Theory of Change for Sustainable Cacao in the Ecuadorian Amazon

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Paper for the Seminar: Towards sustainable cacao: assessing governance strategies and their theories of change, University of Bern

Fall semester 2022

Bern, 5th February 2022

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List of Abbreviations

PdI	Implementacion Plan for REDD+
ICCO	International Cocoa Organization
ATPA	Agenda de Transformación Productiva Amazónica
ToC	Theory of Change

Executive Summary

Ecuador is the biggest cacao exporter in America, however it still receives below average prices for bulk as well as fine flavour cacao. The government has in the past focused its effort in the cacao sector on the promotion of the native fine flavour variety Nacional, which opposes, the most cultivated, the high yielding and pest resistant CCN-51 variety. A theory of change (ToC) with the goal of sustainable livelihoods for cacao farmers through agroforestry in the Amazon is constructed in this seminar paper. The cacao sector is examined through the components of variety, agroforestry and post-harvest practices, as well as the market, which is characterized by highly volatile prices, whereby strengthening of cooperatives is proposed. The varieties compete in yield, flavour and resistances and receive certain price premiums, but these are found to be non-existent, which is why it is proposed to transition to cultivations with Nacional plants in a way that maintains farmers livelihoods. Agroforestry on the other hand offers ecological benefits, higher over-all yields and secures subsistence strengthening food sovereignty. Thus, agroforestry is proposed as a component and desired outcome of this ToC. The last component, with strong influence on the prices received by farmers, is post-harvest practices, like pre-drying and fermentation. For comparison and information on current efforts the REDD+ implementation plan for cacao, which aims at reducing deforestation and carbon loss due to degradation, was examined and used in the construction of the ToC. The activities proposed are training farmers in sustainable practices, provisioning of Nacional and resistant hybrid cacao plants and other plants for agroforestry association, provide training and infrastructure for pre-drying and fermentation as well as stock-centers and finally strengthen cooperatives and local manufacturers. Additionally, tourism could serve as an income diversitication and together with agroforestry food sovereignty could be strengthened. The selling of agroforestry co-products in fair markets is proposed too but innovative use of bi-products of the cacao plant were not considered and could increase revenue. Land tenure and monitoring are considered cross cutting components outside the scope briefly considered in the discussion. The outcomes in the short-term could be an increase in the bean quality, in the amount of fine flavour cacao, more food security and more efficient infrastructure and less transport costs. The expected outcomes in the long-term are sustainable ecosystems and practices, the possible selling of co-products, higher prices for Ecuadorian cacao due to the fine flavour and quality increase. Agroforestry and Nacional cultivations impacts the farmers revenue maybe at the expense of some yield in cacao, but co-cultivation and the strengthened food sovereignty make it an option for cultivating sustainable cacao while maintaining livelihoods and possible certification could increase the benefits. And the strengthening of cooperatives might impact the competitiveness of farmers, additionally the beans increased quality by post-processing methods, infrastructure and stock-centers could mean a higher prices for cacao from Ecuador, which would impact farmers revenues.

Introduction

"Theobroma comes from the Greek 'Food of Gods'."
- Tscharntke et al. (2020)

Theobroma Cacao L., the cacao plant, as the name implies is of high cultural value, it was and is used for more than 100 medicinal purposes but is also spiritually important (Tscharntke et al. 2020). The cacao plant which has its origin in the eastern equatorial region of South America, provides us with beans that are used to fashion chocolate and other commodities. The traditional uses and appreciation of this plant is based on millennial experiences and exchange (Ríos et al., 2017). New scientific inquiries, however, support some claims of medicinal benefits from chocolate (Rusconi and Conti, 2009), including research on model organisms that showed that chemical from chocolate elongate the lifespan of flies (Kanno et al., 2022). The genetical origin of the plant is in the southern Ecuadorian and northern Peruvian Amazon. It was domesticated by the ancestors of indigenous people called Shuar, who still inhabit the historical areas in which ancestral plants of the Nacional variety are expected to exist. This domestication of the cacao plant dates back more than 5000 years (Castañeda-Ccori et al., 2020; Tscharntke et al., 2022). Ecuador is the biggest exporter of cacao in the Americas, in Bulk Cacao the country exports 736'039'000 tons and in the specialty and fine flavour segment of the market it accounts for 263'274'000 tons. Compared to other countries however a lot of the sold beans are sold below the ICCO average price of 2781 US$ per MT and only the two highest categories accounting for less than 6% of the market get higher prices than the International Cocoa Organization (ICCO) average. The quality differentiation of cocoa is based on Standard INEN 176 which specifies five categories for Nacional cocoa and one for the CCN-51 variety. Ecuadors interventions mainly focus on the revival of fine flavour cacao from the Nacional variety. But other countries like Peru and the Dominican Republic export their cacao in only two qualitative categories (Rios et al., 2017). Therefore, Ecuador is not only a producer but the cradle of the cacao plant alongside Peru, Brazil, Bolivia, Colombia and Venezuela and as such these countries are central for the maintenance of genetic diversity of cacao.

