Annex 3: Economic and Financial Analysis (EFA) – Revised Draft (10 October 2024)

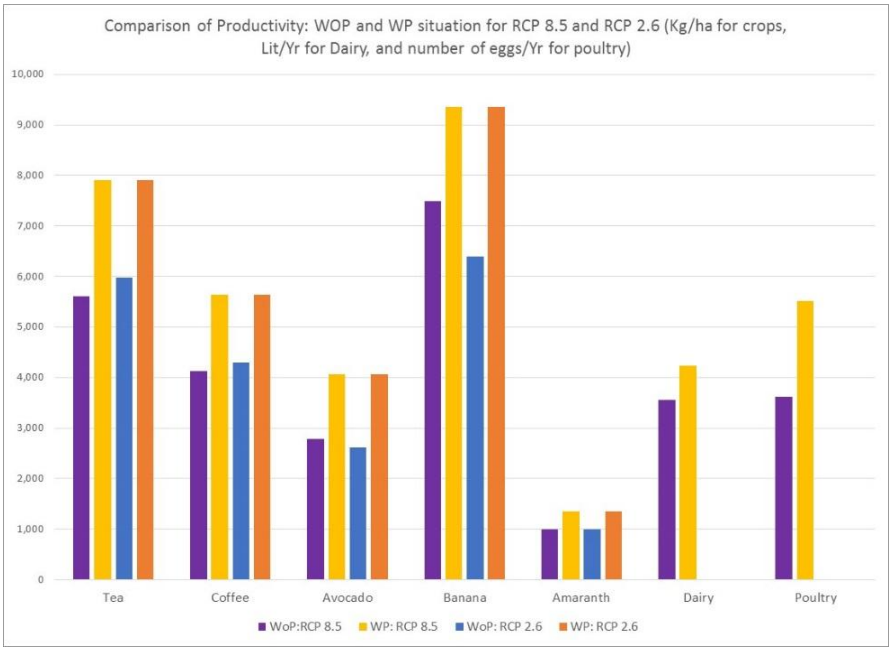
Transforming Livelihoods through Climate Resilient, Low Carbon, Sustainable Agricultural Value Chains in the Lake Region Economic Bloc, Kenya

Executive Summary

1. This Annex 3 presents the methodology, assumptions, key information and results of the Economic and Financial Analysis (EFA) undertaken for the project "Transforming Livelihoods through Climate Resilient, Low Carbon, Sustainable Agricultural Value Chains in the Lake Region Economic Bloc, Kenya". The project will operate in Bomet, Bungoma, Busia, Homa Bay, Kakamega, Kericho, Kisii, Kisumu, Migori, Nandi, Nyamira, Siaya, Trans Nzoia, and Vihiga counties in Kenya. The project has 4 components namely: Component 1 – Enabling local government support for adaptation and mitigation; Component 2 – Sustainable Resilient Agricultural Landscapes; Component 3 - Resilient livelihoods; and Component 4 – Scaling through CRLCSA market and finance.

2. The EFA was undertaken following the guidelines of Annex VI, Economic and Financial Analysis (EFA) Guidance, of GCF Appraisal Guidance note. The EFA has explored the financial and economic performance of the activities considered in the Funding Proposal of the project "with" and "without" GCF support. The project focuses on the top 6 priority value chains, three of which have more of a market orientation (dairy, coffee and tea) and three that have more of a household food security orientation (African leafy vegetables, poultry and fruit tree). Fruit value chain has banana and avocado, and as such the EFA focuses on seven commodities. The total project beneficiaries, 143,000 households, will be reached during the project period with various project assistance. Out of the total beneficiaries the project assumes that, 35,750 will have tea; another 35,750, coffee; 42,900 will have African leafy vegetables; 14,300, avocado, and another 14,300, banana. In addition, 42,900 and 28,600 beneficiaries will have dairy and poultry respectively. These beneficiaries will also have crops that are listed above.

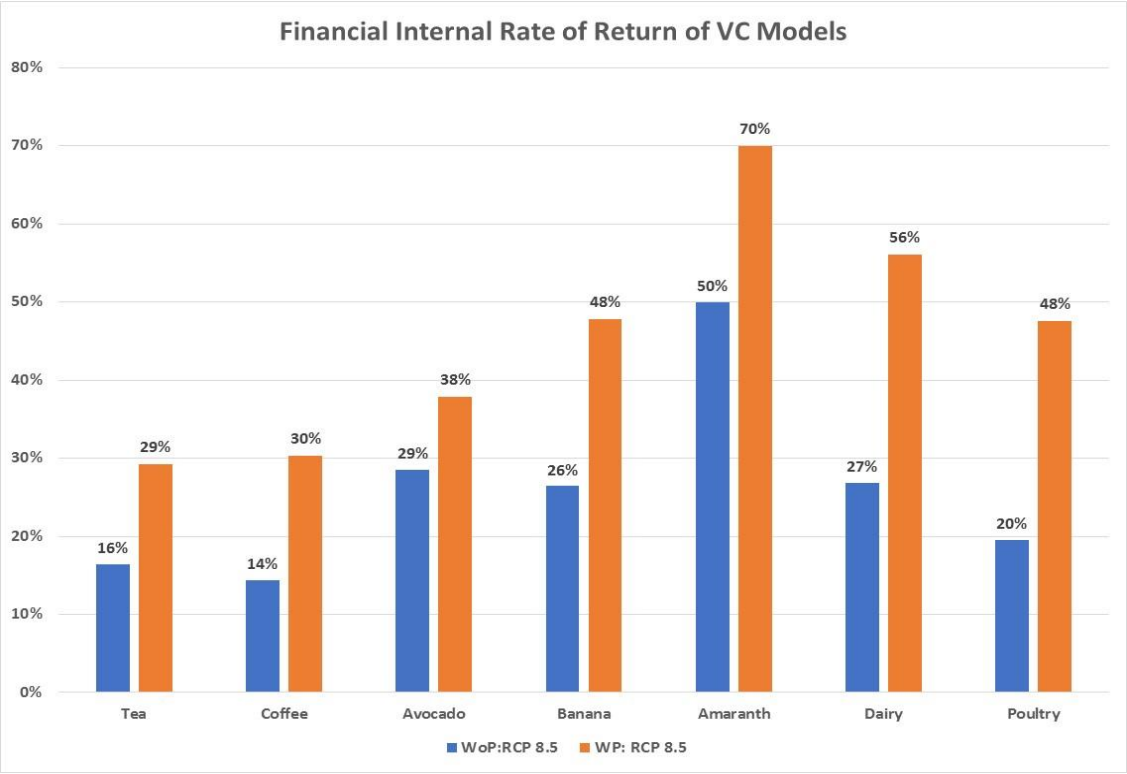
3. The EFA has used the project cost which is in Annex 4 of the Funding Proposal (FP). The total project cost was estimated at US$ 49.997 million. The incremental production of 7 commodities in 6 value chain provided the benefits for the EFA. The increment was estimated by taking the difference between the baseline productivity (without project case) and estimated increased productivity under climate sensitive and low carbon technologies (with project case). The profitability indicators that were estimated for each value chain product at the beneficiary level include the Net Present Value (NPV, economic and financial), the Internal Rate of Return (IRR, economic and financial), the Benefit-costs ratio (B/C), the pay-back period and increase in returns to family labor (for the financial analysis). Using the aggregated cost and benefits flows of the VC commodity models and the project cost, the same profitability indicators were estimated for the project. The financial and economic viabilities were estimated for two climate change scenarios – Representative Concentration Pathways (RCP) 2.6 and RCP 8.5 - for both the beneficiary level and the project level. A 20-year timespan was considered for the stream of benefits from climate change adaptation activities involving agricultural and livestock techniques and practices.



4. The bar chart on the left shows the productivity level of 7 VC commodities for the WOP and WP cases under RCP 8.5 and RCP 2.6 scenarios. For livestock, the changes were not analysed as the projection of yield decline was not

available. Both type of yields was based on the published literature and the Value Chain studies that FAO has conducted for this project.

5. On the basis of the yield levels and cost of production under WOP and WP cases, the profitability indicators were estimated. Considering the Financial Internal Rate of Return (IRR) for 20-year period as a summary indicator to demonstrate the contribution of the project in increasing income for the beneficiaries, the second bar chart below compares the IRRs of WOP and WP cases for all VC commodity models under RCP 8.5 scenario. The same trend of results was obtained for the RCP 2.6 scenario as well.

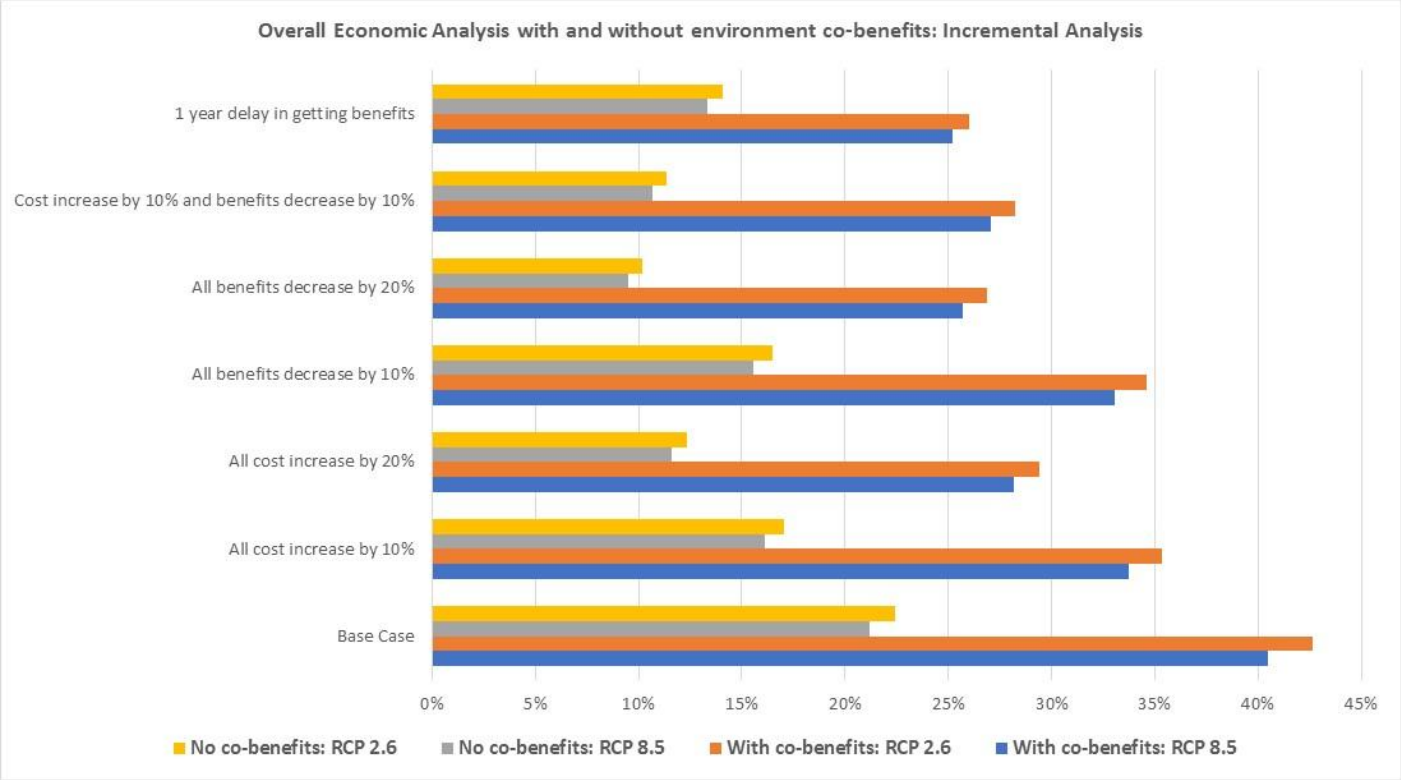


6. As the bar chart shows, the farmers who participate in these VC commodities can generate enhanced profits starting with relatively low profitability and decreasing yield due to climate change under the WoP or baseline situation. The project intervention will allow them to increase their profitability from cultivating the same amount of land with new climate sensitive and low carbon technologies under the WP scenario, which also contributes in reducing the carbon emission.

7. Based on individual VC commodity model analyses, the project level financial and economic profitability indicators were analysed. The financial internal rate of return of the project is 23% with a benefit-cost ratio of 1.11; and 25% and 1.13 respectively for RCP 8.5 and RCP 2.6 scenarios for a 20-years period at 18% discount rate. The project will be able to earn US $ 10.7 million as a net present value under the same discount rate for 20 years under RCP 8.5 (US $ 12.9 for RCP 2.6). The project can breakeven the project expenditure plus the beneficiaries' investments after 9 years (pay-back period) of project commencement for both climate change scenarios.

8. The project level economic internal rate of return is 21% with a benefit-cost ratio of 1.24; and 22% and 1.25 respectively for RCP 8.5 and RCP 2.6 scenarios under 10% economic discount rate. The project is also viable under many sensitivity scenarios. The EFA analyses indicate that the project is therefore adequately viable in financial, economic, and social (environmental) terms and also has the capacity to face many risk factors while being viable. The project also has the potential reduce GHG emission to a significant level with social net present value of US$ 113 million and US$ 116 million for RCP 8.5 and RCP 2.6 scenarios. The project therefore is suitable for receiving public funds for investments.

