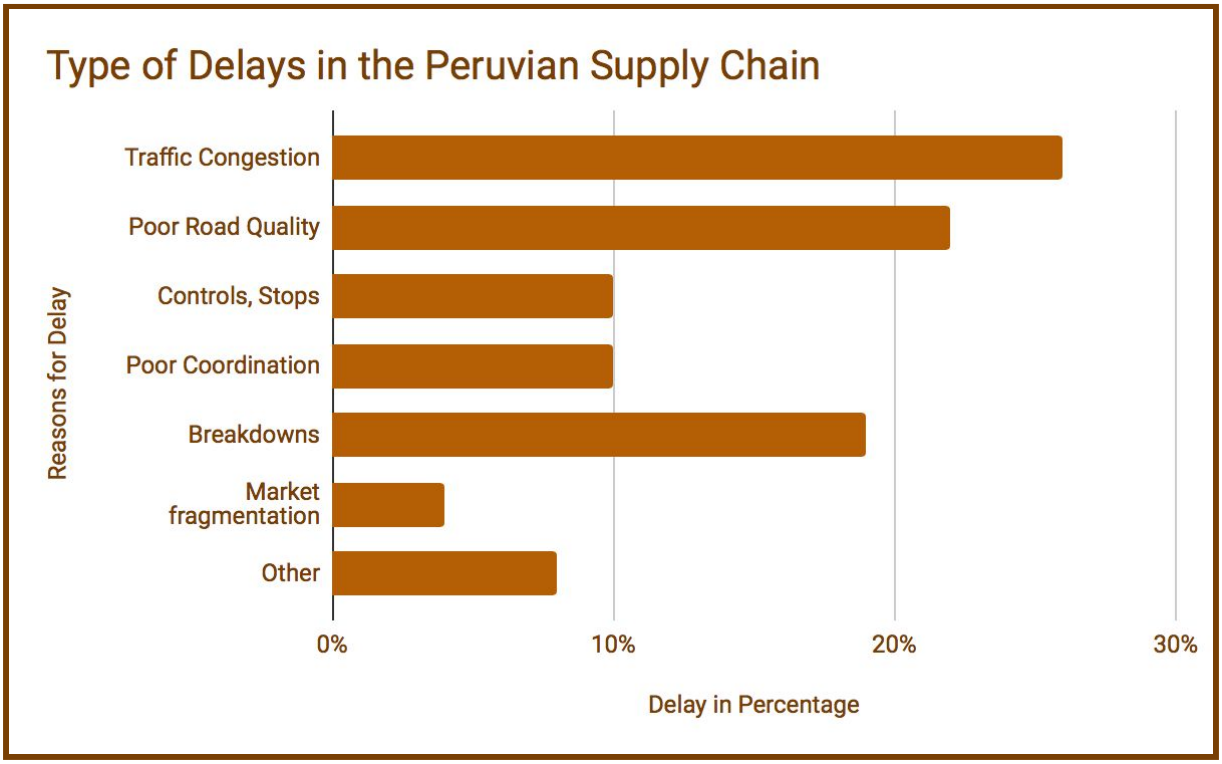
Peru's coffee supply chain has not reached an optimum in efficiency (see Figure 2. and Table 2.). Given the frequent transport delays, traffic congestion and deteriorating road infrastructure, Peruvian coffee supply chains struggle to compete with Colombian and Brazilian coffee exporters (Investopedia, n.d.). The renovation of highways and national roads is needed in order to guarantee timely coffee deliveries.

Table 2. Agricultural Supply Chain Delays in Peru

Corridor/ Products	Frequency of delays
North: Coffee, cocoa	26.9%
North: Grapes	25.2%
Center: Coffee, cocoa, quinoa	51.9%
South: Quinoa	50.4%
South: Onion, grape	4.8%

Data retrieved from Morris et al (2017)

Figure 2. Reasons for Delays during Transport



Data retrieved from Morris et al (2017)

3.3 Agroforestry

In 2018, more than 80% of San Martin's working population considered agriculture as their primary source of income (Municipalidad Provincial De San Martín, 2018). The development of cultivation systems is based on the ecological flooring, in which coffee is produced at higher altitudes. There are a number of problems related to production that were identified by Tenorio and colleagues (2014): over-exploitation of soil and resources, inefficient management of crops, and deforestation. Tarapoto, the third largest urban centre in the region is no exception. Its relationship with the forest and the

