## Annex 3. Project Cost and Financing Economic and Financial Analysis

This annex summarizes the methodology and results of the Economic and Financial Analysis (EFA) prepared for the design of the the Reduced Emissions through Climate Smart Agroforestry (RECAF) Project in the Central Highlands and South Central Coast of Viet Nam to support National REDD+ Action Programme goals. It describes (i) the models representing the costs and benefits of project investments and activities, (ii) the methodology and results of the financial analysis, (iii) the methodology and results of the economic analysis and the sensitivity analysis, and (iv) the limitations of the analysis.

### Description of models

Activity models compare the benefits with and without the project to quantify the overall impact of the several initiatives promoted through RECAF. A without-project (business-as-usual) scenario is compared to a with-project situation for each model. A model is considered viable if beneficiaries derive more profits following the project investments than without the project investments. The models focus on Component 2, in particular benefits stemming from the transformation of monocrop coffee and pepper to agroforestry systems, from changes to monocrop annual crops to fruit-based agroforestry systems, from improved management of bamboo plantations, from the transformation from short-rotation into longer-rotation acacia, from the production of speciality products, and benefits the proposed infrastructure investments. Component 1 focuses on creating the policy environment to support and sustain project activities and objectives, so the benefits of this component are not modelled separately.

Estimating the project benefits is a challenging task due to the complexity of the agroforestry models. These models, which involve multi-crop systems, make it more difficult to estimate inputs and yields. Furthermore, there is a general lack of knowledge of agroforestry systems in the project areas, which is why the project invests in agroforestry research. The activities in Output 2.3 are designed to innovate on forest management and Payments for Forest Environmental Services (PFES), but it is difficult to estimate what the lessons learned from pilots and new implementation models will look like at the design stage.

To circumvent these difficulties, the models often are more simplified agroforestry models with a couple of crops. A more complex model of coffee, longan, acacia, grass and soybeans is also modelled based on experience from the North West of the country, with some adaptations for the Central Highlands.

The information used to build the models comes from literature sources (see bibliography), experience from the World Bank-funded Central Highlands Poverty Reduction Project Implementation Completion and Results Report (ICRR) and inputs from the various technical experts that contributed to the project design.

The project includes benefits not quantified in the analysis. They include, *inter alia*, the benefits outside of the project provinces due to the national level policy activities, the benefits of switching from cashew monocrop to cashew agroforestry models,[1] the benefits from the forest infrastructure, the long-term benefits of improved forest management – through support to Community Forest Management (CFM) and PFES - and knowledge generation on agroforestry systems.

The EFA models focused on project activities included in Component 2, namely the transformation of monocrop coffee and pepper to agroforestry systems, the fruit-based agroforestry systems, the improved bamboo management, the transition from short-term monocrop acacia to long-term

[1] While there was enough information to model a cashew monocrop system, there was insufficient information to model a cashew-based agroforestry system

rotation systems, the support for the development of specialty products and the infrastructure – roads and irrigation. Figure 1 lists the models prepared alongside details on the without-project situation (WOP) and with-project situation (WP) of each model and the investment lifespan. Investments take place in year 1 of the model. The accrual of benefits depends on the crops and models.