The protection of genetic diversity is detrimental for protecting and breeding varieties with certain organoleptic traits, resistances to diseases and to climate change but also economic reasons influence the choice of plant variety. Beneficial traits that are selected in domestication compete with each other, as can be appreciated in the two main variants cultivated in Ecuador. The CCN-51 plants have a significantly higher yield and better resistance to diseases but their organoleptic properties are inferior compared to the native Nacional variety (Villacis et al., 2022) additionally native or wild varieties are well adapted to their biotic and abiotic environment, which is an opportunity to breed more climate resilient cacao crops. These competing traits also affect the farmers choice of which variant to cultivate, in Ecuador about sixty percent of the area for cacao cultivation is dedicated to the CCN-51 variant, whereas the rest is for the native plants (Tscharntke et al., 2022). In the case of Ecuador genetic erosion led to a downgrading in the quality of the cacao beans from Ecuador, which influenced the government to invest in the reintroduction and strengthening of the shade-grown fine flavour variant Nacional (Melo et al., 2013). Expected price-premiums for fine-flavour cacao compete with the higher yield and disease resistance of the CCN-51 variant and as generally small to medium scale farmers produce cacao, the government of Ecuador deemed the benefits from Nacional cultivation a

suitable development strategy to reduce the high rural poverty of 38.2% (Melo et al. 2013; Díaz-Montenegro et al., 2018). The importance of genetics for traits like resilience, taste and yield which influence the economic performance of farmers led to public policies that address the genetic erosion and but benefits from cultivation of native genotypes are limited.

The vulnerable position of farmers is a factor that pressures ecosystems because of extensive agriculture or as a driver of deforestation and biodiversity loss. The expansion of the agricultural frontier as well as extensive agriculture drive deforestation and forest degradation, therefore several public policies exist that address agroforestry and rural poverty. This is addressed for example by REDD+ Projects, that aim at stopping deforestation and land degradation as well as mitigating climate change through carbon sequestration (Nepstad et al., 2019). Another governmental intervention is the Project for the Revival of Fine Flavor Cocoa which exclusively addresses fine flavour cacao production and transition towards it (Rios et al., 2017) however such strategies are estimated to be insufficiently effective (Villacis et al., 2022). Agroforestry is an alternative to extensive cacao cultivation, which results in better ecosystem services and higher biodiversity (Niether et al., 2020) however the question remains whether such practices would benefit the livelihood of farmers. Given that these Projects are already being implemented, this paper will search for new insights that might be used to adapt and improve current efforts.

The farmers that cultivate cacao are often socio-economically vulnerable due to the unequal power relations of the commodity value-chain of cacao. The value-chain consists of the production and sale of the beans, semi-finished products and finished products that are then distributed and marketed (Ríos et al., 2017). The prices for bulk cacao are highly volatile as the beans are traded and speculated in London and New York futures markets from which mostly traders and big companies can profit (Purcell, 2018). Depending on the bulk market the fine flavour cacao prices fluctuate (Tscharntke et al., 2022). The market is asymmetrical and in favour of buyers and traders, this is due to vertical and horizontal concentration of actors, furthermore the main consumption of cacao products is in developed countries (Ríos et al., 2017). The market and actors can even be called oligopolistic. The attempt of farmers to cope and even profit from these market conditions can lead to lower quality beans because of rushed post-harvest rotation cycles which in the long-term increase vulnerability (Purcell, 2018). In this context it was found that post-harvest practices have a significant effect on the prices received by farmers (Villacis et al., 2022), additionally as cacao cannot be substituted and the demand is growing there is potential for farmers to increase their profits also by shifting towards specialty varieties and sustainable practices (Diaz-Montenegro et al., 2017). Nonetheless the mainly smallholder farmers are generally socio-economically vulnerable in this asymmetric market.

The target areas of this paper will be the Amazonian regions of Ecuador namely for two reasons, firstly because of the genetic origin and secondly because the deforestation pressures in these valuable ecosystems is relatively high. This paper introduces a theory of change (ToC) with the aim of reducing poverty and increasing sustainability in the Amazon region of Ecuador. Such theories and projects that target rural poverty and sustainability already exist in Ecuador, consequently these will be examined and used in the construction of the ToC. The main question will be whether agroforestry is an alternative that allows for a sustainable livelihoods of cacao farmers and what other complementary

activities would support this transition. These other components, besides agroforestry, belong to activities in the cacao market, the cultivated variety and post harvest practices.

Methodology

This paper will propose a ToC for sustainable cacao in the Ecuadorian Amazon. Theories of change are models or mental representations and theoretical assumptions that explain the effects of activities of an initiative. These models define goals, contextualize the situation and specify the activities as well as pathways for transformation. ToCs are used in science and make use of it (Oberlack et al., 2019). The goal of this ToC is to transform cacao cultivation sustainably for farmers towards agroforestry and determine other components that influence the livelihoods of farmers, that could support the transition.

The data for the construction of the theories of change are diverse but nonetheless limited as this seminar paper is only a literature review. Primary studies that conducted surveys with farmers, as Villacis et al. (2022) have done, are examined here. Although in this case the study focuses on the coastal region of Ecuador the farmers attitudes and strategies towards certain practices may be translated to the Ecuadorian Amazon, given that the national policies and interventions are similar. Studies from the Amazon region of Ecuador are considered as for example conducted by Castañeda-Ccori et al. (2020), Coq-Huelva et al. (2018) and others. Metanalyses for agroforestry (Niether et al., 2020) are part of this paper account but also primary studies. Such primary studies of agroforestry systems in the Amazon of Ecuador examined the systems performance and benefits and traditional systems of indigenous people (Jarrett, Cummins and Logan-Hines, 2017; Caicedo-Vargas et al., 2022). Studies of livelihood sustainability as Viteri Salazar et al. (2018) have conducted in two Amazonian provinces will inform the proposed theory of change as well. The underlying assumption is that the introduced literature and more could point out possible adaptations of a sustainability project in implementation.