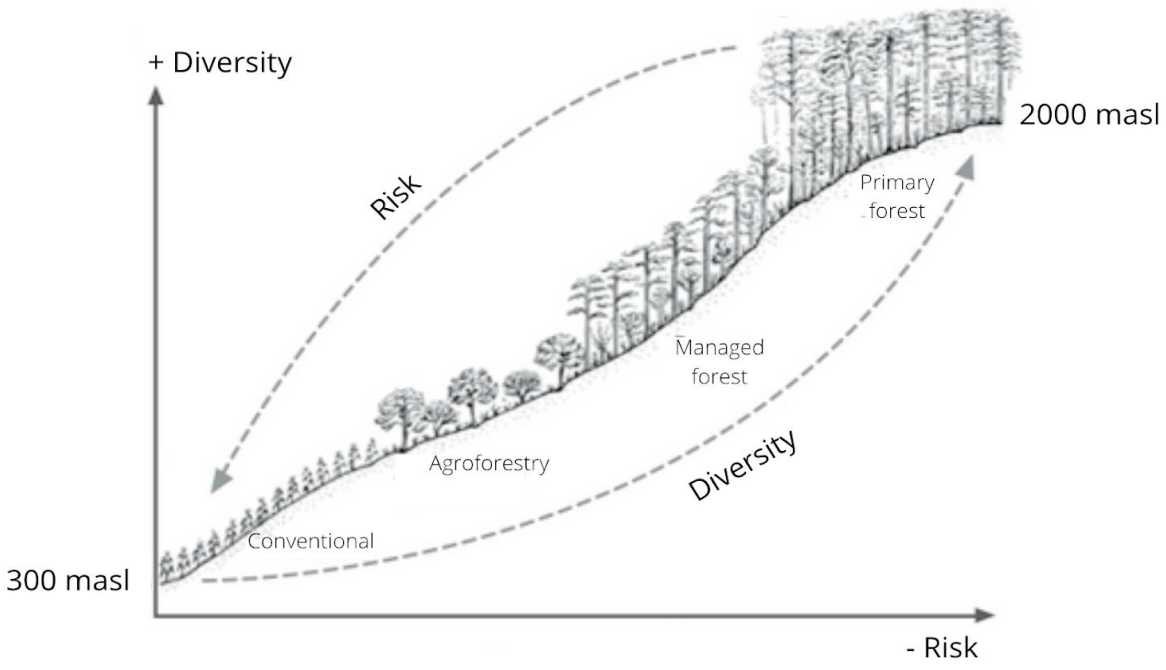
Cumbaza watershed underpins the local resource use dynamics. From 1977-2005, 58% of the forest cover was eliminated due to urbanisation, migration flows and agricultural expansions (Sabogal et al., 2018). The aforementioned trends combined with climate change-related pressures cause serious risks for water, food and energy security.

Until two decades ago, monoculture, or conventional agriculture, was considered an adequate system of farming. This system provided good yields and allowed for the rapid regeneration of ecosystems throughout the post-harvest period. Due to the rapid and high levels of agricultural migration since 2000 (Gallusser, 2007), the system had turned into problematic practice. Agricultural lands are not given sufficient time to regenerate and deforestation prompted by an increase of agricultural lands causing serious breakages in fragile eco-cycles (Dobie et al., 2020).

In contrast, agroforestry is a land management system that unifies and integrates biotic (crops, trees, animals) and abiotic (soil, water, air) factors to complement each other and to imitate the eco-equilibrium found in forests. Trees, bushes and palm trees fulfil an important role for both the farmer through the provision of basic necessities such as timber and food, and for the plants that are managed on the shared land, through the conservation of soil, incrementation of soil fertility and improvement of micro-climates (Jezeer & Verweij, 2015).