**Figure 1. Summary of Models**

| Model | WOP | WP | Unit | Lifespan (years) |
|---|---|---|---|---|
| **transformation of monocrop coffee & pepper to agrofrestry systems** | | | | |
| Coffee durian | Coffee monocrop | Coffee durian | 1 hectare | 20 |
| Coffee-avocado | Coffee monocrop | Coffee-avocado | 1 hectare | 20 |
| Coffee-macadamia | Coffee monocrop | Coffee-macadamia | 1 hectare | 20 |
| Coffee Longan Acacia | Coffee monocrop | Coffee Longan Acacia | 1 hectare | 20 |
| Coffee-pepper-cassia | Pepper monocrop | Coffee-pepper-cassia | 1 hectare | 20 |
| **Fruit based** | | | | |
| Coffee durian | Maize | Coffee durian | hectare | 20 |
| **Bamboo** | | | | |
| Bamboo plantation, improved management | Bamboo plantation, inefficient management | Bamboo plantation, improved management | hectare | 15 |
| **from short-term monocrop acacia to long-term mixed system** | | | | |
| Acacia production, short rotation | Acacia production, long rotation | Acacia production, long rotation | hectare | 5 |
| **Specialty products** | | | | |
| Apiculture | *The model is directly modelled on an incremental basis* | | 20 hives | 10 |
| Mushroom production | *The model is directly modelled on an incremental basis* | | 1 cooperative | 15 |
| **Infrastructure** | | | | |
| Irrigation, lined canals,coffee durian | *The model is directly modelled on an incremental basis* | | 60 hectares | 20 |
| Irrigation, lined canals, coffee avocado | *The model is directly modelled on an incremental basis* | | 60 hectares | 20 |
| Road | *The model is directly modelled on an incremental basis* | | 0.43 km | 10 |

For the agroforestry systems, the WOP and WP situations consider that all trees and crops are planted in year 1 of the model. Hence, the models compare two plantations starting from the start rather than gradually replanting on an existing coffee plantation. This approach was much more feasible since, otherwise, the model would have to assume the starting age of the coffee plantation. In practice, producers might transition from monocrops to agroforestry to phase the costs of planting new trees/crops. Hence, a producer with two hectares of coffee could start by transforming half a hectare of his/her production. Still, modelling the difference at the level of one hectare provides the information necessary to understand the costs and benefits for each hectare of land transitioned.

## Financial Analysis

For the financial analysis, each model compares the costs and benefits to beneficiaries with and without the project. Models include all costs, valued at market prices, irrespective of whether the project beneficiaries or the project bears them. Hence, the infrastructure construction cost is included in the financial model, even if producers or the community do not bear it. A discount rate of 10 percent was used for the financial analysis to account for the opportunity cost of capital.[2]

The project focuses on the production of cash crops such as coffee, pepper and cashew, where prices fluctuate a lot, and it is very difficult to assign farm gate prices for these crops to the models. The UNEP publication (Scott and Gheyssens, 2020) uses a price of VND 40,000 per kilo for coffee while recognising the strong price fluctuations. Here, a lower price of VND 30,000 per kilo was used, as coffee prices are declining long-term[3] (see Box 1. Trends in Coffee Prices). In fact, it is very difficult to assign a long-term price for each commodity, as prices are subject to fluctuations. From the project perspective, it is important to note that the focus on diversification will make

[2] Saving rates on deposits appear to be much lower, 0.4% per month for one saving group for example, but it was considered better to use the higher and therefore more conservative discount rate of 10%, in particular because the RECAF investments would be riskier than deposits.

[3] Data on coffee prices was shared by one province but they were unclear and could not be used.

producers less vulnerable to these fluctuations. However, it might also mean that producers will lose potential profits in the event of price hikes.

The financial analysis shows that the proposed activities are viable (see Figure 2). All models have positive returns on investments, with positive net present values (NPVs) and internal rate of returns (IRRs). The infrastructure models have higher NPVs because they cover higher catchment areas, sixty hectares for the irrigation schemes and twenty hectares for the road. The mushroom production model also has a high NPV because it models the activity on a much larger scale for 150 households. The NPVs are also calculated per household to allow for comparisons across models. Results indicate that the agroforestry models are the most profitable.