9. The overall results of the economic analysis with and without environmental co-benefits and for both RCP 8.5 and 2.6 scenarios are summarised in the bar chart below.



Contents

1. Introduction

1. This Annex summarises the Economic and Financial Analysis (EFA) of the project entitled "Transforming Livelihoods through Climate Resilient, Low Carbon, Sustainable Agricultural Value Chains in the Lake Region Economic Bloc, Kenya" (project). The Annex also summarises project cost (details in Annex 4), the financing plan, and implementation timeline for the six-year implementation period.

2. As for the EFA, the Annex presents a short introduction to the EFA, its main assumptions, a description of the farm and livestock gross margin models, data that was used to formulate models, financial viability indicators of the models, and the aggregated project level economic and financial analysis. The results of the economic analysis including the environmental co-benefits are also presented.

2. Project Cost and Financing - Summary

3. This section presents a summary of the project cost that was used for the EFA. The details of the project costs according to the project activities organized on the basis of project components and outputs are described in Annex 4 of the Funding Proposal (FP). The project design team has prepared the project cost. Total project costs were estimated at US$ 49.992 million. The total cost comprises of a GCF grant of US$ 29.215 million (58.4% of total project cost); Government of Kenya through National Treasury of Kenya contributing US$ 14.0 million (28%); a Grant of US$ 5.791 million (11.6%) from the Ministry of Foreign Affairs of the Government of Denmark (DMFA); and US$ 0.9859 million (2%) from Food and Agriculture Organization (FAO). Table 1 summarises the total project cost by financiers and components. The highest amount (51%) of the project cost will be allocated on component 3 (see Table 2). The main financier for the 3rd component is GCF.

Table 1: Project cost distributed by Financiers and by project components (US $)

	Project Financiers and Project Cost (US $)				
Project Components and Outputs	**DMFA**	**FAO**	**GCF**	**GoK**	**Grand Total**
Component 1 – Enabling local government support for adaptation and mitigation		436,235	2,004,898		2,441,133
Component 2 – Sustainable Resilient Agricultural Landscapes		297,675	315,004	12,999,600	13,612,279
Component 3 – Resilient livelihoods	3,597,425		22,039,949		25,637,374
Component 4 – Scaling through CRLCSA market and finance					
Output 4.1: Increased access to markets and profitability of climate smart, low carbon sustainable agricultural products		252,200	1,070,688		1,322,688
Output 4.2: Vulnerable smallholders and their organizations have increased access to gender-responsive and socially inclusive financial products that support climate resilient, low carbon growth	1,936,668		905,318		2,841,986
Monitoring and Evaluation, Learning	84,458		1,551,189		1,635,646
Project Management Cost	172,468		1,328,264	1,000,400	2,501,131
Grand Total	**5,791,019**	**985,910**	**29,215,309**	**14,000,000**	**49,992,238**
% Cost distribution	11.6%	2%	58.4%	28%	100%

4. The project will be executed by FAO and Agriterra in a co-execution modality to deliver the project activities funded by GCF proceeds and Danish MFA (DMFA) funding. A description of each Executing Entity (EE) is indicated in section 7 of the FP, Part C. The project cost distributed by the EE is presented in Table 2 below. The highest amount (39.5%) of the project cost is managed by FAO.

Table 2: Project cost and project Executing Entities by project components (US $)

Financiers and Component	**AGT**	**FAO**	**GoK**	**Grand Total**
DMFA	**5,618,551.50**	**172,468.00**		**5,791,019.50**

Monitoring and Evaluation, Learning	**84,457.70**			**84,457.70**
M&E	84,457.70			84,457.70
Component 3	**3,597,425.46**			**3,597,425.46**
Output 3.1	3,597,425.46			3,597,425.46
Component 4	**1,936,668.34**			**1,936,668.34**
Output 4.2	1,936,668.34			1,936,668.34
Project Management Cost		**172,468.00**		**172,468.00**
PMC		172,468.00		172,468.00
FAO		**985,910.21**		**985,910.21**
Component 1		**436,235.21**		**436,235.21**
Output 1.1		436,235.21		436,235.21
Component 2		**297,675.00**		**297,675.00**
Output 2.1		297,675.00		297,675.00
Component 4		**252,000.00**		**252,000.00**
Output 4.1		252,000.00		252,000.00
GCF	**10,577,131.10**	**18,638,178.03**		**29,215,309.14**
Monitoring and Evaluation, Learning	**447,788.76**	**1,103,400.00**		**1,551,188.76**
M&E	447,788.76	1,103,400.00		1,551,188.76
Component 1		**2,004,898.07**		**2,004,898.07**
Output 1.1		2,004,898.07		2,004,898.07
Component 2		**315,003.99**		**315,003.99**
Output 2.1		315,003.99		315,003.99
Component 3	**8,607,759.34**	**13,432,188.55**		**22,039,948.89**
Output 3.1	8,607,759.34	13,432,188.55		22,039,948.89
Component 4	**1,149,649.00**	**826,356.67**		**1,976,005.67**
Output 4.1	420,560.97	650,126.67		1,070,687.63
Output 4.2	729,088.03	176,230.00		905,318.03
Project Management Cost	**371,934.00**	**956,329.76**		**1,328,263.76**
PMC	371,934.00	956,329.76		1,328,263.76
GoK			**13,999,999.50**	**13,999,999.50**
Component 2			**12,999,600.00**	**12,999,600.00**
Project Management Cost			**1,000,399.50**	**1,000,399.50**
Grand Total	**16,195,682.60**	**19,796,556.24**	**13,999,999.50**	**49,992,238.35**

The project will disburse its funds through 8 GCF budget categories as summarised in

5. Table 3 below. The contracts budget category takes the highest amount (31%) followed by the travel category.

Table 3: Project cost distributed by GCF budget categories and by project financiers (US $)

Row Labels	DMFA	FAO	GCF	GoK	Grand Total
Consultants	255,283.91	202,500.00	6,029,766.03	231,000.00	6,718,549.94
AGT	255,283.91		2,836,517.29		3,091,801.20
FAO		202,500.00	3,193,248.74		3,395,748.74
GoK				231,000.00	231,000.00
Contracts		554,975.00	11,378,020.89	12,600,000.00	24,532,995.89
AGT			584,871.70		584,871.70
FAO		554,975.00	10,793,149.19		11,348,124.19
GoK				12,600,000.00	12,600,000.00
Equipment	384,436.20	80,580.71	434,978.37		899,995.28
AGT	384,436.20		63,234.37		447,670.57
FAO		80,580.71	371,744.00		452,324.71
Other	1,608,138.04		700,942.23	1,000,399.50	3,309,479.77
AGT	1,608,138.04		403,611.03		2,011,749.07
FAO			297,331.20		297,331.20
GoK				1,000,399.50	1,000,399.50
Professional – Service Provider			102,900.00		102,900.00
FAO			102,900.00		102,900.00
Staff	2,383,825.96		5,100,956.30		7,484,782.26
AGT	2,211,357.96		4,428,956.30		6,640,314.26
FAO	172,468.00		672,000.00		844,468.00
Training/workshops	519,757.75	23,929.50	1,422,885.10	129,600.00	2,096,172.35
AGT	519,757.75		485,699.63		1,005,457.37
FAO		23,929.50	937,185.47		961,114.97
GoK				129,600.00	129,600.00
Travel	639,577.64	123,925.00	4,044,860.21	39,000.00	4,847,362.85
AGT	639,577.64		1,774,240.79		2,413,818.43
FAO		123,925.00	2,270,619.43		2,394,544.43
GoK				39,000.00	39,000.00
Grand Total	5,791,019.50	985,910.21	29,215,309.14	13,999,999.50	49,992,238.35

6. Project implementation period is six years. The project lifespan during which project benefits will accrue is assumed at 20 years. Table 4 presents the project cost by project years.

Table 4: Project cost distributed by project implementation years and project components (US $)

Outcomes	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total (USD)
M&E, Learning	**292,660.98**	**184,277.01**	**301,111.19**	**251,175.08**	**221,480.86**	**384,941.35**	**1,635,646.47**
M&E	292,660.98	184,277.01	301,111.19	251,175.08	221,480.86	384,941.35	1,635,646.47
Outcome 1	**790,739.38**	**355,178.77**	**434,370.50**	**244,053.17**	**310,998.30**	**305,793.17**	**2,441,133.28**
Output 1.1	790,739.38	355,178.77	434,370.50	244,053.17	310,998.30	305,793.17	2,441,133.28
Outcome 2	**354,919.99**	**201,267.00**	**3,255,867.00**	**3,218,512.50**	**3,431,712.50**	**3,150,000.00**	**13,612,278.99**
Output 2.1	354,919.99	201,267.00	3,255,867.00	3,218,512.50	3,431,712.50	3,150,000.00	13,612,278.99
Outcome 3	**2,544,942.44**	**5,106,256.90**	**5,701,287.23**	**6,118,388.99**	**3,883,969.44**	**2,282,529.35**	**25,637,374.35**
Output 3.1	2,544,942.44	5,106,256.90	5,701,287.23	6,118,388.99	3,883,969.44	2,282,529.35	25,637,374.35
Outcome 4	**228,442.42**	**393,009.99**	**995,304.99**	**903,676.99**	**873,746.82**	**770,492.80**	**4,164,674.00**
Output 4.1	128,540.00	119,540.00	250,290.00	261,540.00	337,207.15	225,570.48	1,322,687.63
Output 4.2	99,902.42	273,469.99	745,014.99	642,136.99	536,539.67	544,922.31	2,841,986.37
Project Management Cost	**470,645.81**	**412,045.81**	**394,799.01**	**394,799.01**	**412,045.81**	**416,795.81**	**2,501,131.26**
PMC	470,645.81	412,045.81	394,799.01	394,799.01	412,045.81	416,795.81	2,501,131.26
Grand Total	**4,682,351.01**	**6,652,035.47**	**11,082,739.92**	**11,130,605.74**	**9,133,953.72**	**7,310,552.47**	**49,992,238.35**

7. The budget distribution presented in Table 4 shows that the project year 2, 3 and 4 will have the highest amount of fund disbursement. This indicates that the notable amount of activities, particularly under 3rd component, will be implemented during these two years. The EFA used the total and the annual budget presented in Table 4 as the project cost for aggregated financial and economic evaluation. The EFA assumed that the total budget of the project is required to realised the quantifiable benefits identified in the EFA. The EFA will also use this budget distribution as the basis to assume the phasing of project beneficiaries during the project implementation period undertaking production activities associated with each commodity in the value chain.

3. Project Economic and Financial Analysis

A. Introduction and Methodology

8. The economic and financial analyses consist of comparing the resources required for project implementation, represented by the project cost and the beneficiaries' investment costs with the expected impacts, estimated as benefits for the main promoted activities. For the financial analysis, project beneficiaries are the focus of the analysis, whereas the economic analysis focuses on the whole project using aggregated cash flows of beneficiary production models. In addition, the social benefits of CO2 sequestration as a result of the project has also been added to the benefits flow of the EFA.

9. It is important to clarify the project attribution over project contribution in the approach of the EFA where benefit estimation is paramount. Estimation or measurement of *contribution* refers to examination of the extent to which an outcome of a project activity, for example proper soil conservation in tea lands with project support, has changed in the presence of the project (WP scenario) compared to its absence (WOP scenario or business-as-usual scenario). When measuring *contribution*, no causality

can be inferred, which (causality) require intensive research. On the other hand, when estimating or measuring change with *attribution,* the focus is directly on causation. Outcomes or impacts of a project activity identified with attribution are able to establish a causal link between observed changes in project outcomes and the project or a specific project intervention. When measured with attribution, the change in the outcome is only that which resulted from the project, excluding the impact of all other factors, i.e. weather, markets, shocks, etc. To understand the effectiveness and result of a project, which is what EFA is attempting to undertake in financial and economic terms, it is needed to measure the impact only of the incremental portion of the change that results from the project interventions excluding all other factors. This requires estimation relative to a counterfactual, which is obtained by including the WOP scenario.

10. The counterfactual represents the state of the world that projects' participants will experience without the intervention of the project. In order to approximate the counterfactual which is the WOP scenario, a comparable production model, mimicking what will happen in the absence of the intervention needs to be constructed on the basis of technical references. In the EFA, the WOP model provides the counterfactual. The WOP and WP models of the EFA in this project is based on this logic. The counterfactual or WOP production model for each commodity is presented in the respective EFA excel sheet for the product concerned – the upper part of the excel sheet for each model has the WOP yield levels, input use, labour use and the estimated gross and net incomes, and using these the financial profitability indicators have been estimated. Similarly, the second part has the model representing the WP scenario and the profitability indicators have been estimated. The third part has the incremental cash flows, i.e. the difference between the WOP and WP model cash flows, and the incremental financial profitability indicators have been estimated. This approach has been used to represent both RCP 2.6 and RCP 8.5 cases (four sets of models – WOP and WP for financial and economic). With adjusted prices, the economic viability indicators have been estimated for all four sets of models. The assumed production parameters (yield levels, cost of production etc) for all models are presented in Table 10; financial profitability indicators of all these models are presented in Table 11 and the profitability indicators of the incremental analysis are presented in Table 12.