Agroforestry proves to be a valuable tool to combat the two most important climate change-related problems: intense rains and long droughts. During intense, elongated rainy seasons the fallen twigs and leaves shield the soil from the increased quantities of water. The cape is made out of leaves on the ground and acts as a filtration system. The excess water that remains on the surfaces of the leaves evaporates or channels to the bottom of the inclined surface. During long droughts, the same phenomena of cape formation supports humidity retention and decreases the amount of water lost to evaporation (see Figure 3.) (Tenorio et al., 2014). To maximise the aforementioned benefits, one must consider lands for agroforestry in close proximity to primary forests (Dobie et al., 2020; Jezeer & Verweij 2015).

Figure 3. Agroforestry land allocation model



Retrieved from Tenorio et al. (2014)

Due to its environment-friendly attributes, agroforestry allows the practicing of economically efficient productive activities in increasingly fragile environments in which natural resources are degraded. From an economic perspective, this balanced eco-diverse system, in which nature functions as the provider of shading, essential nutrients, water-storage and tends to reduce maintenance-related labour and other resource input costs, such as fertilisers and pesticides. The provincial government is committed to agroforestry, proposing public investment into the implementation of Cessions in Use for Agroforestry Systems (CUSAF), a mechanism for small farmers to have land tenure formalized as long as they commit to agroforestry, within the framework of the Forest and Wildlife Law (Municipalidad Provincial De San Martín, 2020). The combination of these factors lead to sustainable levels of production and increased quality of life. Thus, one can establish that the objectives regarded by agroforestry are not only ecological, but economic and social.

3.4 Cooperatives

Smallholder farmers are key to coffee production and a significant source of rural employment. However, they suffer from fragmentation and low capacity for production and negotiation, thus tend to receive low prices or be excluded from the value-chain (Najera, 2017). Organisation of smallholder

farmers into producer cooperatives can increase their productivity and sustainability, as well as improve their bargaining position (ILO, n.d.). Cooperatives act as an association and enterprise through which members can benefit from economies of scale and integrate into the value chain by selling their products collectively; cutting out intermediaries and promoting their common interests. Cooperative farmers can achieve better access to markets, knowledge transfer and financing. Cooperatives can also contribute to formalization of the informal economy, obtaining legal recognition if they register as formal enterprises (ILO, n.d.).

The San Martin provincial government recognises the importance of strengthening cooperatives in its Plan de la reactivación económica en la región San Martín (2020), which aims to extend services linked to value chains to small independent producers. Hernan Pinedo Flores from the provincial government explained producers are encouraged to organise into cooperatives, as this provides a mechanism for delivery of technical assistance and ensures spread of adoption (2020). The 2019 UED report (Roche et al., 2019) confirms this, however it also found that farmers are often reluctant to join cooperatives due to risk-aversion and lack of trust. Currently, only 6% of poor agricultural producers in Peru are members of cooperatives (Morris et al., 2017).

The first coffee cooperatives began to form in the region at the end of the 1990s, as a result of anti-coca cultivation policies promoting alternative development (Municipalidad Provincial De San Martín, 2020). The Oro Verde cooperative was formed in 1999, which remains one of the largest cooperatives (Rikolto, n.d.). Since the 2016 leaf rust disease outbreak, Oro Verde has also diversified into cocoa to hedge against climate and market risks. It is now composed of 1203 coffee and cocoa producers. Oro Verde has Organic, UTZ, Rainforest alliance and Fair Trade certifications (Oro verde, n.d.). Certification allows farmers to achieve fairer prices, as well as environmental sustainability (see table 3). Rainforest Alliance works extensively with its certified coffee cooperatives in San Martin, including through agronomic training for better quality and sustainable crop production and linking farmers to buyers (Rainforest Alliance, 2020). Ramos Palomino and colleagues (2017) found that coffee farmers in San Martin cannot get consistent high quality coffee or certification outside of cooperatives. To further its development in 2017, Oro Verde started working with the NGO Cuso International as part of the ILO's My-Coop initiative, which was tailored to the provincial level (ILO, 2017). My-Coop offers a management training programme for cooperative leaders who are encouraged to disseminate their learnings in their respective cooperatives. The fairtrade certified second-tier cooperative COCLA in Southern Peru has created a local brand based on its coffee (CLAC, n.d.). It initiated COCLA TOURS, a tourism co-operative that leads excursions towards Machu Picchu on the path of coffee aroma.