**Figure 2. Financial Analysis Results**

| Model | Lifespan (years) | NPV, @10%, million VND | NPV, @10%, USD | IRR | Households per model | NPV, @10%, USD, per household |
|---|---|---|---|---|---|---|
| **transformation of monocrop coffee & pepper to agrofrestry systems** | | | | | | |
| Coffee durian | 20 | 914 | 39,827 | 35% | 0.5 | 79,654 |
| Coffee-avocado | 20 | 436 | 18,995 | 44% | 0.5 | 37,990 |
| Coffee-macadamia | 20 | 540 | 23,541 | NA | 0.5 | 47,082 |
| Coffee Longan Acacia | 20 | 370 | 16,099 | NA | 0.5 | 32,198 |
| Coffee-pepper-cassia | 20 | 175 | 7,610 | NA | 0.5 | 15,220 |
| **Fruit based** | | | | | | |
| Coffee durian | 20 | 1,036 | 45,148 | 33% | 0.5 | 90,296 |
| **Bamboo** | | | | | | |
| Bamboo plantation, improved management | 15 | 7 | 311 | NA | 0.25 | 1,242 |
| **from short-term monocrop acacia to long-term mixed system** | | | | | | |
| Acacia production, short rotation | 5 | 34 | 1,478 | 36% | 0 | 5,914 |
| **Specialty products** | | | | | | |
| Apiculture | 10 | 184 | 8,027 | 174% | 1 | 8,027 |
| Mushroom production | 15 | 7,757 | 337,892 | 116% | 30 | 11,263 |
| **Infrastructure** | | | | | | |
| Irrigation, lined canals,coffee durian | 20 | 2,273 | 99,007 | 23% | 30 | 3,300 |
| Irrigation, lined canals, coffee avocado | 20 | 275 | 11,973 | 12% | 30 | 399 |
| Road | 10 | 2,290 | 99,756 | 67% | 150 | 663 |

Several factors explain the high profitability of the agroforestry models. One reason is that these models consider a period of twenty years. Hence, the NPV of benefits includes twenty years of additional benefits instead of the ten years often used in annual crop models.

While transitioning to these agroforestry systems is generally financially and economically viable, barriers to investment remain. The project will use GCF concessional financing to address these barriers to investments, and in particular, the following ones:

- **high upfront investment costs,** addressed through the development of adequate credit products and the provision of lines of credit to support financial institutions;
- **revenues not accruing immediately on tree crops (implying that producers have to find alternative sources of income in the medium term),** also addressed through the development of adequate credit products;
- **Risks for early adopters,** addressed through the agroforestry pilots;
- **Risk of price fluctuations on the crops grown,** addressed by testing multi-crop agroforestry mixes that allow producers to diversify crops grown and decrease their vulnerability to price fluctuations and by supporting access to markets;
- **Risk of investing in perennials with long-term benefits** by supporting long-term land tenure.

GCF financing will focus on removing these bottlenecks (except for roads, which are financed through the IFAD loan). Still, most of the direct financing for agroforestry will occur through financial institutions and beneficiaries' capital to avoid crowding out private investment. Hence, the GCF financing will focus on the market failures, including information asymmetry of financial institutions, supporting early adopters of agroforestry systems (through the agroforestry pilots in 2.3), improving access to markets for producers (through the 4P platforms and the roads) and the institutional aspects around land tenure.

**Economic Analysis**

Economic prices were calculated by removing taxes, subsidies, and other transfers for the economic analysis. A shadow exchange rate was computed. The economic models include all costs, including family labour costs. Due to the complexity of the EFA and the numerous models, the economic flows were computed from the aggregate financial revenues and costs, with a separate conversion factor used for revenues and costs. A discount rate of 6 percent was used, which is higher than the long-term (20+ years) rate for government bonds.[4]

The phasing of project activities and outputs/outcomes was translated into a phasing of models for aggregating additional benefits at the project level. The aggregation of benefits was phased according to the project targets, as summarised in Figure 3. For the hectares of agroforestry and the activities of the community interest groups (CIGs), where the phasing will be demand-based, it is assumed that the transformations take place from year 3 to year 6 of the project, equally distributed across all four years. For the infrastructure, the activities' phasing stems from the project budget.