11. The EFA will explore the financial performance of the activities considered in the FP "with" and "without" GCF support. As such the analyses have the potential to contribute to the additionality assessment conducted through the Innovation and Additionality Tool (IAT), which is not attempted in the EFA. The sensitivity analyses, which is a part of the EFA, also can support the assessment of concessionality and the appropriateness of the de-risking financial instruments in the proposal. The EFA, mainly the financial analysis, will also have estimates to respond to the questions such as: (a) changes in beneficiaries' cash flows over time in the absence of GCF support (WOP case); (b) profitability for beneficiaries to invest in mitigation or adaptation measures in their activities (WP case); (c) incremental benefits and profitability of project activities accruing to GCF support of mitigation or adaptation measures (WP minus WOP); (d) time duration that will take the activities to generate a positive financial return with and without GCF support; and (e) level of returns as financial incentives for the beneficiaries to continue mitigation or adaptation activity beyond the GCF funding period.

12. Both in the financial and economic analyses, each project supported activity will be considered financially and economically viable if incremental cash flows, over a 20-year period exceed investment and recurrent costs at a cut-off discount rate. As a result, profitability indicators at the beneficiary level will be the Net Present Value (NPV, economic and financial), the Internal Rate of Return (IRR, economic and financial), the Benefit-costs ratio (B/C), the pay-back period and increase in returns to family labor (for the financial analysis).

13. The financial and economic viabilities were estimated for two climate change scenarios[1] - RCP 2.6 and RCP 8.5. As RCP 8.5 is the highest baseline emissions scenario, the main EFA aggregated results were generated for this scenario. The sensitivity analysis will test vulnerability or robustness of obtained results for the economic profitability indicators. The EFA aggregated results was re-estimated under the RCP 2.6 scenario and presented as a sensitivity test. A 20-year timespan is considered for the

[1] RCP 2.6 is described by the Intergovernmental Panel on Climate Change (IPCC) as a moderate scenario in which emissions peak around 2040 and then decline. RCP 8.5 is the highest baseline emissions scenario in which emissions continue to rise throughout the twenty-first century.

stream of benefits from climate change adaptation activities involving agricultural and livestock techniques and practices.

14. The EFA mainly and closely follows the guidelines of Annex VI, Economic and Financial Analysis (EFA) Guidance, of GCF Appraisal Guidance note. In addition, the references used to obtain detailed technical points include Economic and Financial Analysis by different donors as ADB (2013), IFAD (2019) for Volume 2 and IFAD (2015) for Volumes 1 and 3; and Economic Analysis in Agricultural projects (Gittinger;1985).

B. Discount rates

15. For the financial analysis the overall average interest rate for the beneficiaries from Equity Bank in Kenya2 was used and the financial discount rate which was 18% in March 20233. This rate is applicable to small scale business and farming and therefor relevant for the project. For the economic analysis, social discount rate (SDR) was assumed at 10% which is the rate of yield-to-maturity of sovereign debt issuance in 2023 (the reference provided by FAO - https:// www.federalreserve.gov /econresdata /notes/feds-notes/2014/the-social-discount-rate-in-developing-countries-20141009.html - proposes using the real interest rate at which developing countries can borrow as the social discount rate, which is the rate of yield-to-maturity of sovereign debt issuance. The rates presented in the article is outdated (2014) and the current rate is 10%. The article also states that the leading development banks, such as the World Bank and the Asian Development Bank, typically apply a real discount rate in the range of 10% to 12% when evaluating projects in developing countries as SDR. That rate that was used in this EFA is therefore in line with the above statement. Kenya will be using the project financing as public financing and this rate will represent the SDR. As a sensitivity test, financial discount rate was increased to 20% and 25% and the financial viability indicators were re-estimated for both RCP scenarios. Similarly, the social discount rate was increased to 15% and 22% for both RCP scenarios and economic viability indicators were re-estimated. This sensitivity test takes into account the effects of possible risk premium that may apply to the assumed SDR. The results and interpretation are presented together with the overall results.

C. Project Cost used for the EFA

16. Total and the annual project budget including the co-financiers budget contributions presented in Annex 4 of the Funding Proposal (FP) was used as the project cost for the EFA. The project budget is presented in Table 1 to Table 4 above. As Table 2 indicates, all project outcomes require a budget to finance a series of activities to achieve the outcomes. These outcomes will be the basis for realising both financial and economic benefits of the project. As such the total project budget was used as the project cost in the EFA.

D. Financial and economic benefits

17. The main financial benefit of the project will be the increase in livelihood of smallholder producers and other value chain actors such as aggregators and cooperatives. In the EFA, the livelihood is quantified in terms of income. Income increase will be due to (i) increase in productivity with adoption of climate-resilient, low-carbon practises promoted by the project; and (ii) arresting declining productivity and production as a result of such technology adoption. The linkage between the outcomes, project activities and the way the outcomes are contributing to achieving the financial benefits listed above are summarised in Table 7 below. The financial benefits were captured through designing two sets of gross margin models for all seven commodities representing WOP and WP scenarios. The gross margin model, that were designed for one hectare, for each value chain commodity representing WOP and WP scenarios had the following variables and estimates:

(a) Yield levels that represent the WOP (business as usual) case which is gradually decreasing due to sub-optimal cultural practices and adverse climate effects. The yield levels and the variability under the WOP case were assumed under two climate change scenarios - RCP 2.6 and RCP 8.5;

[2] Equity Bank Kenya Limited is a Kenyan bank and financial services provider headquartered in Nairobi providing retail banking and commercial banking services. The bank is licensed as a commercial bank by the Central Bank of Kenya, which is the national banking regulator of Kenya

[3] Equity Bank (Kenya) Limited Products & Services Tariff Guide (chrome-extension:// efaidnbmnnnibpcajpcglclefindmkaj/https:// equitygroupholdings.com/ke/images/docs/tariff-guide.pdf)

(b) Yield levels that represent the WP case which is assumed to be gradually increasing over the base level as a result of adopting climate-resilient, low-carbon practises that are supported by the project. The incremental yield, which is the difference between WP and WOP levels, was used to assess the financial benefits for the EFA. The yield levels and its variation over a 20-years period were used for the EFA.

(c) Gross revenue of each value chain product was estimated using the farm-gate price observed in 2023 that are reported in Annex 23 (a), Value Chain Analysis Reports of the FP and the yields as mentioned above. The same farm-gate price was used to estimate WOP and WP gross revenues.

(d) Total cost of production of each product was estimated by using all the inputs applied with their market prices (2023 prices). The WOP input levels were assumed to be lower than the recommended levels and obtained from Annex 23 (a), Value Chain Analysis Reports. The recommended levels of inputs that were used in the WP case were obtained from various references which are listed in Table 9 as assumptions and Appendix 1 of this Annex provides the full list of references. Table 9 also presents the climate resilient, low carbon technologies that will require inputs with project support and the current practices that were observed in the project area.

(e) Labour inputs were costed using the level of labour use for cultivation practices with the average wage rate. Annex 23 (a), Value Chain Analysis Reports presented the wage rates. The labour requirement for various practices are presented in the references mentioned above.

(f) The net incremental revenue of all products was estimated taking the difference between the gross revenue and the cost of production.

18. Table 9 presents, VC Commodity, WOP and WP assumptions and targets and sources of data used for model construction for the EFA. The same financial benefits will be the economic benefits as well. In order to quantify the economic values of these financial benefits estimated using the approach outlined above the financial prices were converted to economic prices and re-estimated the benefits in economic values. Section 7 of this Annex presents the conversion process of the financial benefits to economic benefits and assumptions. In addition, the net carbon balance which quantifies GHGs emitted or sequestered as a result of the project compared to the without project scenario is an economic benefit. The project has multiple interventions having potential to reduce GHG emission. The section 8 of this Annex explains the method of including this environmental co-benefit as an economic benefit in the EFA.

19. The social, environmental and economic benefits that were not quantified include the following:

(a) Nutritional and health benefits that the project beneficiaries will enjoy with increased production of vegetables, fruits, poultry products and dairy milk etc are main socio-economic benefit of the project. Quantifying such benefits demand beneficiary family health related data over a period of time to assess the trend of improvement. Such information was unavailable for the designers;

(b) Improvement in the quality of natural resources of the farms including soil texture and composition, soil organic matter, water retention capacity and water conservation, soil micro-organism etc are a type of environmental benefits that the project will contribute. Such qualitative benefits to some extent get included into the yield improvements. However, to quantify the full level of such environmental benefits needs special estimation measure such as fertiliser replacement methods, soil moisture measurement etc which were not available for the project designers; and

(c) Increase in family income and increased return to labour will have cascading impact on the family units such as improved quality of life, education and health etc that were not estimated.

E. Sensitivity analyses

20. A series of sensitivity analyses for both financial and economic analysis were carried out to test the robustness of the project to phase possible risk factors during its implementation period. The analyses include: (i) escalation of all costs by 10% and 20%; (ii) reduction of all benefits by 10% and 20%; (iii) cost increase by 10% and benefits reduction by 10% simultaneously; (iv) one year delay in reaching out to the beneficiaries; and (v) an increase in financial and economic discount rates (DR) from 18% (base rate of financial DR) to 20% and 25%; and from 10% (base rate of economic DR) to 15% and

22%. Also, the switching values of costs and benefits were estimated. The results of these tests are presented in section 6 and 7 of this Annex.

F. Sources of Data for the EFA

21. The data for estimating the WOP scenario of all the crops and livestock models were obtained from the Annex 23 (a), Value Chain Analysis Reports of the FP. Annex 23 (a) had individual reports presenting all the details of each value chain commodity. The information included overview of the VC; statistics on production, productivity and market trends etc; VC development activities; sustainability assessment including economic analysis; and environmental analysis. Under the economic analysis, a gross margin analyses for each VC commodity has been carried out. The information presented in these analyses were limited to values, and therefore the more information on the quantities of inputs and outputs were collected at the time of undertaking this EFA. In country project design team collected such information. The farm data, trends of yields and management practices that represented "with project" (WP) situation, conservation practises etc were double-checked with technical references for each model.

22. In addition to the data sources mentioned above, the references listed in Appendix 1 at the end of this Annex were used for obtaining data (the EFA excel sheets provide the reference for specific variables). FAO has modeled the yield changes in tea and coffee for next 50 years in Kenya using the following references: Kassam, A. H. (1977); Kassam, A. H et al (1991); and Fischer, G et al (2021). Trend of yield changes for the WOP scenario was based on this reference.

G. Project Beneficiaries

23. The project will reach 572,000 individual or 143,000 smallholder beneficiary households[4] (for the EFA, 143,000 farm/livestock units) whose livelihoods depend on any of the 6 value chains product or a combination of livestock and crop farming in the targeted counties. Of these, about 80,000 will be individual cooperative members (project participants), with direct benefits accruing to their households (a total of 320,000 people based on the conservative estimate of 4 people per household). Other beneficiaries are smallholder farmers who are not a part of cooperatives. The project, however, expects to reach 63,000 smallholders (households) through farmer field schools (FFS), (direct beneficiaries accruing to their households, 252,000 people). Annex 2, Feasibility Study, Part B and C[5], section 6.2.1 provides details of the beneficiaries and the selection process. Smallholders, whether they are included in cooperatives or not, are the primary intended beneficiaries of this project. The common characteristics of the smallholders in the project areas include (i) working on small land parcels, typically less than 2 acres and averaging to 0.2 hecatres; (ii) depending on a single commodity for livelihoods with limited diversification; (iii) limited access to off farm employment; (iv) dependent on low input, rain-fed agriculture; (v) a household of on average 4-5 persons; and (vi) with low asset ownership[6].

24. The total project beneficiaries, 143,000 households, will be reached during the project period with various project assistance. On the basis of the distribution of the project budget, as presented in Table 4, it was assumed that the project will have start-up activities and training of master trainers (TOT training) etc, and as such the farmers will start the cultivation practices in the 2nd year. Therefore, no financial benefits from the beneficiaries is expected in in the 1st year; but 22% of the beneficiaries in year 2 will start adopting technologies; 27% in year 3; 32% in year 4 and the balance 18% in year 5. With project closing activities, the project will not reach out to beneficiaries in the 6th year of the project. Table 5 summarises the assumed phasing of beneficiaries for project support. The aggregation of the project benefits in the project level financial and economic analyses was undertaken using the distribution shown in this table.

Table 5: Number of beneficiaries supported by the project during the project period

[4] The total 143,000 consists of 71,500 (50%) men; 71,500 women; 35,750 (25%) mail youth; 35,750 female youth; and 2,860 (2%) PLWD. (Ref: para 406 of Annex 2 – *op cit*.)

[5] Feasibility Study for the GCF-FAO Project "Transforming Livelihoods through Climate Resilient, Low Carbon, Sustainable Agricultural Value Chains in the Lake Region Economic Bloc, Kenya"

[6] Paragraph 400 of ANNEX_02-FS-FAO-KEN-PartB-C-20230726-V1. Average land size is in Para 16 of the same report.