Table 3. Economic comparison between organic and conventional coffee

Description	Conventional coffee	Organic coffee
Productivity (qq/ha)	9 qq/ha	15 qq/ha
Plots (ha/producer)	1.5 ha	2 ha
Sale price ($ /qq)	$ 57.00	$ 86.00
Production cost ($ /qq)	$ 33.00	$ 43.00
Profit ($ /qq)	$ 24.00	$ 43.00
Fair Trade ($ /qq)*	$ 0.00	$ 20.00
USDA Organic ($ /qq)*	$ 0.00	$ 30.00

* The certification provides a plus prorated among partners

Source: Interview CEO Cooperative CAPEMA [18]

(Reprinted from Ramos Palomino et al., 2017, p. 12)

Cooperatives often obtain external financing from the government or NGOs, in addition to member contributions (ILO, n.d.). Cooperatives can enable farmers to access micro-financing for agricultural inputs and investment. Donovan, Blare and Poole's 2017 report on agri-cooperatives in Peru found they would benefit from improved access to financial services. The Aprocassi organic coffee cooperative in the San Ignacio province of Northern Peru has a successful microcredit department called Aprocredit, which allows its members to take out loans worth up to 70% of their harvest (Oikocredit, 2019). This is through a partnership with Oikocredit, an international cooperative investor. Since partnering with Oikocredit in 2012 the cooperative has grown from 150 members producing 7,000 sacks of coffee, to 450 members producing 25,000 sacks of premium coffee a year. Oikocredit also works in San Martin, having a partnership with Indupalsa, a local palm oil processor, since 2015. Aprocassi also has a Women's Committee, where the women not only own land but also a cafeteria in San Ignacio (Oikocredit, 2019). Despite the advantages of cooperatives, Palomino and colleagues (2017) found that San Martin's organic coffee cooperatives had inefficiencies due to lack of knowledge and standardization in management, techniques and technologies, affecting quality (Palomino et al., 2017).

3.5 Public Policy

There is an existing economic development policy framework on both state and regional level. This study recognises the objectives of the nation-wide 2021 policy strategy, such as export diversification, increased value-added production and eradication of poverty (CEPLAN 2011; PRODUCE 2014). However, due to the report's focus on San Martin, the authors prioritise the more localised regional-level strategy established by the municipality of San Martin for the period of 2018-2030.

Special emphasis is put on the importance of the environment and the fight against deforestation. Therefore, the objectives outlined in the three key objective-facilitator strategies, which are Low-emission Rural Development, Declaration of Collective Intentions and Launch of UNDP, NORAD or GCF funds are first validated through their compatibility with the existing Ecological Economic Zoning of San Martin. The region's four primary objectives are improved access to basic & quality services, sustainable resource management, improved labour market outcomes, and improved quality of life.

Low-emission Rural Development prioritises sustainable production, preservation of existing productivity levels, and inclusion of smallholder farmers. The Declaration of Collective Intentions aims to encourage sustainable agriculture and cattle raising, reduce negative impacts of agriculture-led migration and urban expansion, and increase the perceived value of forests. The launch of development funds facilitates the improvement of quality of life, provision of environmental conservation areas and climate change mitigation of soil degradation (Municipalidad Provincial De San Martín, 2018).

3.6 Conceptual Framework

Figure 4. Framework for Sustainable Coffee Cooperatives and Agroforestry

Author's Own (2020)

The group has divided the conceptual framework into the three pillars economy, society and environment inspired by the Brundtland Sustainable Development Model (1987). Five key indicators were chosen for each pillar.