[4] See http://www.worldgovernmentbonds.com/country/vietnam/ accessed on 29/08/2022

## Figure 3. Phasing of Activities

| | Unit | Target | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| ***transformation of monocrop coffee & pepper to agrofrestry systems*** | | | | | | | | | |
| Grand Total | Hectare | 26,100 | - | - | 6,525 | 6,525 | 6,525 | 6,525 | 26,100 |
| ***Fruit based*** | | | | | | | | | |
| Grand Total | Hectare | 500 | - | - | 125 | 125 | 125 | 125 | 500 |
| ***Bamboo*** | | | | | | | | | |
| Grand Total | Hectare | 79,700 | - | - | 19,925 | 19,925 | 19,925 | 19,925 | 79,700 |
| ***from short-term monocrop acacia to long-term mixed system*** | | | | | | | | | |
| Grand Total | Hectare | 11,200 | - | - | 2,800 | 2,800 | 2,800 | 2,800 | 11,200 |
| ***Specialty products*** | | | | | | | | | |
| Grand Total | Farmers | 10,200 | - | - | 2,550 | 2,550 | 2,550 | 2,550 | 10,200 |
| ***Irrigation*** | | | | | | | | | |
| Grand Total | Hectare | 12,000 | - | 3,000 | 3,000 | 3,000 | 3,000 | - | 12,000 |
| ***Roads*** | | | | | | | | | |
| Grand Total | km | 174 | - | 43 | 43 | 44 | 44 | - | 174 |

Because it is unlikely that all beneficiaries will successfully adopt the new practices, the analysis applies adoption rates to the uptake of production models. For the transformation of monocrop coffee and pepper into agroforestry systems, the numbers above (Figure 3) already consider an adoption rate of 25% of surfaces owned by trained project beneficiaries. In other words, farmers are assumed to adopt the new practices on 25% of their surface, and the hectares reflect this. Producers need to replant coffee as part of their production, in any case, due to the ageing of trees. For pepper, the hectares are considered 50% of the surface of targeted beneficiaries. Adoption/success rates for other models are 70% on all production activities. On the infrastructure models, the adoption rate is 90% because there are no additional labour costs for beneficiaries required to benefit from the investment.

## Figure 4. Phasing of Models for the Aggregation, with Adoption Rates

| Phasing of models, with adoption rate | Unit | Adoption rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **transformation of monocrop coffee & pepper to agrofrestry systems** | | **Coffee** | | | | | | | | |
| Coffee durian | hectare | 25% | - | - | 1,631 | 1,631 | 1,631 | 1,631 | | **6,525** |
| Coffee-avocado | hectare | 25% | - | - | 1,631 | 1,631 | 1,631 | 1,631 | | **6,525** |
| Coffee-macadamia | hectare | 25% | - | - | 1,631 | 1,631 | 1,631 | 1,631 | | **6,525** |
| Coffee Longan Acacia | hectare | 25% | - | - | 1,631 | 1,631 | 1,631 | 1,631 | | **6,525** |
| | | | | | ***6,525*** | ***6,525*** | ***6,525*** | ***26,100*** | | ***26,100*** |
| **transformation of monocrop coffee & pepper to agrofrestry systems** | | **Pepper** | | | | | | | | |
| Coffee-pepper-cassia | hectare | 50% | - | - | 1,588 | 1,588 | 1,588 | 1,588 | | **6,350** |
| **Fruit based** | | | | | | | | | | |
| Coffee durian | hectare | 70% | - | - | 88 | 88 | 88 | 88 | | **350** |
| **Bamboo** | | | | | | | | | | |
| Bamboo plantation, improved management | hectare | 70% | - | - | 13,948 | 13,948 | 13,948 | 13,948 | | **55,790** |
| **from short-term monocrop acacia to long-term mixed system** | | | | | | | | | | |
| Acacia production, short rotation | hectare | 70% | - | - | 1,960 | 1,960 | 1,960 | 1,960 | | **7,840** |
| **Specialty products** | | | | | | | | | | |
| Apiculture | householc | 70% | - | - | 893 | 893 | 893 | 893 | | **3,570** |
| Mushroom production | 150 house | 70% | - | - | 6 | 6 | 6 | 6 | | **24** |
| | | | | | | | | | | |
| **Infrastructure** | | | | | | | | | | |
| Irrigation, lined canals,coffee durian | 60 hectare | 90% | - | 23 | 23 | 23 | 23 | - | | 90 |
| Irrigation, lined canals, coffee avocado | 60 hectare | 90% | - | 23 | 23 | 23 | 23 | - | | 90 |
| | | | ***-*** | ***45*** | ***45*** | ***45*** | ***45*** | ***-*** | | ***180*** |
| Road | km | 90% | - | 39 | 39 | 40 | 40 | - | | 157 |