Direct BENEFICIARIES (HH)	Units	Total	Proj Yr 1	Proj Yr 2	Proj Yr 3	Proj Yr 4	Proj Yr 5	Proj Yr 6
Budget Distribution		100%	9%	13%	22%	22%	18%	15%
Out reach Distribution (based on budget)		100%	0%	22%	27%	32%	18%	
Project Participants in FFS (HH)	HHs	63,000	0	14,112	16,949	20,350	11,589	
Project Participants in COOPs (HH)	HHs	80,000	0	17,920	21,523	25,841	14,716	
Total	HHs	143,000	0	32,032	38,472	46,191	26,305	

H. Project Area and the Value Chain Crops

25. The project will operate in Bomet, Bungoma, Busia, Homa Bay, Kakamega, Kericho, Kisii, Kisumu, Migori, Nandi, Nyamira, Siaya, Trans Nzoia, and Vihiga. Given that many of the climate change impacts are felt through – and mitigated through – land use, land use changes and forestry, it is important to ensure that climate-resilient, low-carbon practises promoted by the project are well adapted to current and future conditions. These were included in the WP gross margin models. The project focuses on the top 6 priority value chains[7], three of which have more of a market orientation (dairy, coffee and tea) and three that have more of a household food security orientation (African leafy vegetables, poultry and fruit tree – avocado and banana). Table 6 summarises the typical VCs in each county (Source: Table 7, ANNEX_02-FS-FAO-KEN-PartB-C-20230726-V1). For the EFA, gross margin models representing with and without project scenarios were developed for each VC crop for two climate change scenarios – RCP 2.6 and RCP 8.5. It is assumed that a single model for each climate change scenario of a VC commodities will be appropriate for all the counties.[8] It is noted, however, that livestock model has not differentiated models for climate change scenario as the production information regarding RCP 8.5 and 2.6. is not available.

Table 6: Project counties and the Value Chain Crops

Counties	*Coffee*	*Dairy*[9]	*Fruit Trees (avocado and banana)*	*Vegetables*	*Poultry*	*Tea*
Bomet	X		X			X
Bungoma	X			X	X	X
Busia				X		
Home Bay		X				
Kakamega		X		X		
Kericho	X	X	X			X
Kisii	X	X	X	X		
Kisumu		X	X		X	
Migori	X	X		X		
Nandi	X		X	X	X	
Nyamira	X	X		X		X
Siaya			X			
Trans-Nzoia	X	X		X	X	X
Vihiga		X	X		X	
Model summary	WOP: RCP8.5 & 2.6 WP: RCP8.5& 2.6	WOP WP	WOP: RCP8.5/2.6 WP: RCP8.5/2.6	WOP: RCP8.5/2.6 WP: RCP8.5/2.6	WOP WP	WOP: RCP8.5/2.6 WP: RCP8.5/2.6

I. Project activities and intervention in the VCs

26. The project has 4 components namely: Component 1 – Enabling local government support for adaptation and mitigation; Component 2 – Sustainable Resilient Agricultural Landscapes; Component 3 – Resilient livelihoods; and Component 4 – Scaling through CRLCSA market and finance. There are

[7] Each county was asked to undertake a list of all the value chains that were practiced by smallholders in their territory, and to rank these according to each of the criteria, on a scale of 1 to 5, 1 being the lowest potential and 5 being the highest. The total scores were then added, and scores for the groups of criteria were weighted as follows: climate/environment, economic and social criteria were allocated 60% of the score, and the last criteria on availability of technology was given 40%. The final score of the value chains was used to rank them by order of priority.
[8] A variation in the model characters could be expected in different counties. However, data limitation precluded forming county specific models.
[9] For dairy and poultry there are no RCP models as the projected productivity declines due to climate change were not available for the EFA.

multiple activities under each of these components that will support the production, processing and marketing of VC commodities. Table 7 summarises the project activities under each component, direct interventions of these activities and whether or not the VC products will be directly benefitted by these activities. It is noted that some activities have only indirect contribution to the productivity improvement of the VC products. The EFA has captured, to the extent possible, the impacts of the activities on the improved production.

Table 7: Project activities and their interventions in VC commodity models

Component	Project Activity	Direct intervention in the VC	Benefit to the VC gross margin models
Component 1 – Enabling local government support for adaptation and mitigation	1.1.1 Develop and deploy innovative and efficient extension methods for disseminating and demonstrating CRLCSA knowledge, technologies, and practices	Diagnose extension gaps and develop more effective extension systems	Provide climate-resilient and low-carbon technologies to with-project (WP) models. All 7 VC commodities.
	1.1.2. Strengthen the dissemination of climate information services to last-mile users	Improve the quality, reach, usefulness and timeliness of climate information transmission to last mile-users.	Adaptation of WP models to use improved technologies. All 7 VC commodities.
	1.1.3. Develop and test methodologies for decentralized carbon accounting	No direct intervention, county level capacity improvement for carbon accounting	No direct benefits
	1.1.4 Upgrade and update agricultural databases, crop and productivity datasets, cooperative census	Helps developing climate resilient business plans for cooperatives and FOs and aligned investment in infrastructure and market development; inform local climate change risk assessment and management for taking better farmers' decisions	Help improve adoption of climate-resilient and low-carbon technologies in WP VC models. All 7 VC commodities.
	1.1.5. Assess eligible climate solutions for the agriculture sector in relation to climate impacts	This is to enable county governments to provide services related to the screening, assessment and participatory selection of suitable climate technologies and list of climate technologies (green list) will be identified	VC model users will be effectively informed on such technologies which improve WP model productivity. All 7 VC commodities.
	1.1.6. Share knowledge and lessons learned through existing platforms	Upscaling and broader adoption of project outputs and outcomes	No direct benefits immediately for the VC models.
Component 2 – Sustainable Resilient Agricultural Landscapes	*2.1.1*- Develop county and regional climate-resilient and low-carbon agricultural landscape management strategies	Develop a climate resilient, low-carbon landscape management strategy and action plan and train stakeholders on climate resilient, low-carbon landscape management – at county level.	No direct benefit to the WP VC models.
	2.1.2. Implement and monitor climate-resilient and low-carbon landscape management plans	Support the development of implementation plans and monitoring and evaluation plans for each landscape management strategy at county level. Implement forestry related activities.	No direct benefit to the WP VC models.
Component 3 – Resilient livelihoods	*3.1.1*. Deploy CRLCSA production/ processing assets and training to smallholder farmers, farmer organizations and associations	Through the FFS approach, the project will allow farmers to experiment with and uptake climate-resilient practices, technologies, and farming systems.	Beneficiaries will adopt climate-resilient and low-carbon technologies in WP models resulting from FFS training. FFS beneficiaries in all 7 VC commodities.

	3.1.2 Disseminate CRLCSA technology, knowledge, and assets to cooperative members through peer-to-peer networks and exchanges	Transfer technology to farmers through cooperatives through training; providing inputs, materials, equipment, supplies to support technology; and fully finance rehabilitation or upgrading of cooperative infrastructure	Coop members will adopt technologies for WP crop models. Coop beneficiaries in all 7 VC commodities.
	3.1.3. Support smallholder farmer aggregation into cooperatives and other business units as climate risk reduction and risk sharing mechanisms	Training and capacity development will be provided to farmer organizations with a focus on the management and governance of FO and cooperatives which will improve their capacity	No direct benefits to the WP VC models.
	3.1.4. Support improvements in social inclusion and women's meaningful participation in CRLC value chains	This ensures that project activities, technology transfer and support to cooperatives also contribute to the social inclusion (women, youth and PLWD in the 6 value chains).	No direct benefits to the WP VC models – except inclusion
Component 4 – Scaling through CRLCSA market and finance	*4.1.1* Work with buyers and aggregators to increase demand and market opportunities for CRLCSA commodities	The project will work on the demand side of the value chain to increase uptake of CRLCSA commodities produced by project beneficiaries and the project will begin by carefully analyzing the demand, quality standards, grading norms and prices for climate resilient, low-carbon products. Further, starting year 3, the project will team up with relevant value chain actors to develop and deliver a targeted marketing campaign for each of the 6 value chains	Stable prices with increasing trend (assumed) for VC products for WP cases. All 7 VC commodities.
	4.1.2. Increase access to various third-party certification and labeling schemes	This is to remove market access barriers and create a distinct market pathway for commodities produced or processed under climate resilient, low-carbon processes.	Certification result in better prices for goods produced at a higher cost for the farmers and processors. A selection of 30 cooperatives and FO is expected, starting at year 3, who will get 10% (assumed) higher prices.
	4.2.1. Develop gender-responsive and socially inclusive private finance tools, procedures, and products to promote the upscale of CRLCSA value chains	The project will support the development of capacity within financial institutions to support climate resilient, low-carbon value chains and it helps strengthening and increasing the supply and accessibility of financial products available to support climate resilient, low-carbon agriculture in the region. New financial products or revised existing products will be rolled out.	All seven VC commodities will be able to access debt financing. WP models will demonstrate the viability of accessing credit.
	4.2.2. Support smallholders and their business units in the development of bankable business plans	Farmer organizations, value chain actors (e.g processors) and cooperatives will access, with project support, financial services offered by the partner financial institutions	Capital availability for the WP VC models. All 7 VC commodities.
	4.2.3 Facilitate smallholders access to financial incentives schemes for agroforestry	Supporting accessing carbon markets, payments for ecosystem services, biodiversity offsets or conservation finance	WP VC models are not directly impacted.

4. Main assumptions for the EFA

27. The EFA of the project was based on the following main assumptions:

(a) The VC crops, dairy and poultry included in the EFA are already in production and they will improve the productivity by adopting climate resilient, low-carbon technologies in the existing farms.

(b) It is assumed that a single gross margin (GM) model for each crop can be used to represent that crop in each county. Thus, the EFA did not have county specific GM models for WOP and WP cases.

(c) Most crop farmers including tea and coffee growers are smallholders, having farms with an average size of 0.2 hectare (ha) with chronic low productivity[10]. For the EFA, average size of cultivations of all crops was therefore assumed at 0.2 ha for both WOP and WP cases.

(d) Livestock farmers also have small herds (typically 3-4 animals for dairy and 20-50 for poultry) with limited coping capacity and low productivity. Representing this situation both WOP and WP cases for dairy was assumed to have 3 cows for one farm, where as 50 birds for WOP and 70 birds for WP.

(e) Although there are active markets in the counties, it was observed[11] that adoption of improved technologies and practices and climate-proof inputs such as improved seed varieties, mechanization services, proper fertilizer, input use, and access to extension services, remain relatively low. The WOP scenario was formulated on the basis of this assumption. The improved practices were assumed in the WP scenario. The model descriptions include the list of such practices that were considered in the gross margin models.

(f) The WOP scenario assumed low productivity of crops as a result of climate variability, and high levels of loss and wastage in the post-harvest stages. It was also assumed that tea and coffee, in particular, are characterized as unsustainable mono-cropping systems. The WOP models were designed to represent such situations. The WP models assumed improvements in the agronomic practices and mixed cropping systems. The incremental net revenue flows of tea, coffee and avocado will be negative for the initial 2-3 years. This is because the farmers will adopt agronomic practices that are listed in Table 9 and the return to such investment will be realised after about 3-4 years period. During negative income period, famers should be supported with debt financing. The models' descriptions included the details.

(g) Adoption rates: it is assumed that for all promoted technologies with project support, the adoption rate will be 60% for crops and livestock. This is based on experience from FAO and Agriterra through both cooperatives and farmer field schools. It is also a reasonable assumption that not all farmers will be applying all technologies by the end of the project, but rather will focus on the ones that provide them with the most economic and resilience benefits. The assumption is that at least 60% of participating farmers will adopt at least 2 of the promoted climate resilient, low-carbon practises (in addition to any practices they are already implementing) with project influence.[12]

(h) On the basis of the average land size of 0.2 ha[13] per beneficiary households, land extent under different crops to be improved has been estimated. The total land that will be targeted for improvement with project guidance and support will be 28,600 ha (0.2 x 143,000). The project will contribute to avoid deforestation and land clearing and thus results in supporting the estimated extent of 28,600 ha. The assumed adoption rate is 60% and therefore the land extents under different crops that will eventually be developed will be 17,160 hectares (60% of 28,600). Table 8 presents the extents under different crops and livestock.

(i) It is assumed that the WOP case will also be characterised by the practise of burning crop residues, having no or minimum irrigation for all crops, and no application of organic manure. Therefore, all improved management techniques will be recommended under the project, with expected adoption rate of 60%.

28. On the basis of the assumption listed above, the total targeted hectares of the VC product that will be developed under the project, corresponding beneficiary households and the distribution of the targets by the project years are presented in Table 8.