There exist several government projects that target cacao production, which will also be used to inform the construction of a theory of change. These projects like the Agenda de Transformación Productiva Amazónica (ATPA) that are part of the REDD+ Implementations to reduce carbon loss due deforestation and degradation are examined in the implementation plan (PdI) for cacao (MAE, 2017; Nepstad et al., 2019). The Project for the Revival of Fine Flavor Cocoa which is analysed in a policy overview among other interventions by Rios et al. (2017) will also be included. These policy evaluations and overviews may prove helpful but on their own this data is at risk of ignoring the market conditions and possible improvements originating from the private sector, like certification schemes or direct trade relations (Cadby and Araki, 2021). The market conditions that shape income of farmers but also the agricultural practices will be examined, like the analysis of the bulk trade by Purcell (2018) as well as the Ecuadorian experience from 15 years in the fine flavor cacao in alternative food networks (Melo and Hollander, 2013) will be used to avoid creating ToCs that disregard the economic reality.

Limitations of this paper are the temporal and spatial heterogeneity of the selected literature but also the lack of primary sources, including an interview with a resource person as well as experience in the field. For the general activities and factors of the cacao production and market the REDD+ PdI for

cacao will serve as orientation as it is itself a theory of change (MAE, 2017). This might be considered a short-coming as the risk of copying without adding any new suggestions exists, nonetheless recent studies may still provide new perspectives on how to transform the cacao production and farmers livelihoods in the Ecuadorian Amazon towards sustainability.

Results

For the theories of change constructed and described in this part, the REDD+ implementation plan for cacao will serve as a rough blueprint and comparison (MAE, 2017), although some activities will be combined and others will be left out, according to the focus of the research question. The components of the ToC in this chapter will be presented as follows. First the varieties of cacao, their genetics and trade-offs will be analysed as well as the possibilities that these varieties pose for farmers to increase benefits. Secondly post-harvest practices and other local possibilities to increase benefits of cacao cultivation or processing are evaluated. Subsequently agricultural practices, their ecological impact and their relation to the farmers will be presented. The last component is the market, described in further detail below. In the discussion the situation of rural lend-tenure and indigenous rights for forest protection shall be examined together with other variables of the cacao sector not included in this ToC.

Genetics, varieties and traits

A possibility for farmers to receive better prices is by cultivating fine flavour cacao, which is characterized by its unique genetic make-up and flavour, therefore an activity for farmers in Ecuador to improve livelihoods could be the cultivation of the local fine flavour Nacional variety. As stated in the introduction yield, flavour and disease resistance are all encoded in the cacao plants genetics, subsequently the different varieties and their traits will be shortly summarized. CCN-51 is a sun tolerant and high yielding variety cultivated in Ecuador as opposed to the shade-tolerant fine flavour variety Nacional, which has been promoted by the government. CCN-51 yields nearly 4 times more than the Nacional variety (Melo et al., 2013). Nonetheless properly dried and fermented CCN-51 can be sold as fine flavour cacao. The markets categorization of cacao is defined by the International Cocoa Organization (ICCO), which only recognises two commodity categories namely bulk cacao and fine flavour cacao, however specialty cacao is an upcoming segment characterized by distinct flavours. There exist circa 10 genetic groups, which are traditionally classified into three varieties (Rios et al., 2017). Therefore, the binary categorization of the ICCO appears to insufficiently consider origin, flavour differences among other factors.

The Forastero type is the most popularly and extensively grown variety, the fine flavour and shade tolerant Ecuadorian Nacional variety belongs to this category. Criollo type is the second variety and the last variety is Trinitario, which is a cross-breed between Forastero and Criollo, the high yielding and resistant CCN-51 is part of this type. Besides exceptions, as for example the Nacional variety, fine flavour cacao comes from Criollo and Trinitario trees and the majority of bulk cacao originates from Forastero varieties. The specialty segment could be considered premium fine flavour as opposed to the

ICCOs fine flavour category, the prices for specialty cacao are also higher. Attributes of this new segment are distinct genetics, physical quality and origin (Rios et al., 2017; Cadby and Araki, 2021).

Ecuador has exclusively promoted the cultivation of the Nacional variety due to genetic erosion (Rios et al., 2017) however Melo and Hollander (2013) found that over a 15-year period the interventions favouring and promoting the local variety farmers still opted to cultivate the higher yielding CCN-51 variety. This is because the premium offered for Nacional did not compensate for the diminished yield as well because the prices received by farmers are roughly the same as for CCN-51. Consequently, farmers aiming at improving their livelihoods made far-sighted entrepreneurial choices in shifting cultivation to CCN-51. Furthermore, it was found that strategies focusing solely on fine flavour varieties are insufficient as they ignore the underlying problem of the markets inequality and that it is not always the case that buyers pay a premium for the Nacional variety (Villacis et al., 2022). Despite Ecuador being a main producer of fine flavour cacao a large proportion is sold below the ICCO price average. This is because a good part of the supply is deemed to be of poor quality (Rios et al., 2017). Nonetheless, replacing non-native plantations (i.e. CCN-51) by fine flavour cacao varieties to agroforestry systems with rejuvenation by clonal propagation and under medium canopy cover can guarantee a transition with slight gaps in productivity (Tscharntke et al., 2022). The strengthening of the Nacional variety and other clones is proposed because of the shade tolerance, possible price premiums for fine flavour cacao as well as because of other benefits from agroforestry systems, scrutinized in more detail below.

The agricultural research center of Ecuador INIAP is investigating the breeding of varieties and has already released two clones among others that maintain the high productivity of CCN-51 clones and have a high tolerance to frosty pod rot disease without losing the organoleptic qualities of the National-type (Jaimez et al., 2022). Another such variety is the Amazonian ‘Super Arbol’ ,which is high yielding (ca. 700-900 kg/ha per year), pest resistant and good quality Trinitario clone type (Burbano-Cachiguango et al., 2022). Production models that combine different varieties and crops need to be examined and transferred to farmers. As remarkably beans from CCN-51 clones show a better sensory profile when grown in combination with fine flavour varieties in the same plantations (Jaimez et al., 2022).