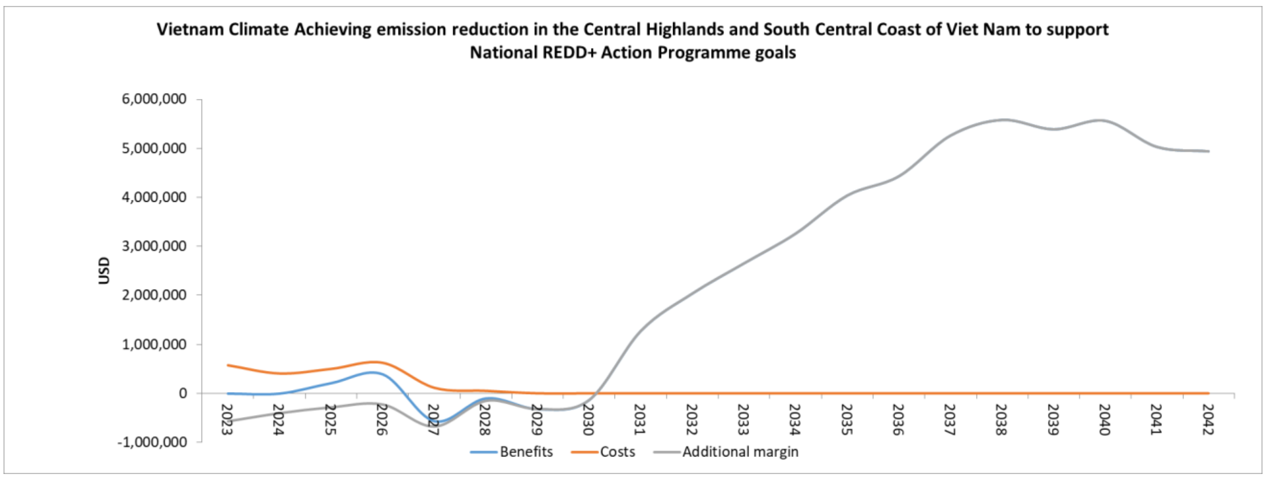
Following the aggregation of benefits, incremental costs not otherwise included in the models were added to the final flow of additional benefits. The economic analysis spans twenty years. The lifespan of each model remains the same as that of the model presented in the first section of the appendix.

The project mitigation benefits were further added as benefits. The FAO EX-ANTE Carbon Tool (Ex-ACT) measured the project mitigation capacity. The tool measures the increase/decrease of CO2 stock and GHG emissions throughout the project activities. The volume of -6.68 M tCO2-eq over 12 years of reduced emissions is quantified in monetary terms that expectedly will be paid through the national REDD+ Fund, national PES Fund, FCPF, LEAF, other partners' funds, and the private sector (the buyers participating in the zero-deforestation value chain). To add the carbon benefits, a market price of USD 5 per ton tCo2 equivalent was used, as prices per ton fluctuate from around USD 5 per ton to about USD 15 per ton. Carbon benefits were only added at the economic aggregate level, and it is assumed that the full mitigation benefits measured under the EX-ACT tool occur from years five to twenty of the project lifespan. In other words, it is assumed that there are no carbon benefits in years one to four, as the benefits depend on activities first taking place[5].