4. Benchmarks

4.1 Nicaragua

Existing cooperative initiatives in conjunction with Nicaraguan coffee smallholders can serve as an inspiration for Tarapoto's agribusinesses. Furthermore, there are also international incentives that are driven to make the coffee supply chain in Nicaragua more sustainable, involving coffee cooperatives. The Dutch government and Hivos have contributed funding to the Sustainable Global Biomass Fund (SGBF), which has developed an anaerobic biodigester for smallholder farmers (see Appendix 4 for more info) (Guardian, 2014). The technology can transform solid waste and wastewater through hydrolysis and decomposition of organic and inorganic substances into biogas energy, pure water and bio-fertiliser. The main aim of the biodigester is to treat wastewater created by the pulping process, so water discharge is less contaminated. The nutrient rich waste is a byproduct which can then be used as a natural fertiliser. In fact, levels of soil contamination had been reduced by 81.3% during the first harvest in a Nicaraguan coffee cooperative. The SGBF project had also positive side effects: Up to 1200 litres wastewaters per 100 kilograms of coffee, making up a net gain of 80% to conventional processing, had been saved by using the water pulping mechanism of the anaerobic biodigester (Guardian, 2014). The project and its immense farming benefits of reduced wastewaters, increased biogas production, increased crop yield productivity through renewable soils and nutrient rich bio fertiliser has gathered funding from UTZ. However, a disadvantage could be the price point of 20,000 USD per digester unit, which is unaffordable for most smallholders, thus requiring external funding. The initiatives presented in Nicaragua can be replicated in Tarapoto.

4.2 Guatemala

Funded by McDonalds, TechnoServe, an international NGO, implemented a five year training project from 2012 to 2017 to improve the productivity and sustainability of smallholder Arabica coffee farmers in three regions of Guatemala - Sololá, Chimaltenango, and Socatepéquez (Technoserve & McDonald's, 2017). The project helped the farmers to adopt sustainable agronomic practices, costing an average of $155 per year per participating farmer. The strategy included training in agroforestry and management of leaf rust disease, which has also affected farmers in San Martin. Technoserve found that low productivity was driven by poor farming practices and exacerbated by climate change and therefore training of smallholders was the best way to increase productivity. Hernan Pinedo Flores

from the San Martin provincial government highlighted that, "From this administration a major challenge is training and technical assistance of producers" (2020).

Technoserve's training model would typically be aimed at cooperatives, however Guatemala had few cooperatives due to various institutional issues (Technoserve & McDonald's, 2017). Therefore, producers were targeted directly. Similarly to the My.Coop model of training implemented by the Oro Verde cooperative in San Martin, a key part of the programme involved recruiting a large base of teachers from the community to lead the group training of smallholder farmers. Technoserve worked with the local governments to identify potential community trainers, prioritising those with social and language skills over experience with coffee, such as school teachers. Out of the 61 trainers chosen, 18% were women and two-thirds were under 35. The community trainers were then educated in the teaching methodology and agronomic techniques by a small team of experts including eight professional agronomists. It was through the community trainers that potential participants were found, and "farmers came to the initial trainings mainly because they knew and trusted the community trainers" (Technoserve & McDonald's, 2017, p.17). The use of community trainers boosted impact by promoting attendance and effectiveness of training and achieving cost-efficiency. Training was implemented through Technoserve's farm college model which combined monthly small-group instruction, using only visual material, with hands-on learning through demonstration plots. The demonstration plots on coffee farmland provided visual evidence of the success of the techniques and promoted adoption. Participants received a diploma at the end of the two years training which later helped them obtain certification (Technoserve & McDonald's, 2017).

The impact of the project was significant, exceeding original targets (see Table 4). Despite widespread leaf rust disease and a changing climate, average crop yields of participating farmers increased by 45% while incomes grew by 35%. The project was highly cost efficient, with a return on investment of $4.60 per dollar invested. This impact is expected to continue long term as the community trainers can contribute to knowledge spillovers. Farmers' best practice adoption rate was relatively high at 82%. Farmers were most reluctant to adopt use of pesticides, but were more open to cheaper organic methods. The main barrier to higher productivity however was the lack of affordability of more resistant coffee varieties (Technoserve & McDonald's, 2017).

The project contributed to women's empowerment. 57% of training attendees were women, many of whom said their communication and participation in livelihood decisions was improved. It also created a foundation for building formal cooperatives out of the informal, trust-based groups which grew out of teamwork among the participating farmers. The case demonstrated that small low-cost

changes in production practices can generate significant results. Technoserve proposes the model can be scaled up and implemented in other Latin American countries. The organisation has previously worked with the Peruvian government in San Martin in partnership with USAID to build a sustainable cocoa value chain (Technoserve, 2015). Technoserve found the regional government's support was essential in helping communicate to farmers that farming is a business which requires investment. Technoserve contended that future interventions supporting the value chain should be increasingly led by the national and regional government, including "delivery of technical assistance, organizational strengthening, and market access" (Technoserve, 2015, p.29).