In the PdI for cacao research and establishment of gardens for breeding cacao plants, that are good in yield as well as in quality and flavour, are planned interventions. The second activity is the provisioning of these ‘certified’ plants namely the Nacional and Super Arbol variety but also other plant species for agroforestry systems. Another part of the plan is the establishment of schools that teach sustainable practices as for example plant-care, fertilization and pest control. The creation of pilot projects or farms is part of the PdI too (MAE, 2017). Seeing the limited profitability of fine flavour cacao the only additional proposition to the activities of the government would be the investigation and support for small-scale farmers to make the transition to Nacional cultivars in a way that maintains livelihoods and productivity, possibly through co-cultivation of two varieties. This would need to be examined in the pilot projects and could be promoted in policies similarly to Peru, which exports all its cacao as fine flavour. Expected short-term outcomes for fine flavour variety introduction and transition to such cultivars would be increased amount of fine flavour cacao, which

could internationally increase/restore the renown of Ecuador as a Cacao producer. In the long-term the recovery of the genetic variety of Ecuadorian cacao could translate into higher prices and revenue for farmers. This would diversify and strengthen farmers livelihoods depending on cacao. Negative impacts on farmers could be a temporary loss of productivity and an increase in off-farm work for income generation, which could have a negative environmental impact as in the Amazon such activities are often extractive, as for example mining. However, if the quality of cacao increases the revenue of cacao farmers in Ecuador would increase too and more farmers could cultivate two varieties.

Post-harvest practices and quality

Villacis et al. (2022) concluded after observing farmers behaviour and prices for CCN-51 and Nacional varieties, that the price premium for Nacional is non-existent but that farmers who ferment and dry the beans receive higher prices than those who do not. Furthermore, the climatic conditions mostly the high humidity for the Amazon regions in Ecuador is a limitation that affects the beans quality irrespective of variety. Post-harvest practices that had a positive effect on quality in these tropical conditions were pre-drying and fermentation. Although different fermentation methods exist the wooden box fermentation is the most favourable, because the turning and handling of the jute sacks is exhausting and needs at least two people. By adapting and practicing pre-drying and fermentation farmers would obtain cacao beans that meet national requirements or even exceed quality standards (Sanchez-Capa et al., 2022)

In the Ecuadorian coast, the most common fermentation methods are jute sacks, bearing or heaps, and wooden boxes (Burbano-Cachiguango et al., 2022). In a study in the northern Ecuadorian Amazon Burbano-Cachiguango et al. (2022) compared the wooden box fermentation to a newly developed semi-automatic fermentation method. They found that fermentation time was higher for Rohan (wooden) boxes but that quality parameters for higher quality fine cacao could be met irrespective of the fermentation method. Although CCN-51 is not a fine flavour cacao, cultivation method and post-harvest methods can significantly increase flavour and quality. Very recently, a controlled postharvest process for enhancing fine flavor attributes in CCN 51 has been proposed and with recent efforts to breed high yielding but fine flavour CCN-51 clones (Jaimez et al., 2022), the improvement of farmers livelihoods seems possible.

The PdI for cacao aims at strengthening infrastructure for schools or centres of technological innovation for cacao cultivation, fermentation and drying but also stock centers (MAE, 2017). The implementation of pre-drying and training of farmers in fermentation methods are activities proposed for this ToC as well, additionally the stock centers could improve the farmers market position as the beans could be stored depending on the prices of the market. In this sense short term outcomes would be improved bean quality and in the long term the farm-gate prices could be increased due to well fermented and stored beans. The impacts would be increased revenue and more sustainable livelihoods, consequently the pressure for expanding the agricultural frontier and employing unsustainable practices would be decreased. However, a perquisite is that the methods taught and material would need to be affordable for small producers.

Agroforestry, a sustainable agricultural practice

Niether et al., (2020) have conducted a meta-analysis comparing agroforestry to monocultures, which will be summarized as an introduction to show the benefits of this cultivation system. Although the direct yield from cacao agroforestry systems is on average 75% that of monocultural cacao cultivation, the total yield of all harvested crops in agroforests is circa ten times higher. Agroforestry has the potential to improve food security and decrease dependency on a single crop, which creates more resilience to fluctuations of prices and demand. As cacao is an export commodity it normally receives higher prices than other associated crops in agroforestry systems. However, despite lower income because of lower yield, it is estimated that cacao agroforestry is economically similarly profitable as monocultures. It was found that soil parameters are not significantly influenced by agroforestry as opposed to monocultures but have no negative impact on pest and disease resistance contrary to popular beliefs. But cacao agroforestry systems provide more stable microclimate and therefore climate change resilience. Furthermore, agroforestry contributes to climate change mitigation as on average agroforestry systems store 2.5 times more carbon than monocultures. Lastly biodiversity is significantly higher too in cacao agroforests (Niether et al., 2020). The food security and higher total yield are promising benefits from agroforestry systems and is therefore a component of this ToC for sustainable cacao.