Based on these assumptions, the project is highly profitable, with an NPV of USD 786.1 million, corresponding to an Economic Internal Rate of Return (EIRR) of 29.8%. Using the lower bracket for the social price of carbon that ranges from USD 43 per ton of Co2eq in 2023 to USD 55 per ton of Co2eq, as opposed to a market price of USD 5 per ton of Co2eq, increases the project NPV to USD 887.4 million, corresponding to an EIRR of 33.9%.

The stream of additional benefits shows that additional benefits are negative until year 8 of the project, except for the positive benefits in year 4. This is because, for the transitions to agroforestry models, producers would typically earn income from coffee in year 3 of the plantation. By intercropping with other crops that yield revenues more slowly, producers forego revenues around year 3 of their transition.

**Figure 5. Stream of Costs, Benefits and Additional Margin**




Conducting the economic analysis only on the benefits of the infrastructure component, the project returns are positive but not particularly high, with an NPV of USD 21.6 million and an EIRR of 20%. This sub-analysis considers the additional benefits from the three infrastructure investments modelled and half of project management costs.

A sensitivity analysis tests the robustness of the overall results to some changes in assumptions, particularly a decrease in additional benefits and a change in coffee prices.[6] The project remains very profitable in the event of a reduction in benefits of 10% or 20%. Testing the robustness of the project benefits to fluctuations in coffee prices shows that in the event of an increase in coffee prices, project returns decrease because switching away from mono-crop coffee becomes less attractive if coffee prices increase. Oppositely, the project return increases as coffee prices decrease. With strong price fluctuations, coffee prices have been declining in the long term, primarily due to increased productivity and production.

[5] In the financial models, the carbon benefits were not included due to the difficulty of estimating the timeframe of obtaining these benefits (it depends on the way producers phase the adoption of activities of their land and then the methodologies for estimating carbon mitigation and the payment system).

[6] The increase in project costs was not tested because project costs are much lower than the additional benefits from the model, so the economic results would obviously be very robust to increases in project costs.

**Figure 6. Sensitivity Analysis**

| Scenario | Δ% | Hypothesis | NPV, million USD | IRR |
|---|---|---|---|---|
| **Baseline scenario** | | | 786 | 29.8% |
| Decrease in benefits of | 10% | Stronger than expected extreme weather events (which could also destroy plantations), fluctuation in commodity prices | 699 | 28.5% |
| Decrease in benefits of | 20% | | 612 | 27.1% |
| Increase in coffee prices | 20% | Fluctuation in world coffee prices | 760 | 28.0% |
| Decrease in coffee prices | 20% | | 811 | 31.7% |

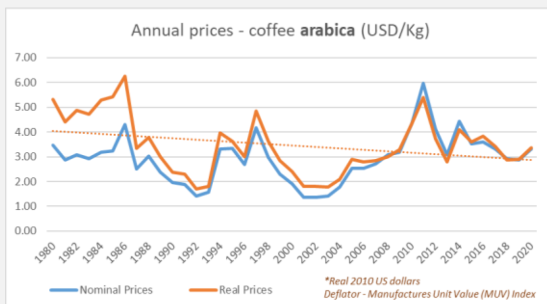
## Box 1. Trends in Coffee Prices

The current trend of increasing coffee production is expected to continue. World coffee production increased annually by 1.9 percent to 10 million tons over the decade to 2019, reflecting significant increases in countries such as Viet Nam and Brazil. Significant production upturns were also recorded in Colombia, Honduras and Uganda. By 2029, world coffee production is projected to increase at an annual growth rate of 1.7 percent to reach 11.9 million tons. Production is predicted to expand by 2029 also in Asia, notably in Viet Nam, driven by policy incentives to strengthen the sector. [7]

Similarly, the projections indicate that global coffee demand will continue to grow in the next decade. Continued strong demand for specialty coffee and niche products is expected in emerging markets, notably in China, Latin America and developed countries.

Despite the growth in the sector, nominal coffee prices trended steadily downwards since their peak of April 2011, apart from short-lived spikes in 2014 and 2016, mainly because of supply growth exceeding demand growth. International coffee prices, as measured by the ICO composite price index, show an overall decreasing trend over the past decades due to productivity gains and abundant global supplies, which more than offset the upward pressure from strong world demand. The depreciation of the local currencies against the US dollar in key producing countries also weighed on prices.