[10] Lake Region Economic Bloc, 2015
[11] Value Chain studies conducted by FAO for this project made the observation.
[12] Para 434, ANNEX_02-FS-FAO-KEN-PartB-C-20230726-V1
[13] GCF Funding Proposal, Version 3, para 287

Table 8: VC commodities and their targets with number of households practicing and extent (ha) of cultivation

VC Products	Units for Target	Total Target (ha) and Nb livestock		Outreach	Number of Units of VC products targeted (ha with 60% adoption rate) and Livestock Number				
		WOP Units	WP Units (with 60% adoption rate)	Total HH	WP - Yr 1	WP - Yr 2	WP - Yr 3	WP - Yr 4	WP - Yr 5
Total Land Extent	ha	28,600	17,160	143,000					
Tea cultivation	ha	7,150	4,290	35,750	0	961	1,154	1,386	789
Coffee cultivation	ha	7,150	4,290	35,750	0	961	1,154	1,386	789
African Leafy Vegetables	ha	8,580	5,148	42,900	0	1,153	1,385	1,663	947
Avocado	ha	2,860	1,716	14,300	0	384	462	554	316
Banana	ha	2,860	1,716	14,300	0	384	462	554	316
Dairy Cows	Nb Animals	85,800	85,800	42,900	0	19,219	23,083	27,715	15,783
Poultry	Nb Animals	286,000	286,000	28,600	0	64,065	76,943	92,383	52,609
		28,600	17,160	143,000					
Yearly distribution of total land area developed (with 60% adoption rate; ha) - WP					0	3,844	4,617	5,543	3,157

29. The EFA was based on several technical assumptions which are listed in Table 9 below. These assumptions involved the WOP (baseline) situation in terms of adoption of technologies in the production of all VC commodities; the climate resilient, low-carbon technologies that were assumed to be adopted by the project beneficiaries (as mentioned above, not all the technologies adopted); targets for the EFA as presented in Table 8; and a summary of the data sources that were used for obtaining information. The same set of technologies and the input-output coefficient of such technologies were used for both climate change scenarios – RCP 2.6 and RCP 8.5.

(a) All benefits were estimated using 2024 constant prices. The incremental costs and benefits of the project supported VC commodities will continue for a 20-year period which include the 6-year project implementation period. It is assumed that the general inflation will have a similar impact on cost and benefits flows at an equal rate and hence the price escalation on costs and benefits have not been adjusted.

(b) For all activities which used labour, a financial rural daily wage rate of KSh 500 person-day was used. The wage rate was not differentiated by gender, and the same rate was paid to female labour. The same wage rate was used to value household family labour too because of the availability of wage labour opportunities in the project areas.

(c) For all farm models, the cash flows were generated for 1 ha unit and thereafter the cash flows were scaled down to represent the cultivation sizes of the crops in the farm (average was 0.2 ha). The scaled down extents were used in the project level aggregated analysis.

(d) The discount rate of 18% was used for the computation of financial profitability indicators which is the current rate for agricultural loans that are provided by the Equity Banks to small and medium enterprises in the project counties.

(e) The beneficiaries will use a portion of the production of fruits, vegetables, milk and poultry for domestic consumption. However, the total production net of post-harvest losses has been valued and included in the analysis.

5. Model Description

30. Table 9 summarises the description of the models used for the EFA and the source of information used to formulate the models. The baseline situation (WOP situation or business-as-usual) assumes the adoption of current agronomic and livestock practices for 20 years including the 6-year project implementation period. With such technologies and existing plant varieties, it is expected that the yield of tea, coffee, avocado, banana and the African Leafy Vegetable will gradually decline. FAO has modeled the extent of yield decline based on climate change variation for two scenarios – RCP 8.5 and RCP 2.6[14]. For all crops, yield under rain-fed conditions were used for a without project scenario, which

[14] The climate impact assessment in agriculture for tea, coffee, bananas, and cowpea for representative counties in the LREB, is based on findings on simulated agroclimatic potential yields (kg/ha) emerging from the Python Package for Agro-ecological zoning (PyAEZ) tool developed by FAO,

shows a slight gradual decrease as well as interannual variability in yield due to the high interannual rainfall variability estimated by the FAO models. WP scenario assumed yield under rainfed conditions. The EFA has used the rate of decline under both scenarios to discount the yield for a period of 20-years and formulated two sets of gross margin models.

With the intervention of the project, it is expected that the project target group will adopt several climate resilient and low-carbon technologies to address the yield decline under both of these RCP scenarios and to stabilise the yield. The WP models were formulated assuming that climate resilient and low-carbon technologies will be adopted and accordingly the inputs and the yield parameters have been modified. The EFA excel sheets present these parameters representing WOP and WP cases.

which estimates biomass based on an eco-physiological model (Kassam, A. H. 1977. Net Biomass Production and Yield of Crops with Provisional Results for Tropical Africa. Soil Resources, Management and Conservation Service, Land and Water Development Division, FAO). A constraint free crop biomass is accumulated along the growing season mainly driven by incoming solar radiation, temperature, and crop specific characteristics (e.g., length growth, maximum rate of photosynthesis, Leaf Area Index-LAI at full development, harvest index and crop's sensitivity to heat provision). To maximize yields, the choice of the start of the growing season is determined automatically by the Agro-ecological zoning (AEZ) tool. The simulation is conducted independently for rainfed conditions and irrigated conditions [Fischer, G., Nachtergaele, F.O., van Velthuizen, H.T., Chiozza, F., Franceschini, G., Henry, M., Muchoney, D. and Tramberend, S. 2021. Global Agro-Ecological Zones v4 – Model documentation. Rome, FAO. https://doi.org/10.4060/cb4744en].

31. Table 10 shows key parameters namely productivity, cost of production and labour use of all VC commodities for both WOP and WP cases under both RCP scenarios.

Table 9: VC Commodity, WOP and WP assumptions and targets and sources of data used for model construction

VC Commodity	WOP (Baseline) Situation	WP situation: climate resilient and low-carbon technologies listed below will be assumed to be adopted	Targets for the EFA		Data Sources (full bibliography is presented in Appendix 1 of this Annex)
			Nb HHs	Hectares/heads of animal	
Coffee – RCP 8.5 Coffee – RCP 2.6	- Low fertilizers and no control coffee diseases; - Limited availability of organic manure; - No proper picking techniques reducing overall quality of coffee cherries; - Poor drying and processing methods reducing coffee quality; - Residues are burnt and there is no irrigation practices	- Mulching, crop cover, double digging (DD) -Intercropping with legumes, green manures, shade trees - Biofertilizers for coffee - Contour bunds – soil conserv - Integrated Pest Management - Solar drying -Gap filling with new plants	35,750	WOP: 4,290 WP: 4,290 Adoption rate: 60%	WOP Yd and cultural practices: Kenya Coffee Platform (2018); Daniel M. Wambua, Bernard M. Gichimu, Samuel N. Ndirangu; (2021); Kenya Coffee Platform (2018), Coffee Economic Viability Study. WP yd & cultural practices and market price: ANNEX_23a-VCA-FAO-KEN-Coffee-20230726-V1)
Tea – RCP 8.5 Tea – RCP 2.6	-Low use of fertilizers; -Weak post-harvest infrastructure; -Low access to weather-informed agricultural advisory; -limited diversification practises; -lack of access to technologies; -increasing future need to use pesticides due to a risk of pests and disease outbreaks as a result of climate change	- Mulching, crop cover, double digging (DD) (DD involves loosening of two layers of soil, and the addition of organic matter); - Intercropping with legumes and green manures or shade trees; -Use of Biofertilizers; - Use of contour bunds, pits, strip catchment; - Integrated Pest Management[15]; -Gap filling with new plants	35,750	WOP: 4,290 WP: 4,290 Adoption rate: 60%	WOP Yd and cultural practices: Onduru, D. D; and Muchena, F. N (2011); World Soil Information (2021); Tea Growers' Guide (2019); WP yd & cultural practices and market price: ANNEX_23a-VCA-FAO-KEN-Tea-20230726-V1 & Tea Growers' Guide; M.S.A. Mamun; M. Ahmed; and S.K. Paul (2014)

[15] M.S.A. Mamun; M. Ahmed; and S.K. Paul (2014): Many different tactics of IPM strategies including cultural practices, physical, mechanical and biological control agents, pest-resistant varieties and chemical pesticides are used in tea plantation. In tea husbandry, cultural control measures such as plucking, pruning, shade regulation, field sanitation, fertilizer application, host plant resistance, manipulation or destruction of alternate hosts and selection of pest resistant/tolerant varieties and mechanical mechanisms like manual removal, heat treatments, light traps, use of bio-pesticides, bio-control agents and sex pheromone trap need to be given more importance in pest management programme in tea.

Dairy There are no RCP models as the projected productivity declines due to climate change were not available for the EFA.	-Weak fodder and water management practices, favouring free-range production systems; -limited infrastructure for feed storage and transportation as well as for milk cooling, processing, packaging and storage; -Delays in veterinary services.	-On-farm fodder production -Rainwater harvesting (RWH) to compensate for dry periods -Improved feed conservation and diversification (e.g., organic-crop residues, herbs, branches, shrubs, and grass) -Improved access to veterinary services and insurance schemes; -improved pests and disease control	42,900 These HH are counted for crops grown HHs	Animals: WOP: 85,000 WP: 85,000	Both WOP and WP cases and milk prices: FAO (2023), Youth centered value chain analysis WP milk yd: FAO (2020), LSIPT Livestock Sector Investment and Policy Toolkit ANNEX_23a-VCA-FAO-KEN-Dairy-20230726-V1 ANNEX_22c-GHG-FAO-KEN-GLEAM-20230726-V1
Poultry There are no RCP models as the projected productivity declines due to climate change were not available for the EFA.	-Limited access to adequate feed and water resources; -Damage to input storage infrastructure, feed spoilage due to heavy rainfall -Reduced vigour of breeding poultry due to extrema heat -Increased animal mortality and feed spoilage; -increased pest and water-borne disease attacks	-Climate-proofed local poultry houses (brick walls, iron sheets); -Procure water; -purchase and/or store supplementary feed. - Vaccinating flock - Disinfecting feeding/water equipment - Sanitation practices in poultry houses	28,600 These HH are counted for crops grown HHs	Birds: WOP: 286,000 WP: 286,000	Both WOP and WP cases: FAO. 2022. Africa Sustainable Livestock 2050 FAO (2023), Youth centered value chain analysis ANNEX_22c-GHG-FAO-KEN-GLEAM-20230726-V1 Egg prices: https:// www.expatistan.com/ price/ eggs/nairobi
Vegetable – RCP 8.5 Vegetable – RCP 2.6	-Lack of information on tailored climate-smart agricultural practices and technologies; -Lack of public and private investments and credits; -Limited access to agronomic packages;	- Intercropping with legumes and green manures -On-farm elaboration of organic fertilizers through composting or vermiculture -Other methods include contour bunds, pits, strip catchment, contour farming. -Drip or precision irrigation -Improved soil preparation practises to reduce soil erosion, increase retention of organic matter and prepare more uniform seed beds	42,900	WOP: 5,148 WP: 5,148 Adoption rate – 60%	All cultural practices: WP case: ANNEX_23a-VCA-FAO-KEN-AFV-20230726-V1 Both WOP and WP cases: all cultural practices: Rampa, F; and Obiero Were, T. 2021 C.M. Onyango; J.K. Imungi; L.O. Mose; J. Harbinson; & Olaf Van Kooten (2009) UC Davis Nutrition Project (2021)

Banana and Avocado – RCP 8.5 Banana and Avocado – RCP 2.6	-Limited superior varieties or planting materials, -Pests and diseases (beetles and thrips for bananas) with a large proportion of harvest losses; -Weak infrastructure for post-harvest and off-farm activities;	-Inclusion of leguminous, multipurpose species -Mulching, crop cover -Use of organic fertilizers -For soil and water conservation - contour bunds -Water management & irrigation -Climate resilient, drought-tolerant varieties -Reduce use of non-organic pesticides, fungicides, and herbicide and introduce integrated pest management	Avocado & Banana, each: 14,300	Avocado (WOP): 1,716 Avocado (WP): 1,716 Banana (WOP): 1,716 Banana (WP): 1,716 Adoption rate – 60%	<u>Avocado – both WOP and WP production practices</u> Daniel M. Wambua; Bernard M. Gichimu; and Samuel N. Ndirangu; (2021); and Avocado prices: ANNEX_23a-VCA-FAO-KEN-Fruits-20230726-V1 <u>For Avocado yield curve (WP):</u> Mulugeta Mokria, et al (2022), and per ac yield potential[16] **Banana: Both WOP and WP cases** – cultural practices Onduru, D. D; and Muchena, F. N. (2011), and Banana prices: ANNEX_23a-VCA-FAO-KEN-Fruits-20230726-V1

[16] Yield estimation and socioeconomic potentials of avocado production In the study area, the mean yield was nearly 45 kgtree−1 for Ettinger, Fuerte, Hass, Reed and it was about 90 kg tree−1 for Nabal. Among other factors, tree age, cultivar type, agroecology, management, and tree density within an orchard are important factors to influence the yield. Other studies showed that avocado trees at age eight(8) years can provide a yield ranging from 30–100 kg tree−1.Hence, our finding is in line with other research reports on the productivity of young avocado plantations] . Moreover, the life cycle of avocado (longevity and productive period) is long and a tree of eight years onwards is considered an adult and fully productive for a period that can extend for more than 20 or 25years. The adult orchard typically stabilizes its annual production from 80 to100 kg of fruit per tree from 10–1 5years of age. Hass Avocado Yield Per Acre [https://www.linkedin.com /pulse/hass-avocado-yield-per- tree-while-taking-advantage-rains-trend]

6. Results of the Financial Analysis

A. Gross margin model analyses for VC commodities

33. On the basis of the assumptions listed above, the financial viability of all the value chain commodities has been estimated for both RCP scenarios.