The Chakra is a traditional agroforestry system of the indigenous Kichwa people living in the Ecuadorian Amazon, but other indigenous people as for example the Shuar also have traditional knowledge of agroforestry association, known as Aja. Unfortunately for both indigenous communities the benefits from cacao agroforestry are too small and inconsistent which does not allow them to depend on agroforestry systems as a main source of income. Opportunity costs imposed by organic markets are too high and because the amount of production is simply too low. Although examples of communities exist where organic cacao of fine flavour varieties is cultivated and associated with eco-tourism and chocolate promotion, the economic sustainability is questionable and has not replaced basic agriculture. In addition, alternative (off-farm) activities, like producing charcoal and mining are attracting more inhabitants because of urgent needs for revenue sources. Despite efforts to promote certain varieties for agroforestral association the main problems are the limited land tenure, which hinders them to rely fully on agriculture, and the disadvantaged position of raw producers in the value chain (Castañeda-Ccori et al., 2020). However, it was found by Santafe-Troncoso and Loring (2021) that traditional agroforestry, like the CHAKRA, have a symbolical and practical embodied meaning of food sovereignty for local people, in the Amazon region of Ecuador. The authors examined the Chakra Chocolate and Tourism Route in relation to food sovereignty of Kichwa people. This hints at the wide knowledge and practicing of agroforestry although mainly for subsistence. A strengthening of indigenous food sovereignty through Chakras, in combination with Tourism and fair farm gate prices for cacao and other crops could benefit all farmers practicing agroforestry or Chakras with cacao.

The difference between organic and conventional agroforestry with cacao as main crop for the environment and their economic performance for the Amazon region was studied by Caicedo-Vargas et al. (2022). It was found that conventional agroforestry had the larger negative environmental impact, whereby the main differences were found in fertilization and crop protection input. Organic

agroforestry had a lower environmental impact for energy use and efficiency along with less emissions and water use. The yield in both agroforestry types was higher than the average yield in the Amazon (250–440 kg/ha) but still lower than the average yield of Ecuador (621 kg/ha). The economic profitability for both systems is relatively low, however this could be improved by the selling of co-products (Caicedo-Vargas et al., 2022). Nonetheless monocultures despite their higher yield deplete the soil faster and loss of pollinators can significantly influence the production. Therefore, different production models that combine CCN-51 with shade trees or other crops must be designed, examined and transferred to farmers. Remarkably, mixtures of CCN-51 clones with fine-flavour varieties in the same cultivars have been found to improve the sensory profile of the bulk variety. But the co-cultivation unfortunately lead to the practice of mixing the beans of the different varieties, which forfeited the price premium for fine flavour cacao (Jaimez et al., 2022).

The PdI for cacao (MAE, 2017) aims at providing plants that can be associated for agroforestry systems with cacao. Strengthening of knowledge and technologies of fertilization and cultivar management for technicians and farmers as well as programs for pests with the focus on prevention rather than control. This would mean that synthetic chemicals would be less employed for pest control by trained technicians and farmers. Proposals for the ToC of this paper are therefore similar. Namely to support farmers transitioning from monocultures to agroforestry with species association, provision, rejuvenation and the creation of a market for agroforestry co-products as well as research and cooperation with indigenous people and farmers. Short-term outcomes of agroforestry promotion could be increased independency of farmers due to the subsistence aspect of these traditional land-use systems. In the long-term ecosystem services and biodiversity could be improved, diverse and well managed cultivation systems could result in competitive cash-crop yields. Finally, these activities should impact the farmers livelihood sustainability, increase income, if a market for agroforestry products is well established, finally monitoring could facilitate the certification, which would also impact farmers income. Such benefits could be additional subsidies or payment for ecosystem services from REDD+ for example.

Market

The benefits of the cacao value-chain are asymmetrically received by traders and producers situated in privileged ‘developed’ economic positions and not by the farmers. However, there exist possibilities for the disadvantaged farmers to improve their livelihoods and benefits from cacao cultivation. For example, cooperatives can increase the bargaining power of smallholder farmers, but in 2015 cooperatives in Ecuador accounted for only five to ten percent of total exports (Cadby and Araki 2021). On average cacao farms receive just about five percent of the total income in the cacao value chain and then transportation reaps 22.2% of the total value, which can be considered the first intermediaries after the farmers. The rest of the profit in the cacao value chain goes to traders with 33.4% and 38.9% is received by manufacturers and distributers (Rios et al., 2017). According to Purcell (2018) ‘’of the 115,000 small-scale cocoa producers in Ecuador only around 50,000 work through some form of association, buying union or cooperative. This leaves an estimated 65,000 non-associated small owner-producers, with an average of two hectares of land and some of the lowest levels of productivity in Latin America, directly exposed to a value chain which forces prices down

further at every node'' (p.920). The low level of participation is the reason for proposing strengthening cooperatives as an intervention in the market component.

In a study that compares types of farms depending on different crops for income generation, the defined categories were combinations of cacao and coffee, cacao only, oil palm combined with coffee and cacao as well as coffee only. There is a tendency that coffee cultivation is gradually being replaced by cacao and that only recently the palm oil production is gaining popularity due to subsidies and higher direct income. Although oil palm is generating the highest income (144 USD) surplus, the dependency on agrochemicals along with the highest detrimental environmental impact, dissuade the authors to recommend this production system for development. Additionally, the surplus of cacao and coffee production is lower (73 USD) as well as for cacao only cultivation (118 USD) and although coffee-only cultivation (122 USD) has the lowest environmental impact and dependence on off-farm income is the highest for this livelihood system (Viteri Salazar et al., 2018). Although cultivation of fine flavour varieties can bring a premium, immediate economic needs, low premiums due to quality deficits (lack of post-harvest practices) or too low yield for meeting the minimum tradeable quantities may force farmers to mix their fine flavour beans with bulk cacao. This mixing stimulates buyers to pay lower prices (Villacis et al., 2022).