Table 4. Technoserve Project Results

Indicator	Project Goal	Actual results
Farmers reached	12,000	**15,129***
Participation by women	35%	**57%**
Average increase in yield	25%	**45%**
Average increase in net coffee income	25%	**35%**
Adoption of best practices	75%	**82%**
Attendance at least 50% of training sessions	70%	**84%**
Increase in food crop yields	25%	**30%**

(Note: *represents over 12 percent of the country's total coffee producers. Revisualized from Technoserve & McDonald's, 2017)

5. Recommendations

5.1 Agroforestry

Agroforestry proves to have an enormous potential to reach the region's economic development and environmental protection objectives. Although the benefits can be significant, one must identify the preceding conditions and requirements for the successful implementation of these practices (see Appendix 1 for strategy).

Technical education and assistance for local farmers is essential to reach the desired levels of productivity. It includes knowledge about the species that are compatible with coffee production in shading and management of trees. As seen in Guatemala, strategically implemented training programmes that involve local leaders can successfully address the social and economic challenges that local farmers face (see Appendix 1 for strategy).

The authors encourage future research on the long term effects that agroforestry and the cultivation of shade-grown plants have on productivity levels and the environment. In this context, more knowledge is required on techniques that support the mitigation of crop plagues and protection of lands from environmental damages (see Appendix 4 for more info). In addition, for farmers to maximise potential of their small plots, the introduction of sustainable fertilisation methods is encouraged, in which the SBGF bio-fertiliser initiative established in Nicaragua can serve as an inspiration to Tarapoto (see Appendix 1 for strategy).

To improve productivity levels and maximise farmer capabilities, region-wide investment into infrastructure is recommended, with a special focus on sustainable agricultural practices, and those that are geographically segregated from existing coffee supply-chains and markets (see Appendix 1 for strategy).

In order to increase the equity of smallholder farmers, municipal-level effort should be put into the protection of land rights and protection of the existing ecological economic zoning, including through continued investment in CUSAF (see Appendix 6 for strategy evaluation). The introduction of regulatory frameworks including nation or region-wide certification programmes for agroforestry can further enhance smallholder farmer capabilities and support their integration into global value chains.

5.2 Cooperatives

Cooperatives provide many benefits to smallholder coffee farmers, thus the provincial government should continue to encourage and strengthen their development. Smallholders would benefit from increased access to credit, which should be targeted at cooperatives. Although Peruvian banks do not offer microfinancing for smallholder farmers, other organisations such as Oikocredit have successfully created microfinancing schemes for cooperatives such as in the case of Aprocredit. The provincial government could set up a Common Cooperatives Fund, in partnership with Oikocredit, offering loans to farmers. This ensures farmers can invest in the productivity and sustainability of their land (see Appendix 2 for strategy).

Another important issue is inclusive labour and scaling up of training, which will help address problems of poverty and low productivity. Technical training should be aimed at cooperatives of women and young people especially. This will help with the problem of rural-urban migration to Tarapoto, and achieve upskilling in human capital. An agroforestry-focussed training scheme using community trainers, as seen in the case of Technoserve in Guatemala, can be used to create informal groups of farmers not existingly in cooperatives, creating the foundations for formal cooperatives to develop. In order to strengthen supply chain efficiency of cooperatives, the government should encourage expansion of the My.Coop initiative, which has already been tailored to San Martin. Supply chain efficiency also requires improving infrastructure such as roads, however this is an expensive intervention (see Appendix 2 for strategy).

Cooperatives should be encouraged to obtain certification, which will help them achieve higher prices on the international speciality coffee market. The provincial government could partner with Rainforest Alliance to provide them with a list of cooperatives. An agroforestry-focussed training scheme led by the government, potentially with Technoserve, could result in local certification, creating a San Martin brand (see Appendix 2 for strategy).