Table 10 presents the production parameters such as yields and farm-gate prices that were used in the analysis. The table also presents the total cost and the net revenue of each model. The model size of one hectare was used to estimate the financial viabilities of the models. The average size of the farms that represent these models is, however, 0.2 hectares. As

34. Table 10 indicates, there will be a substantial increase in the net income of all VC commodities at full development after adopting climate resilient and low-carbon technologies which are listed in Table 9 under both RCP scenarios.

35. The yield of crops for WOP and WP cases were based on the following information sources (the full reference is in Annex 1). The yield of the WP cases was adjusted to some extent to represent the actual situations of the project counties. The assumption that was maintained in the adjustment was that the project is mainly going to target vulnerable farmers, and as such their level of change in yield from WOP and WP might be lower than what is shown in literature that were referred.

(a) Tea – WOP: Onduru, D. D; and Muchena, F. N (2011), World Soil Information, Cost Benefit Analysis of Land Management Options in the Upper Tana, Kenya

(b) Tea – WP: Samson Kamunya; Simon Ochanda; Evelyn Cheramgoi; Richard Chalo; Kibet Sitienei, Ogise Muku; Wilfred Kirui; and John K. Bore (2019); *Tea Growers' Guide*

(c) Coffee – WOP: Daniel M. Wambua; Bernard M. Gichimu; and Samuel N. Ndirangu; (2021), *Smallholder Coffee Productivity as Affected by Socioeconomic Factors and Technology Adoption*

(d) Coffee – WP: ANNEX_23a-VCA-FAO-KEN-Coffee-20230726-V1, with a slight downward adjustment to reflect lower production based on the basis of Onduru et al (above reference)

(e) Avocado – WOP: Mulugeta Mokria et al (2022)

(f) Avocado – WP: Same reference with different cultural practices

(g) Banana – WOP: Copy of FAO-KEN-Data-for-EFA_working

(h) Banana – WP: Onduru et al (above reference)

(i) Dairy – WOP: ANNEX_22c-GHG-FAO-KEN-GLEAM-20230726-V1 (sheet, Cattle, cell L36).

(j) Dairy – WP: FAO (2023), Youth centered value chain analysis, The cases of Siaya and Kakamega counties in Kenya

(k) Poultry – WOP: FAO (2023) (above reference)

(l) Poultry – WP: FAO. 2022. Africa Sustainable Livestock 2050: Business models along the poultry value chain in Kenya

(m) African leafy vegetable – WOP and WP: C.M. Onyango; J.K. Imungi; L.O. Mose; J. Harbinson; & Olaf Van Kooten.

Table 10: Production parameters of VC commodity models

RCP 8.5 Scenario

Model (VC Product)	Units	Model Size for the analysis	Farm Size	Type of product	Productivity/Yr (at FD)	Total Cost (KSh/Yr)	Tot gross revenue (KSh/Yr)	Tot net revenue (KSh/Yr)	Labour Use (md/Yr)	Price at Farm-Gate (KSh)	Yd Changes
Tea: WOP	ha	1	0.2	Green tea leaves (kg/ha)	5,604	141,484	179,322	37,837	238	32	
Tea: WP	ha	1	0.2		7,912	192,950	253,184	60,234	301	32	41%
Coffee: WOP	ha	1	0.2	Fresh cherry beans (kg/ha)	4,129	257,154	293,141	35,987	145	71	
Coffee: WP	ha	1	0.2		5,643	342,051	400,653	58,602	238	71	37%
Avocado: WOP	ha	1	0.2	Fresh Fruits (kg/ha)	27,830	431,666	1,057,539	625,874	141	38	
Avocado: WP	ha	1	0.2		40,625	595,616	1,543,750	948,134	213	38	46%
Banana: WOP	ha	1	0.2	Fresh Fruits (kg/ha)	7,488	124,200	202,388	78,188	136	9	
Banana: WP	ha	1	0.2		11,000	161,700	279,000	117,300	151	9	47%
Amaranth: WOP	ha	1	0.2	Fresh leaves (kg/ha)	10,000	145,220	260,000	114,780	62	26	
Amaranth: WP	ha	1	0.2		13,500	174,220	351,000	176,780	70	26	35%
Dairy: WOP	Cow	3	3	Milk Lt/Yr/HH	3,552	218,169	168,715	-49,453	120	50	
Dairy: WP	Cow	3	3		5,009	197,888	255,908	58,020	240	50	41%
Poultry: WOP	Birds	47	47	Nb eggs/Yr/HH	3,610	81,990	71,816	-10,174	70	10	
Poultry: WP	Birds	47	47		6,656	108,875	117,855	8,980	100	10	84%

RCP 2.6 Scenario

Model (VC Product)	Units	Model Size for the analysis	Farm Size (ha)	Type of product	Productivity/ Yr (at FD)	Total Cost (KSh/Yr)	Tot gross revenue (KSh/Yr)	Tot net revenue (KSh/Yr)	Labour Use (md/Yr)	Price at Farm-Gate (KSh)	Yd Changes
Tea: WOP	ha	1	0.2	Green tea leaves (kg/ha)	5,973	144,434	191,121	46,687	244	32	
Tea: WP	ha	1	0.2		7,912	192,950	253,184	60,234	301	32	32%
Coffee: WOP	ha	1	0.2	Fresh cherry beans (kg/ha)	4,295	261,078	304,929	43,850	147	71	
Coffee: WP	ha	1	0.2		5,643	342,051	400,653	58,602	238	71	31%
Avocado: WOP	ha	1	0.2	Fresh Fruits (kg/ha)	26,074	414,109	990,823	576,714	141	38	
Avocado: WP	ha	1	0.2		40,625	595,616	1,543,750	948,134	213	38	56%
Banana: WOP	ha	1	0.2	Fresh Fruits (kg/ha)	6,401	124,200	192,612	68,412	136	9	
Banana: WP	ha	1	0.2		11,000	159,200	279,000	119,800	146	9	72%
Amaranth: WOP	ha	1	0.2	Fresh leaves (kg/ha)	10,000	145,220	260,000	114,780	62	26	
Amaranth: WP	ha	1	0.2		13,500	174,220	351,000	176,780	70	26	35%
Dairy: WOP	Cow	3	3	Milk Lt/Yr/HH	3,618	174,481	201,513	27,033	120	50	
Dairy: WP	Cow	3	3		5,009	197,888	255,908	58,020	240	50	38%
Poultry: WOP	Birds	47	47	Nb eggs/Yr/HH	3,610	68,824	71,816	2,992	70	10	
Poultry: WP	Birds	47	47		6,656	108,875	117,855	8,980	100	10	84%

36. In addition to the net income, other financial viability indicators for all the VC commodities were estimated for both RCP scenarios and summarised in Table 11. The financial viability indicators of all VC commodity models, as shown in the table, have positive values for the WOP cases. This indicates that the beneficiaries can continue to farm and raise livestock with current technologies (WOP case) with positive financial results under both RCP scenarios. The financial indicators, however, shows (Table 11) that the beneficiaries will be better off by adopting climate resilient and low-carbon technologies that are listed in Table 9, which is the WP scenario. All financial viability indicators are higher for the WP cases than that of the WOP cases.

37. The farm and livestock models are slightly different from each other in the WOP and the WP case because of differences in the adopted technologies. Therefore, the modified internal rate of return (MIRR) was also estimated for all models to confirm the improvement in WP cases. MIRR assumes that positive cash flows of the farm are reinvested at the farmer's cost of capital, which is the financial discount rate, and that the initial outlays are financed at the farmer's financing cost, which is the IRR.[17] By

17 The MIRR is used to rank investments or projects of unequal size or di-similar characters which is the case in WOP and WP scenarios. The calculation is a solution to two major problems that exist with the popular IRR calculation. The first main problem with IRR is that multiple

contrast, the traditional internal rate of return (IRR) assumes the cash flows from a farm are reinvested at the internal rate of return itself, which may not be the case in traditional farming. The MIRR, therefore, more accurately reflects the profitability of a farm, and it is higher than the DR indicating the viability.

38. Return to family labour is also notably higher for the WP cases. As most of the beneficiaries use family labour for farming (ANNEX_02-FS-FAO-KEN-PartB-C-20230726-V1), return to family labour is important for rural farmers. The analysis shows that it is higher for the WP cases indicating that more returns to labour can be obtained by adopting climate resilient and low-carbon technologies. The pay-back period, which was computed taking the discounted cash flows (where the year in which the Net Present Value will be zero) has also shown that the WOP models can break-even the cost and the benefits flows in a shorter period. This was observed in both RCP 8.5 and RCP 2.6 scenarios. As vegetable is an annual crop, year 1 itself generate positive benefits.

Table 11: Financial viability parameters of VC commodity models – comparison of WOP and WP

RCP 8.5 Scenario

Model (VC Product)	NPV-Cost: 18% DR; 20 yrs (KSh)	NPV-Ben: 18% DR; 20 yrs (KSh)	NPV: 18% DR; 20 yrs (KSh)	B/C ratio	IRR	MIRR (modified IRR)	Return to Family Labour (KSh/md)	Pay-back period: Yrs
Tea: WOP	885,542	877,407	-8,135	0.99	16%	17%	646	9
Tea: WP	1,146,175	1,236,666	90,491	1.08	29%	21%	703	7
Coffee: WOP	1,413,840	1,403,388	-10,452	0.99	14%	17%	642	10
Coffee: WP	1,861,730	1,954,476	92,746	1.05	30%	22%	747	9
Avocado: WOP	1,327,028	1,808,758	481,731	1.36	29%	23%	5,495	11
Avocado: WP	1,850,506	3,064,703	1,214,197	1.66	38%	26%	5,522	10
Banana: WOP	933,344	1,027,719	94,375	1.10	26%	20%	1,045	8
Banana: WP	1,153,529	1,480,832	327,303	1.28	48%	24%	1,321	7
Amaranth: WOP	777,326	1,545,685	768,359	1.99	>50%	>50%	3,038	0
Amaranth: WP	932,555	1,878,814	946,259	2.01	>50%	>50%	3,025	0
Dairy: WOP	974,674	990,027	15,353	1.02	27%	20%	725	9
Dairy: WP	1,128,172	1,267,116	138,944	1.12	56%	26%	53	8
Poultry: WOP	383,808	384,413	605	1.00	20%	18%	543	8
Poultry: WP	596,670	621,123	24,453	1.04	48%	24%	590	7

RCP 2.6 Scenario

Model (VC Product)	NPV-Cost: 18% DR; 20 yrs (KSh)	NPV-Ben: 18% DR; 20 yrs (KSh)	NPV: 18% DR; 20 yrs (KSh)	B/C ratio	IRR	MIRR (modified IRR)	Return to Family Labour (KSh/md)	Pay-back period: Yrs
Tea: WOP	883,353	868,652	-14,701	0.98	16%	17%	662	7
Tea: WP	1,146,175	1,236,666	90,491	1.08	29%	21%	703	7
Coffee: WOP	1,420,747	1,380,012	-40,735	0.97	9%	14%	724	17
Coffee: WP	1,861,730	1,954,476	92,746	1.05	30%	22%	747	9
Avocado: WOP	1,328,031	1,812,569	484,539	1.36	29%	23%	5,560	11
Avocado: WP	1,850,506	3,064,703	1,214,197	1.66	38%	26%	5,522	10
Banana: WOP	933,344	1,024,778	91,434	1.10	26%	20%	1,005	8
Banana: WP	1,153,529	1,480,832	327,303	1.28	48%	24%	1,321	7
Amaranth: WOP	777,326	1,503,106	725,780	1.93	>50%	>50%	2,521	0
Amaranth: WP	932,555	1,878,814	946,259	2.01	>50%	>50%	3,025	0
Dairy: WOP	974,674	990,027	15,353	1.02	27%	20%	725	9
Dairy: WP	1,128,172	1,267,116	138,944	1.12	56%	26%	53	8
Poultry: WOP	383,808	384,413	605	1.00	20%	18%	543	8
Poultry: WP	596,670	621,123	24,453	1.04	48%	24%	590	7

B. Incremental cash flow analysis

39. Using incremental cash flows of each model, incremental financial indicators have been computed and presented in Table 12. The incremental cash flows were used to estimate the project level

solutions can be found for the same project. The second problem is that the assumption that positive cash flows are reinvested at the IRR is considered impractical in practice. With the MIRR, only a single solution exists for a given project, and the reinvestment rate of positive cash flows is much more valid in practice. (Ref: Investopedia: ADAM HAYES [https://www.investopedia.com/terms/m/mirr.asp].

financial viability indicators. Incremental cash flows also generate positive results for all viability indicators. Both IRR and MIRR confirms that the VC commodities are capable of generating incremental incomes (WP – WOP) that are above the financial opportunity cost of capital that the beneficiaries can invest. Banana, however, shows marginal profitability. Since the incremental return to labour is attractive for the family labour, the project can nevertheless expect beneficiaries to adopt climate sensitive and low-carbon technologies in banana as well. Both climate change scenarios have the same trend of results.