Another possibility to create benefits for the farmers is through certification schemes. This is also envisioned for REDD+, where cacao produced in farms that are part of these land-use policies, would be deforestation free, improve carbon sequestration and reward conservation with payments for ecosystem services (MAE, 2017). Additionally, there exist private certification schemes too for ecological sustainability, as for example the Rainforest Alliance but also schemes for ethical sourcing as for example FairTrade. Such private sector models have created successful initiatives in Ecuador (Rios et al., 2017). Lastly another private sector scheme direct trade or sourcing can increase benefits for farmers as the transportation and trading intermediaries that receive about half of the value-chain profits are left out (Cadby and Araki, 2021). The strategies that focus on the business development can increase benefits however they are not independent of the variety cultivated and agricultural as well as post-harvest practices (Villacis et al., 2022) thus in this paper certification and direct trade are assumed to be outcomes or co-benefits of these dependent variables. But the strengthening of cooperatives and local manufacturing are activities of their own in this theory of change. The Ecuadorian PdI for cacao includes the strengthening of stock-centers, creation of innovation centers plus schools for cacao cultivation and processing as well as the creation of sustainable model farms, information systems for monitoring and subsequently certification. Promotion for Ecuadorian cacao in masses is also part of the PdI (MAE, 2017).

Short term outcomes through cooperatives could be better quality of beans through training members in practices that improve quality or by providing infrastructure for post-harvest- and stock-centers. This has been attempted by national initiatives for strengthening the Nacional variety but with limited success (Melo et al., 2013), nonetheless this could prove a possible intervention to increase farmers revenue. Additionally, the strengthening of local manufacturers could improve the trade relations and alternatives for farmers to sell beans at better prices, as the transportation costs would be lower, as well as the number of intermediaries. However, the local economy could prove to be too weak to

allow better prices for farmers. Because increased farm-gate prices do not necessarily translate into increased farmer welfare, and the cost of production will differ by local resource availability (Cadby and Araki, 2021). Long term outcomes of strengthening cooperatives, due to the low level of participation in these, could be higher revenues for farmers and possibly lower costs for participation in certification or direct trade schemes. Costs from certification arise because the certifying body must be paid and opportunity costs arise. These opportunity costs are the loss of yield due to abandonment of synthetic inputs, conversion to organic systems, additional labour costs and administrative costs, all these together may prove too high a risk for farmers looking to increase livelihood sustainability (Rios et al., 2017). As such costs for certification could be carried by cooperatives and the monitoring through projects like REDD+ for verification could transferred to agriculture, as is already done in the ATPA. Expected Impacts for strengthening cooperatives and supporting local production would be increased revenue from cacao cultivation, therefore more sustainable livelihoods and reduced pressure to push the agricultural frontier.

Discussion

The components for interventions of the proposed ToC in the Ecuadorian cacao value chain were cacao plant varieties, cultivation systems, post-harvest practices and the market. Cacao plant provisioning as well as other plants for agroforestry association, breeding of plants and the creation of pilot projects and schools are activities already being implemented by the different partners and projects described in the PdI for cacao (MAE, 2017). As mentioned before strategies that only focus on varieties, in this case the fine flavour Cacao from the Nacional variety are limited in success (Rios et al., 2017), nonetheless these interventions could have an impact on the price received by farmers for fine flavour cacao and subsequently improve livelihoods. The trade-offs from the different varieties mainly concern yield depending on shade-tolerance and disease resistance, these impacts on traits by genetics or environment should not be neglected. Planning and management can enable a shift towards shade-tolerant varieties with only with slight decreases in yield but additional ecological benefits (Tscharntke et al., 2022). Further, the research and breeding conducted in order to improve farmers livelihoods show promising results, as for example the creation of the Super Arbol variety, that is well suited for the Amazon region (Jaimez et al., 2022). All the components depend on each other to a certain degree. The cultivation of the Nacional variety does not necessarily imply a price premium as the bean quality is a factor that is considered in the pricing and this strongly depends on post-harvest practices (Villacis et al., 2022).

The Amazon has distinct climatic conditions to the coastal region in Ecuador, a humid climate that is detrimental to the storage and quality of beans and because of the possible price premiums, post-harvest methods like pre-drying and fermentation are a component of the ToC. The implementation of pre-drying and fermentation methods would lead to beans exceeding quality standards (Sanchez-Capa et al., 2022). Training farmers in innovation centres to practice these post-harvest methods, providing infrastructure and services as well as strengthening stock centres is part of the PdI for cacao (MAE, 2017) and is also proposed for this ToC. Because the benefits from fine flavour cacao cultivation are

low and the costs of shifting from the productive CCN-51 variant to Nacional are high, Villacis et al., (2022) proposes that only with post-harvest practices can price premiums effectively reach farmers.

The government support for shifting to the shade-tolerant Nacional variety in addition to the high deforestation rate in the Amazon hint to the attractive possibility of cultivating cacao in agroforestry systems. These systems have an even higher over-all productivity in the Amazon than monocultures (Niether et al., 2020) and in a study conducted for REDD+ in the Yasuní Biosphere reserve it was found that often the colonists as well as the indigenous people unintentionally practice agroforestry (Laoiza et al., 2015), which is not surprising as these sustainable cultivation systems for subsistence are traditional knowledge of the indigenous people. Increased yield of different crops, however, could decrease the income as for example minimum amounts for certain crops could not be met. Such minimum amounts are the reason that harvests of fine flavour cacao are not rewarded due to farmers mixing fine flavour with bulk cacao to reach minimum amounts and therefore receive lower prices (Villacis et a., 2022). Agroforestry should not be romanticized (Burgoa, 2020). Nonetheless, this cultivation system has various benefits, notably strengthening indigenous food sovereignty (Santafe-Troncoso, 2021). Thus, the support of the government or the private sector is important to create a fair market. These markets would have to buy cacao but also other crops at fair conditions unlike today. Further cooperation with farmers as well as research is needed to evaluate pest resistance and control in agroforestry systems. But as agroforestry is a traditional system that focuses on subsistence the independence of indigenous people could be strengthened.