Overall, these strategies require a long-term outlook, which is difficult for farmers struggling with poverty, low productivity and small plots of land. Furthermore, it relies on the willingness of farmers to participate in training and be open to new practices (Hivos et al., 2018). However these recommendations are based on rigorous analysis of the context of San Martin and successful cases from Northern Peru and internationally (see Appendix 7 for strategy evaluation). They have potential to have significant impact in the advancement of the Sustainable Development Goals.

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Appendix

(1) Recommendations for Agro-Foresting in Tarapoto: Strategy Map

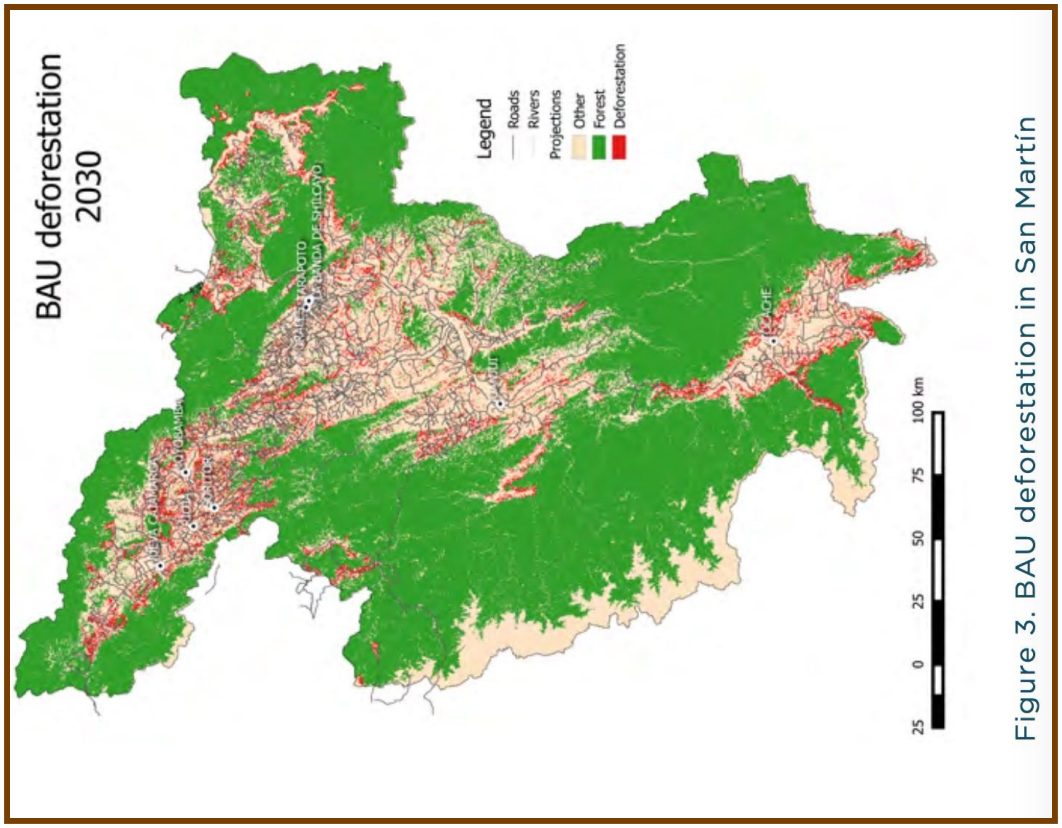
ISSUE	PROPOSAL	IMPLEMENTATION	MAIN IMPACT
Loss of Fertile Land	1. Biodigester 2. Bio-Fertilizer (Animal and Bacterial)	1. UTZ 2. HIVOS 3. GSBF	1. 81% less soil contamination 2. Reduced Wastewater
Unequal Land Tenure	1. Smallholder Land Rights 2. Indigenous Land Rights	1. CUSAF Policy 2. Rainforest Alliance	1. Formalising Smallholder Land Rights 2. No expansion
Environmental Degradation	1. Agro-foresting Certifications 2. Education and Training Plan	1. Technoserve 2. Reforest Action 3. ECOALDEAS	1. Reforestation 2. Microclimate preservation 3. Higher Yields