Table 12: Financial viability indicators of incremental cash flows

RCP 8.5 Scenario

Model (VC Product)	NPV-Cost (KSh)	NPV-Benefits (KSh)	NPV: 18% DR; 20 yrs (KSh)	B/C ratio	IRR	MIRR	Return to Family Labour (KSh/md)
Tea	260,633	359,259	98,626	1.38	48%	23%	703
Coffee	447,889	551,087	103,198	1.23	43%	24%	747
Avocado	523,478	1,255,945	732,467	2.40	69%	34%	5,522
Banana	220,185	453,112	232,927	2.06	>50%	>50%	1,321
Amaranth	155,230	333,129	177,899	2.15	>50%	>50%	3,025
Dairy	153,498	277,089	123,591	1.81	97%	30%	53
Poultry	212,862	236,711	23,849	1.11	48%	27%	47

RCP 2.6 Scenario

Model (VC Product)	NPV-Cost (KSh)	NPV-Benefits (KSh)	NPV: 18% DR; 20 yrs (KSh)	B/C ratio	IRR	MIRR	Return to Family Labour (KSh/md)
Tea	262,822	368,014	105,192	1.40	60%	25%	703
Coffee	440,983	574,464	133,481	1.30	106%	31%	747
Avocado	522,475	1,252,134	729,659	2.40	69%	35%	5,522
Banana	220,185	456,053	235,868	2.07	>50%	>50%	1,321
Amaranth	155,230	375,708	220,479	2.42	>50%	>50%	3,025
Dairy	153,498	277,089	123,591	1.81	97%	30%	53
Poultry	212,862	236,711	23,849	1.11	75%	27%	590

C. Farm level analysis

40. As mentioned above, the average land size of a farm is 0.2 ha and therefore the net income that a typical beneficiary will receive by adopting these models will be lower than the net revenues that are presented in

41. Table 10. The model size was scaled down from 1 ha to 0.2 ha to estimate the net revenue that a beneficiary who adopts all climate resilient and low-carbon technologies will receive in farming the selected crops. Table 13 presents the results of both climate change scenarios. The same table also presents the net incremental income for the 1st four years of each commodity model.

Table 13: Average net income of VC commodity models received by a typical beneficiary

RCP 8.5 Scenario

Model (VC Product)	Unit - WP	Farm Size - WP	Net Income (KSh/Yr): WOP	Net Income (KSh/Yr): WP	Net increase (KSh/Yr/HH)	% Increase in income (WP)
Tea	ha	0.2	7,567	12,047	4,479	59%
Coffee	ha	0.2	7,197	11,720	4,523	63%
Avocado	ha	0.2	125,175	189,627	64,452	51%
Banana	ha	0.2	15,638	23,460	7,822	50%
Amaranth	ha	0.2	22,956	35,356	12,400	54%
Dairy	Cow	3	-49,453	58,020	8,567	17%
Poultry	Poultry	70	-10,174	8,980	19,154	12%

RCP 2.6 Scenario

Model (VC Product)	Unit - WP	Farm Size - WP	Net Income (KSh/Yr): WOP	Net Income (KSh/Yr): WP	Net increase (KSh/Yr/HH)	% Increase in income (WP)
Tea	ha	0.2	9,337	12,047	2,709	29%
Coffee	ha	0.2	8,770	11,720	2,950	34%
Avocado	ha	0.2	115,343	189,627	74,284	64%
Banana	ha	0.2	13,682	23,960	10,278	75%
Amaranth	ha	0.2	22,956	35,356	12,400	54%
Dairy	Cow	3	27,033	58,020	30,988	115%
Poultry	Poultry	70	2,992	8,980	5,988	200%

Incremental income for the 1st 4 years of the gross margin model of all commodities

Model (VC Product)	**Units**	**Incremental Income due to the Project**			
RPC 8.5		**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**
Tea	KSh/ha	-47,631	-61,887	92,179	97,420
Coffee	KSh/ha	-41,126	-52,587	60,803	52,536
Avocado: Newly planted	KSh/ha	-37,375	-34,750	-10,776	-17,738
Banana	KSh/ha	7,282	44,581	65,408	63,342
Amaranth	KSh/ha	39,219	31,550	23,779	33,343
Dairy	KSh/Unit	-13,027	-15,785	44,947	30,988
Poultry	KSh/Unit	-8,711	5,988	5,988	9,388
RPC 2.6					
Tea	KSh/ha	-31,777	-44,896	73,276	80,163
Coffee	KSh/ha	-83	-28,781	29,103	26,062
Avocado: Newly planted	KSh/ha	-37,375	-34,750	-3,965	-10,679
Banana	KSh/ha	6,780	50,619	50,886	51,094
Amaranth	KSh/ha	81,121	9,604	63,495	28,031
Dairy (same as 8.5)	KSh/Unit	-13,027	-15,785	44,947	30,988
Poultry (same as 8.5)	KSh/Unit	-8,711	5,988	5,988	9,388

42. Project level family income increase owing to the project was estimated using the income increase presented in Table 13. The approach used for the estimation is the following: income increase in the two scenarios (RCP 8.5 and 2.6) was averaged for each VC commodity; weighted average of such averages was obtained where the weight was the number of farm units of each VC commodity; and finally the adoption rate of 60% was applied to the weighted average and the assumption was that only 60% of the beneficiaries will adopt all technologies. The overall family level income increase at the end of the project implementation period will be 37% on average and 20% at the minimum (Appendix 4 of this Annex shows the computation). For the computation of the minimum income increase, the 20% drop in all benefits assumption, which was used in the sensitivity analyses, was used. The incremental income was estimated for all VC commodities and under this assumption and the weighted average with 60% adoption rate of all models provided the minimum income increase.

D. Project level financial analyses

43. The incremental cash inflows and incremental outflows (i.e. WP – WPO) of all VC crop models with 0.2 ha have been populated to estimate the project level aggregated cash flows using the total targeted extents and livestock that are presented in Table 8.

44. . The phasing of targets presented in the same table, which was based on the phasing of the project budget, was used to populate the cash flow to compute the aggregated cash flows. The project cost that is presented in Table 4 was used as the project investment cost for the analysis. The EFA excel sheets show the details. Using aggregated cash flows, the project level financial viability indicators were estimated and the results are presented in Table 14.

45. The financial internal rate of return of the project is 23% with a benefit-cost ratio of 1.11, and 25% and 1.13 respectively for RCP 8.5 and RCP 2.6 scenarios. The pay-back period for the base case is 12 years and for 10% cost increase, it is 16 years for RCP 8.5 scenario and it is 11 and 15 years respectively for the RCP 2.6 scenario. Together with the sensitivity analyses of cost increases and benefit decreases, the results demonstrate that the project is financially viable except for cost increased beyond 20% and benefits decrease below 10%. The discounted net revenue flow (at 18% financial DR) of the project shows that the project can breakeven the project expenditure plus the beneficiaries' investments after 12 years (pay-back period) of project commencement for both climate change scenarios.

Table 14: Sensitivity analysis of the project level financial analysis

RCP 8.5 Scenario

Sensitivity Analyses	Pay-back (Ys)	FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	12	23%	1.11	1,392.4	10.71
All cost increase by 10%	16	18%	1.01	93.9	0.72
All cost increase by 20%		14%	0.92	-1,204.6	-9.27
All benefits decrease by 10%		18%	1.00	-45.4	-0.35
All benefits decrease by 20%		12%	0.89	-1,483.1	-11.41
Cost increase by 10% and benefits decrease by 10%		13%	0.91	-1,343.9	-10.34
1-year delay in getting benefits		15%	1.09	-976.4	-7.51

RCP 2.6 Scenario

Sensitivity Analyses	Pay-back (Ys)	FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	11	25%	1.13	1,686.6	12.97
All cost increase by 10%	15	19%	1.03	388.8	2.99
All cost increase by 20%		15%	0.94	-908.9	-6.99
All benefits decrease by 10%		19%	1.02	220.2	1.69
All benefits decrease by 20%		13%	0.90	-1,246.3	-9.59
Cost increase by 10% and benefits decrease by 10%		14%	0.92	-1,077.6	-8.29
1 year delay in getting benefits		16%	1.12	-706.8	-5.44

46. The switching values were computed for both RCPs. The results are presented in the matrix on the right. The analysis indicates that the financial viability indicators of the project will be stable until the project benefits fall below 10% and 12%, and cost increase above 11% and 13% respectively for RCP 8.5 and RCP 2.6 scenarios. It indicates that the project is sensitive for benefit dropping.

Switching value analysis	KSh 1000: RCP 8.5	KSh 1000: RCP 2.6
NPV Total Cost Flow	12,984,995	12,977,590
NPV Total Benefit Flow	14,377,368	14,664,169
Switching value of benefits	-10%	-12%
Switching value of cost	11%	13%

E. Sensitivity analyses for the financial and economic discount rates

47. A series of sensitivity analyses were carried out to test the sensitivity of the project financial and economic viabilities to the changes in financial and economic discount rates. The financial DR was assumed at 20% and 25%, and re-estimated the financial viability of the project for both RCP 8.5 and 2.6 scenarios. The benefit cost ratio drops to 1.09 and 0.97 respectively from 1.11 in the RCP 8.5 scenario. The drop is 1.09 and 1.00 for the RCP 2.6 scenario. The result indicate that the project is sensitive to the increase in financial DR to 25% from 18% which was used for the EFA. The same set of tests were conducted for the economic viabilities for both RCP 8.5 and 2.6 scenarios. The benefit cost ratios drop to 1.12 and 0.98 for economic DR of 15% and 22% respectively for RCP 8.5 from 1.24 of the base analysis, and 1.14 and 1.01 respectively for RCP 2.6 from 1.25 of the base analysis. Appendix 5 of this Annex presents the results of this 8 sets of analyses.

F. Viability of debt financing

48. A scenario was included in the financial analysis to assess the financial viability of the leveraged financing of US$ 10 million loans from the Cooperative Bank and Equity Bank which will start in year 7. The analysis indicted that the post-project debt financing for the project beneficiaries is a financially viable option. The assumptions used for the analysis are the following:

(a) The capital of the loan is US $ 10 million (Ksh 1,300 million) and the total amount is fully disbursed in the 7th year of the project;

(b) The interest rate of the loan for the project beneficiaries is 18%[18], which is the financial discount rate that was used in the EFA;

(c) The loan repayment period is 3 years starting from the 8th year;

(d) Loan recipients will repay the full amount of loan capital and interest within the 3-year period with 3 annual repayments.

49. On the basis of these assumptions the loan repayment schedule including capital and interest repayment is presented in Appendix 6 in this Annex. The financial analyses of both RCP 8.5 and 2.6 cases were recomputed inserting the provision of the loan and the repayment schedule, and the results are presented in the box below (details are in the EFA excel sheets). In addition, the debt service coverage ratio (DSCR) for the three years during which the total debt will be repaid (served) was also computed. The DCSR was computed by dividing the net income by the total debt service (capital and the interest payment on the loan) for the respective servicing years. The DSCR will be 3.66, 3.73, and 4.01 for the 8th, 9th and the 10th years respectively for the RCP 8.5 scenario indicating that the project generate a net income that is 3.66 times higher than the required total debt service in the 8th year and so on. For the RCP 2.6 scenario the DSCRs will be 3.64, 4.00, and 4.33. Excel sheets provide details of the computations. It shows that providing a loan of USD 10 million at the 7th year of the project is financially viable with above 23% financial IRR and also having a viable net benefit flow to fully service the loan

RCP 8.5	FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	23.6%	1.10	1,392.4	10.7
RCP 2.6	FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	25.1%	1.13	1,686.6	13.0

7. Project level economic analysis

A. Assumptions of the analysis

50. The economic analysis of the project was carried out by adjusting the cost and benefits flows that were used in the financial analysis to reflect economic values. In addition to the assumptions made in the financial analysis, the following assumptions were used in the economic analysis.

[18] Equity Bank (Kenya) Limited Products & Services Tariff Guide (chrome-extension:// efaidnbmnnnibpcajpcglclefindmkaj/https://equitygroupholdings.com/ke/images/docs/tariff-guide.pdf)

(a) The economic investment cost of the project is based on the project cost presented in Table 4 converted to economic cost using the standard conversion factor of 0.895.

(b) The following procedure was used to convert all prices of VC commodity models to economic prices and to derive the SCF:

(i) using border prices, import parity prices applicable to the farm-gate were estimated to value tradable goods, where VAT and subsidies were removed and the computation is presented in the EFA excel sheets;

(ii) using Free on Board (FOB) prices of exportable goods, namely tea, coffee and avocado, the export parity price applicable to the farm-gate were derived and the computation is presented in the EFA excel sheets (Appendix 2 shows the estimation for tea, coffee and avocado);

(iii) for all non-tradable goods, standard conversion factor (SCF) of 0.895 was used to adjust the prices – the market distortion includes some degree of protection and over-valuation of local currency in terms of the US dollar – the SCF was computed taking the ratio between Official Exchange Rate (OER)[19] and Estimated Shadow Exchange Rate (SER)[20] [SCF=ER/SER]; EFA excel sheets presents details; and

(iv) VAT rate of 16% was used to remove the tax portion of the prices of the locally traded and tradable goods.