The selling of bi-products of cacao agroforestry and the use of traditional waste like the pulp or the pod husk could be a possibility of income diversification for farmers. The pulp could be used for juices, beer and wine production among other uses (Guirlanda et al., 2021) and the pod husk could be used as feed for cattle, for cosmetic products or as bio-fuel, which could decrease the transportations negative impact on sustainability (Panak Balentić et al., 2018) these new and alternative uses of cacao are unfortunately not considered in the governments PdI for cacao as well as in this ToC, but are promising venues that the cacao market could adopt and commercialize. This can be considered a variable of the market component. This could increase income, reduce input and diversity farmers revenue.

Despite government support mainly focusing on genetics and varieties (Melo and Hollander, 2013; Rios et al., 2017), the strengthening of cooperatives is potentially a way to improve farmers livelihoods besides the local manufacturing of chocolate. Thus, the strengthening of cooperatives is part of the market component of this ToC. Not part of this paper were the Cadmium (Cd) limits of the European market as well as methods for reducing the Cd content in beans. The Cd content could be influenced by variety, cultivation method as well as post-harvest practices, generally the content decreased depending on acidity (pH) of soil or beans (Vanderschueren et al., 2020; Barraza et al., 2019). As Cd influences the accessibility to markets, prices and health further research is urgently needed in this area, however this aspect is considered in the PdI for cacao of Ecuador (MAE, 2017). Another advantageous quality of the CCN-51 variety, which is mainly being cultivated, is the lower accumulation of Cd as opposed to other clones (Jaimez et al., 2022).

The Amazon is characterized by climatic conditions that are detrimental to bean quality. Post-harvest practices, like drying and fermenting, are therefore essential for farmers to get increased prices for both CCN-51 and fine flavour Nacional cacao (Sanchez-Capa et al., 2022; Villacis et al., 2022) but eco-tourism, as for example the 'Ruta del Cacao' promoted by the provincial government of coastal Guayas in combination with sustainable cacao cultivation (Rios et al., 2017) or the Chakra Chocolate and Tourism Route, which strengthens indigenous food security of Kichwa people (Santafe-Troncoso and Loring, 2021) could be possible sources for income diversification in the Amazon. Furthermore, the importance of the Amazon for global climate change mitigation and as a biodiversity hotspot should not be forgotten, and although agroforestry has positive impacts, forest protection by programs like Socio Bosque, could provide attractive external revenues (Nepstad et al., 2019) at the expense of commercial cacao cultivation. But indigenous agroforestry systems are mainly used for subsistence. Nonetheless, tourism combined with cacao (agroforestry) could create more income. For this, as stated above, the cooperatives or buyers would need to guarantee the purchase of even small amounts of (fine flavour) cacao and other agroforestry crops as well as the payment of fair prices.

A Variable that is not examined in further detail for this ToC is the monitoring, because it is considered a cross-cutting component. Monitoring is an important aspect for verification, certification as well as for result-based payments, which are part of REDD+ and other Payment for Ecosystem Services programs. It also helps in spatial planning and is a tool that can be used for optimizing cultivation (Nepstad et al., 2021). More importantly monitoring allows to track the impact of interventions but as payments for programs that require monitoring have already been issued (Latorre and Bravo, 2022), these mechanisms were considered to be working well enough, although they could always be adapted. Because monitoring is often a perquisite for certification, certification schemes are viewed as outcomes of the interventions proposed in this seminar paper. Due to the monitoring systems already existing, these systems could facilitate the market entry to certification or direct trade for sustainable farms. But these certification schemes along with direct trade relations are considered to be components of the market, although in this ToC they are viewed possible outcomes. These market mechanisms can provide benefits to farmers but they often require investments and costs for compliance and monitoring for certification (Rios et al., 2017), this indicates that the interventions and changes need to be in place before an application to certification or direct trade schemes.

Lastly another cross-cutting component is the land tenure, it strongly depends on the high rural poverty, a symptom of the disadvantage in the value chain (Purcell, 2018) as well as on (post-)colonial hegemonies. Poor territorial planning, unsustainable policies and legal arrangements that favour the states extractivism are still in use despite the same government initially planning the REDD+ and other conservation programs (Latorre and Bravo, 2022). In the Amazon 32% of indigenous land tenure is still unrecognized (Laoiza et al., 2017) and in the context of agroforestry systems the main sources of income are still external from extractive processes like mining, which indicates that agroforestry is mainly used for subsistence and not as income source for rural livelihoods (Castañeda-Ccori et al., 2020). Furthermore, it remains to be seen how the Covid-19 pandemic in addition with the new neo-liberal government of Guillermo Lasso affects the livelihoods of farmers and indigenous people (Llaguno, 2021). But the situation seems bleak as people and organizations in the Amazonian province of Napo, due to unchanged policies concerning mining and its expansion, have declared environmental

emergency as well as actions to demand (environmental) justice (Mantuano, 2023). Unrecognized indigenous land tenure as well as the policy framework and the states impunity to expand extractive projects need to be resolved if the Ecuadorian Amazon is ever to have sustainable land-use practices, farmers escaping rural poverty and sustainable livelihoods (sensu Nepstad et al., 2021).

Conclusion

All in all, the ToC for cacao in the Ecuadorian Amazon has four components. The variety component, which determines flavour and yield but also post harvest practices are components that strongly influence the beans quality, flavour and consequently the revenue of farmers (Villacis et al., 2022). Thirdly the economically well performing monocultures of high yielding clones have a bigger ecological impact and more expenses, therefore agroforestry is a component of this ToC, for farmers to diversify their income, have more food security as well as increase ecosystem benefits (Niether et al., 2020; Burgoa, 2020). Although it should not be romanticized and regarded as infallible (Burgoa, 2020). There are hints and examples where ecotourism has strengthened cacao farmers livelihoods but still few actually earn revenues from tourism (Castañeda-Ccori et al., 2020) but as agroforestry is also practiced traditionally by indigenous people and others it is considered of symbolic and embodied importance for food sovereignty and culture (Santafe-Troncoso and Loring, 2021). The fourth component is the market, which is characterized by highly volatile prices (Purcell, 2018) thus the strengthening of cooperatives is a proposed intervention for this ToC, this could increase farmers bargaining power.