(2) Recommendations for Cooperatives in Tarapoto: Strategy Map

ISSUE	PROPOSAL	IMPLEMENTATION	MAIN IMPACT
Smallholder Funding	1. Common Cooperatives Fund 2. Private loans	Macro: 1. Oikocredit Micro: 1. Aprocredi	1. Income Increase 2. Access to funding
Inclusive Labour	1. Technical Training 2. Rural Women Cooperatives	1. COCLA 2. Wind Of Change 3. Technoserve	1. Upskilling in Human Capital 2. Fairer Wages 3. Job Security
Supply Chain	1. Smallholder Processing Plants 2. Local Brand 3. Infrastructure	1. Rainforest Alliance 2. My Coop 3. Municipality 4. G.C.F.	1. Domestic Returns 2. Producer surplus for smallholders

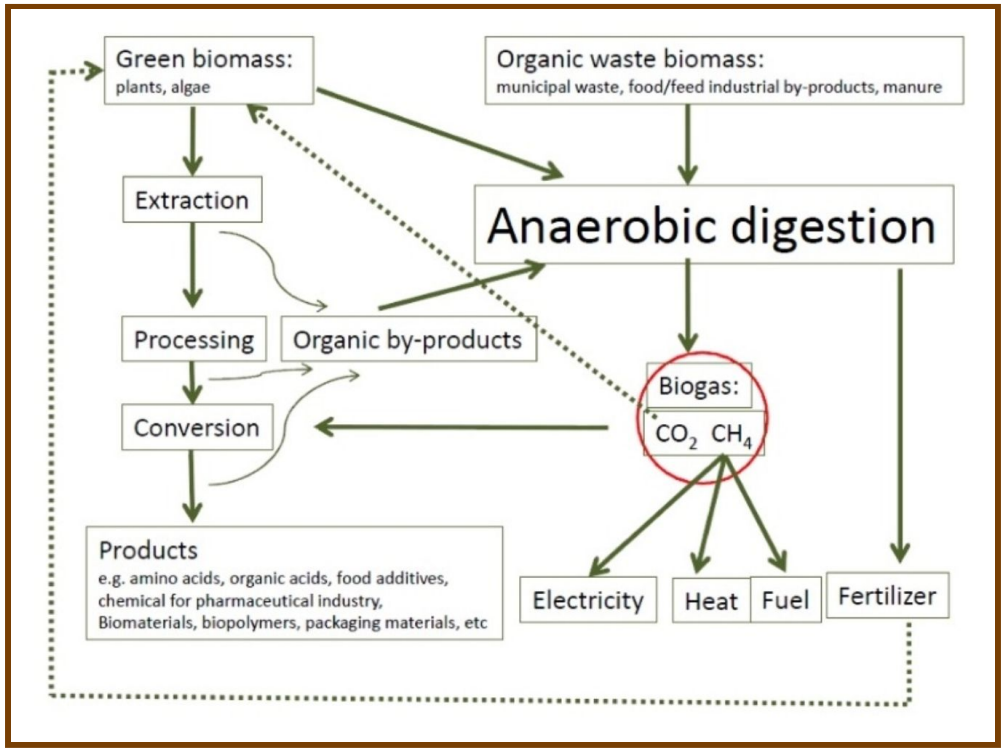
Author's Own (2020)

(3) Deforestation Map: San Martin Department



Retrieved from Unlocking Forest Finance (2016)

(4) Bio-Digester: Scheme



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(5) Environmental Threats for the Coffee Industry

Limited Use of Sustainable Fertilization and Post-Harvesting Techniques	Nitrate-based fertilizer leads to soil erosion and acidification
Deficiencies in the management of waste-water	Traditional irrigation techniques, only 20% is drip irrigation, polluted rivers (Ginsberg)
Increased Incidences of Diseases	Traditional Coffee Farms are spreading bugs
Increase in GHG Emissions	Deforestation and coffee transport supply chain
Increased Risk for Natural Disaster	Landslides, Acid Rain, El Nino, Desertification

Author's Own (2020)

(7) Strengths, Weaknesses, Opportunities and Threats of Cooperatives Strategy

(6) Strengths, Weaknesses, Opportunities, Threats of Agroforesting Strategy

Author's Own (2020)