Figure 4: Coffee Prices, 1980-2020 (source: based on data from the International Coffee Organization)




In 2020, the COVID-19 pandemic caused supply chain disruptions, including labour shortages and impediments in transport services, which increased prices and significantly affected out-of-home consumption due to movement restrictions. In June 2021, the price was around 40 percent above a year earlier, supported by concerns over reduced availabilities in key exporting countries and a rebound in out-of-home consumption after the COVID-19-related downturn. Yet, the current scenario is believed to be another short-lived peak within an overall downward trend.

Over the next ten years, the declining trend in real prices will be expected to continue but at a lower rate than in the previous decade, driven by productivity gains and expansion in cultivation areas. The reasons behind the predicted slowdown include the following challenges: (i) accelerating impacts of climate change, which, for instance, is already driving a surge in the number of pests and diseases affecting coffee crops; (ii) increasing labour and energy costs; (iii) growing quality requirements for exports; and (iv) market volatility driven by weather-related events and inelastic supply. All the mentioned causes could significantly impact smallholders, squeezing margins and compromising competitiveness.[8]

[7] The information in this paragraph comes from an unpublished FAO report (under revision) on the medium term outlook for the global coffee market

## Limitations of the Analysis

The analysis has several limitations that are important to note.

At the level of the activities modelled, a few project activities were not modelled due to access to information. In particular, the cashew-based agroforestry systems were not modelled. The expected benefits and additional payments from the PFES Innovative Fund (PIF) were also not modelled due to the difficulty of making assumptions on these.

The agroforestry models that were prepared do not systematically include tree crops. This is because it is extremely difficult to find accurate data on agroforestry models that include tree crops. In practice, some of the benefits might be over-estimated because the tree crops would replace fruit or coffee trees and presumably have lower returns. Nonetheless, the models that include tree crops also have positive returns, and all models are to be taken as indicative. The project will invest in agroforestry pilots precisely to fill that knowledge gap.

At this stage, the financial models do not include financing costs (i.e. interests paid by producers) because these will depend on the products developed by financial institutions during the life course of the project and on whether producers take loans or not to adopt the new practices. In addition, the models are modelled per hectare. Still, the transition to agroforestry might take place in a more phased manner, which means that financial costs will depend heavily on individual farmers and the chosen financial product. Again, the project will invest in ensuring adequate financing mechanisms for these models.

## Bibliography

George Scott and Jonathan Gheyssens (2020), "Addressing smallholder resilience in coffee production in the Central Highlands, Viet Nam", UNEP

Phan Thi Thuy, Le Duc Niem, Thi Minh Hop Ho, Philippe Burny and Philippe Lebailly (2018), "Economic Analysis of Perennial Crop Systems in Dak Lak Province, Vietnam", Sustainability 2019, 11, 81

Vivekananda Byrareddy, Louis Kouadio, Shahbaz Mushtaq, Jarrod Kath, Roger Stone (2021), "Coping with drought: Lessons learned from robusta coffee growers in Vietnam", Climate Services, Volume 22, 2021, 100229, ISSN 2405-8807, https://doi.org/10.1016/j.cliser.2021.100229.

La Thi Tham, Dietrich Darr, Jürgen Pretzsch, Analysis of Acacia hybrid timber value chains: A case study of woodchip and furniture production in central Vietnam, Forest Policy and Economics, Volume 125, 2021, 102401, ISSN 1389-9341, https://doi.org/10.1016/j.forpol.2021.102401.

World Agroforestry (ICRAF) Viet Nam (2019), brochure on planting of coffee longan acacia, World Agroforestry in Viet Nam | 2019

[8] The information in this paragraph comes from personal communication with the FAO coffee expert, ElMamoun Amrouk, Senior Economist, FAO in September 2021