The proposed activities informed by the REDD+ PdI for cacao (MAE, 2017) are breeding suitable cacao varieties as well as providing cacao and other plants for agroforestry association and increasing and promoting Nacional cultivation. The creation of schools and innovation centres for teaching agroforestry, sustainable cultivation management as well as pest control to guarantee profitable yields. In these centres post-harvest practices could be taught and optimized as well, which would increase farmers revenues from cacao production and finally the strengthening of cooperatives along with local manufacturers could increase the bargaining power of farmers, skip intermediaries that all want to profit too from the value chain and boost the local economy. These are the proposed activities for the ToC briefly summarized.

Nonetheless there are barriers that, if not addressed alongside the activities proposed in this ToC, could prove detrimental for the Amazonian ecosystem as well as prevent the alleviation and abolition of rural poverty. These barriers include administrative aspects necessary for certification like monitoring, that would allow farmers to receive a price premium for fair or organic cacao cultivation (Rios et al., 2017). Furthermore, the market itself poses a barrier that cannot only be addressed by strengthening cooperatives and local manufacturers, as the highly volatile financialized market, is disadvantageous to farmers (Purcell, 2018). Similarly, land tenure and policies of the government favouring extractivism are also barriers that can pollute entire ecosystems indifferent on whether sustainable agriculture is practiced nearby. Therefore, this issue needs to be addressed politically, in for example the form of subsidies, aid, programs and policies as it is not only the environment that is

polluted but people that are poisoned. Nonetheless a lot of programs are being implemented like the REDD+ projects for cacao, the ATPA, the Project for the Revival of Fine Flavor Cocoa among others, these programs still need to prove their effectiveness. But with the current situation in Ecuador that still favours extractivism and the province of Napo now declaring an environmental emergency (Mantuano, 2023) frameworks and directional policies need to be worked out that strengthen Amazonian indigenous people and farmers while generating benefits and income with sustainable practices. Extractive practices, like mining and oil extraction should be minimized and only allowed with informed consent of the land-owners and forest dependent people likely to be affected by such projects. Ecuador is still a developing country from a western perspective, but efforts to fight rural poverty and to transform sustainably are present, which indicates a lot of potential but adaptability as well as continued and economic support are detrimental.

All the proposed activities depend on each other if they are to succeed in establishing sustainable land-uses as well as improve farmers well-being. The highly volatile prices for cacao depending on an international market (Purcell, 2018) are also depending on the quality of the beans, which can be improved through post-harvest methods like pre-drying and fermentation (Villacis et al., 2022) especially pre-drying brings benefits in the humid Amazon and can even improve the quality as well as flavour of CCN-51 (Jaimez et al., 2020; Sanchez-Capa et al., 2022). Furthermore, the prices for beans also depend on the variety of which CCN-51 a high yielding and disease resistant bulk variety and Nacional are the most prominent in Ecuador. Breeding efforts have, however already yielded varieties or clones, like the Super Arbol, with favourable organoleptic traits while maintaining high yield and resistances. The local climatic conditions and productivity of the Amazon are a barrier however as new varieties are provided and rural population often unintentionally practices agroforestry for subsistence, these processes may prove synergistic and favourable. Nonetheless agroforestry should not be regarded as a romanticized magic solution (Burgoa, 2020) but should be implemented cooperatively and improve farmers livelihood. For this the projects and pilot farms should serve as an orientation, in order to enable the advantageous implementation and smart improvement of intervention aiming at farmers well-being and sustainability.

All in all, agroforestry seems a promising cultivation system for the Amazon region of Ecuador, because of its higher over-all productivity (Niether et al., 2020), because of the strengthening of food sovereignty through subsistence and (Santafe-Troncoso and Loring, 2021) although it is not a fit for all solution (Burgoa, 2020), as the transition from monocultures to agroforestry or shade-grown (fine flavour) cacao requires investments and subsidies or support for small-to-medium-scale farmers is needed. The components that have an influence on farmers revenue and livelihoods are the cultivated variety, the pre-drying and fermentation as well as the market that dictates farmers revenues among other cross-cutting components like monitoring. The variety plays a role in the categorization of the beans, less so in the pricing, as the quality influences prices and is strongly dependent on the post-harvest practices (Villacis et al., 2022), thus the pre-drying and fermentation are the most important components besides agroforestry. Because the market influences the farmers income, this ToC proposes to strengthen cooperatives to increase revenue from cacao cultivation in the Amazon of Ecuador. Due to the government ongoing efforts to promote the Nacional variety, this ToC proposes to support farmers willing to transition to Nacional or agroforestry systems in a way that maintains yield

and livelihoods, through experiences and research on how to transition from CCN-51 to Nacional or co-cultivate and introduce agroforestry elements. The variety is important but good post harvest methods can even allow CCN-51 cacao to be sold as fine flavour cacao (Rios et al., 2017), therefore this ToC will not propose a single variety or clone to cultivate but proposes schools for teaching cultivar (agroforestry) management, disease control and possibly non-agricultural activities like tourism. Further research is needed and time will reveal how the PdI for cacao and other projects have impacted sustainability and farmers livelihoods in the cacao sector, as well as provide feedback for the ToC developed in this seminar paper.

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