(c) Shadow wage rate factor is assumed at 0.895, which is the SCF, to account some out-migration, seasonal labour shortages, and semi-urban labour demand. Labour is idle during some periods of the year indicating that the full employment point has not been reached.

(d) The economic discount rate (EDR) of 10%, which was recommended by the EFA Modelling Advice for FAO Kenya, FP #27500.

(e) For the valuation of the environmental benefits of the reduction of green house gas (GHG) emission, the price of CO2, carbon co-benefit values were used, which is presented in Appendix 3 of this Annex.

B. Results of the economic analysis

51. After making the required adjustments to the cash flows of the financial analysis on the basis of the above assumptions, the economic analysis for the project was carried out for both RCP scenarios. The Economic Internal Rate of Return (EIRR) is 21% and 22% respectively for RCP 8.5 and RCP 2.6 respectively. The economic benefit cost ratio is 1.24 and 1.25 with the economic discount rate of 10% respectively for RCP 8.5 and RCP 2.6. The project earns an Economic Net Present Value (ENPV) of USD 42 million (KSh 5,481 million) for RCP 8.5, and USD 45 million (KSh 5,832 million) for RCP 2.6 for the 20-year period with 10% discount rate. Table 15 presents the results. The EIRR and the economic benefit cost ratio indicate that the project is economically viable to receive all financing including co-financing as listed in Table 1.

C. Sensitivity analyses

52. A series of sensitivity analyses were carried out to assess whether the project is economically robust in light of potential risks that can increase cost of production of enterprise, decrease benefits or delay in realising benefits for both climate change scenarios. A combination of risk factors that have been identified in section F, Risk Assessment and Management, of the FP were used as the basis to rationalise the sensitivity scenarios.

[19] Official Exchange Rate (ER) Jan 2024] IMF rates

20 Computed: SER = [[b+(b*c)] + [a-(a*d)]/ [b+a]]*e: a = average export value; b = average import values; c = Import Tariff (the average Most Favored Nation tariff rate: MFN is the relevant rate); d = Export duties (export of all business items); and e = Official (or market) Exchange Rate.

53. Table 15 presents the risk factors considered and the results of the sensitivity analyses for RCP 8.5 and RCP 2.6. The project generates EIRRs that are higher than the opportunity cost of capital (10%) under all sensitivity scenarios for both RCPs. The analyses indicate therefore that the VC commodity models and the overall project are both financially and economically justifiable even under most of the adverse risky environments. The two extreme conditions of 20% cost increase and benefit reduction with a reduced EIRR, yet viable, alarm the project to monitor for cost escalations and keep adequate controls to maintain the cost as estimated, and undertake training and other capacity building activities for the producers to maintain the productivity level as expected.

Table 15: Results of the project level economic analysis

RCP 8.5 Scenario

Sensitivity Analyses	EIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)	Risk Factor
Base Case	21%	1.24	5,481	42	
All cost increase by 10%	16%	1.13	3,180	24	Increase in farm input prices and unit cost of the project budget
All cost increase by 20%	12%	1.03	879	7	
All benefits decrease by 10%	16%	1.11	2,632	20	Combined risks on sale prices, yields, adoption rates
All benefits decrease by 20%	10%	0.99	(217)	-2	
Cost increase by 10% and benefits decrease by 10%	11%	1.01	331	3	Combination of the above
1 year delay in getting benefits	13%	1.20	2,101	16	Delay in adopting technology

RCP 2.6 Scenario

Sensitivity Analyses	EIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)	Risk Factor
Base Case	22%	1.25	5,832	45	
All cost increase by 10%	17%	1.14	3,534	27	Increase in farm input prices and unit cost of the project budget
All cost increase by 20%	12%	1.04	1,236	10	
All benefits decrease by 10%	17%	1.13	2,951	23	Combined risks on sale prices, yields, adoption rates
All benefits decrease by 20%	10%	1.00	69	1	
Cost increase by 10% and benefits decrease by 10%	11%	1.03	652	5	Combination of the above
1 year delay in getting benefits	14%	1.22	2,504	19	Delay in adopting technology

D. Switching value analysis.

54. This is considered as the percentage change in a variable required to reduce the economic net present value (ENPV) to 'zero' at an economic discount rate of 10%. The chosen variables for the analysis are: total economic benefits flow and the total economic cost flow (EFA excel sheets have the analysis). The switching value of the total benefits is -19% (reduced) and total cost is +24% (increased) for RCP 8.5 scenario, where the ENPV becomes zero. The similar values for RCP 2.6 are -20% and +25%. The results indicate that the project becomes unviable when the farmer producers' benefits drop by 19%, and total costs increase by 24% under RCP 8.5 scenario and 20% and 25% for the RCP 2.6 scenario. Likelihood of such changes is limited and thus the project is seen as stable to face cost increases and benefit decreases.

8. Greenhouse Gas (GHG) analysis

55. A greenhouse gas (GHG) balance calculation for the project has been undertaken by FAO using the EX-ACT tools to estimate GHG emissions associated with land changes and agricultural practices in crops (tea, coffee, fruit trees and African leafy vegetables). In addition, the GLEAN method,

which is based on the changes in production of animal protein (poultry and dairy), estimated the GHG emission reduction in dairy and poultry value chain. FAO has undertaken the estimation process (ANNEX_22b-GHG-FAO-KEN-EXACT-20230726-V1 and ANNEX_22c-GHG-FAO-KEN-GLEAM-20230726-V1) and results were provided to include in the EFA as environmental co-benefits.

56. The net carbon balance quantifies GHGs emitted or sequestered as a result of the project compared to the without project scenario. The project has multiple interventions having potential to reduce GHG emission. The climate sensitive and low-carbon technologies that the project is promoting is the main intervention. In that, changing feeding practices for livestock; crop residue management by utilising as green manure; soil and water conservation practices etc are the key interventions. The production targets that are used in the EFA are also used for the GHG analysis.

57. The estimation shows that the project has a positive impact leading to a decrease in GHG emission of a total of 3.5 million tons equivalent CO2 (tCO2eq) during 20-years of project life. Table 16 summarises the annual values and the total for decreasing GHG in tCO2eq. These benefits are valued in the economic analysis at a social value of carbon that is increasing over time in real value (2017 constant prices) from US$ 52 per tCO2eq in 2024 to US$ 80 per tCO2eq in 2044 at the lower bound (FAO estimations). Appendix 3 of this Annex presents the values for the 20-year period. They will be progressively realized through the project life.

58. The economic analysis of RCP 8.5 and RCP 2.6 scenarios were updated using the social value of CO_2 that will be sequestered as a result of the adoption of climate resilient and low-carbon technologies in VC commodity models. The social value was estimated using the lower bound of the carbon price. Table 16 presents the incremental annual carbon balance and the incremental (saved) co-benefits values for a 20-year period including the 6-year project implementation period. The results of the updated economic analyses using the co-benefits values in Table 16 is presented in Table 17. Inclusion of environmental co-benefits in the economic analysis has enhanced the project level economic IRR in both RCP scenarios. This indicates that the project is capable of generating significant social benefits in terms of reducing GHG emission in the farming and livestock models.

Table 16: Annual carbon balance of crops and livestock models and incremental co-benefits

		Yearly carbon balance (All crops)	Yearly carbon balance: Crops & Livestock	Cumulative carbon balance	Incremental: Yearly carbon balance	Incremental Co-benefit Value (USD)	Incremental Co-benefit Value (KSh 1000)
		tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e		
Year 1: 2024	Yr 2024	-35,447	-35,447	-35,447	0	0	0
Year 2	Yr 2025	-70,894	-70,894	-106,341	35,447	1,884,444	250,017
Year 3	Yr 2026	-106,341	-106,341	-212,682	70,894	3,852,638	511,145
Year 4	Yr 2027	-141,788	-141,788	-354,470	106,341	5,904,587	783,385
Year 5	Yr 2028	-177,235	-177,235	-531,706	141,788	8,040,288	1,066,737
Year 6	Yr 2029	-212,682	-212,682	-744,388	177,235	10,259,743	1,361,201
Year 7	Yr 2030	-248,129	-248,129	-992,517	212,682	12,562,951	1,666,777
Year 8	Yr 2031	-248,129	-248,129	-1,240,646	212,682	12,814,210	1,700,112
Year 9	Yr 2032	-248,129	-248,129	-1,488,776	212,682	13,065,469	1,733,448
Year 10	Yr 2033	-248,129	-248,129	-1,736,905	212,682	13,316,728	1,766,784
Year 11	Yr 2034	-248,129	-248,129	-1,985,034	212,682	13,819,246	1,833,455
Year 12	Yr 2035	-248,129	-248,129	-2,233,164	212,682	14,070,506	1,866,790
Year 13	Yr 2036	-248,129	-248,129	-2,481,293	212,682	14,321,765	1,900,126
Year 14	Yr 2037	-248,129	-248,129	-2,729,422	212,682	14,573,024	1,933,461
Year 15	Yr 2038	-248,129	-248,129	-2,977,552	212,682	15,075,542	2,000,132
Year 16	Yr 2039	-248,129	-248,129	-3,225,681	212,682	15,326,801	2,033,468
Year 17	Yr 2040	-248,129	-248,129	-3,473,810	212,682	15,829,320	2,100,139
Year 18	Yr 2041	-248,129	-248,129	-3,721,939	212,682	16,080,579	2,133,475
Year 19	Yr 2042	-248,129	-248,129	-3,970,069	212,682	16,331,838	2,166,810
Year 20	Yr 2043	-248,129	-248,129	-4,218,198	212,682	16,834,356	2,233,481
Total		-4,218,198	-4,218,199		3,509,258	233,964,036	31,040,945

Table 17: Results of the project level economic analysis including the climate co-benefits

RCP 8.5 Scenario

Sensitivity Analyses	EIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	40%	1.68	15,598	120
All cost increase by 10%	34%	1.53	13,297	102
All cost increase by 20%	28%	1.40	10,996	85
All benefits decrease by 10%	33%	1.51	11,737	90
All benefits decrease by 20%	26%	1.34	7,876	61
Cost increase by 10% and benefits decrease by 10%	27%	1.37	9,436	73
1-year delay in getting benefits	25%	1.63	11,003	85

RCP 2.6 Scenario

Sensitivity Analyses	EIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	43%	1.69	15,949	123
All cost increase by 10%	35%	1.54	13,651	105
All cost increase by 20%	29%	1.41	11,353	87
All benefits decrease by 10%	35%	1.52	12,056	93
All benefits decrease by 20%	27%	1.36	8,163	63
Cost increase by 10% and benefits decrease by 10%	28%	1.39	9,758	75
1-year delay in getting benefits	26%	1.65	11,406	88

59. **Conclusion**. The EFA analyses indicate that the project is adequately viable in financial, economic, and social (environmental) terms and also has the capacity to face many risk factors while being viable.

The project also has the potential reduce GHG emission to a significant level with social net present value of US$ 113 million and US$ 116 million for RCP 8.5 and RCP 2.6 scenarios. The project therefore is suitable for receiving public funds for investments.

60. The farmers who participate in these VCs can generate enhanced profits starting with relatively low profitability and decreasing yield due to climate change under the WoP. The project intervention will allow them to increase their additional profitability from cultivating the same amount of land under the WP scenario, which contributing reducing the carbon emission.

Appendix 1

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Appendix 2

Economic Prices of export Commodities

Tea

Variable	Units	2024
Free On Board (FOB) Price (Auction Price: From July 1998, Kenya auctions. Prior, Longon auctions): Average for 2023	US $/kg - Black Tea	1.6724
Commission which include all cost of auction	% of Auction price	1.25
Cost of Auction (handling, auction charges and all other cost)	US $/kg - Black Tea	0.021
Price after Tea at Auction	US $/kg - Black Tea	1.651
Cost of Black Tea production at the factory (total)	US $/kg - Black Tea	0.450
Price net of processing cost at Auction	US $/kg - Black Tea	1.201
Transport from Mombasa (Port) to Project area (average)	US $/kg - Black Tea	0.1
Price at the Transport agent in the project area	US $/kg - Black Tea	1.101
Conversion of green tea leaf to black tea [4 kg of green leaf is needed to produce 1 kg of black tea]	kg	4
Economic price at the Agent	US $/kg - Green Tea	0.28
Economic price at the Agent (at Off Exchange rate)	KSh/kg - Green Tea	36.53
Transport from farm to the transport agent	KSh/kg - Green Tea	3
Economic price at the Farm Gate	KSh/kg - Green Tea	33.53

Coffee

Variable	Units	2024
Free On Board (FOB) Price [10% less for bulking]	US$/kg - Roasted Bear	18
Handling at the Port (or wholesale having the FOB price): assumed 10% more than tea as tea comes in crates from factories	% of FOB	1.5
Cost of handling	US$/kg	0.27
Price after handling	US$/kg - Roasted Bear	17.73
Cost of roasting (by roasting value of dry green beans increase by 1.19 time	Value Scale	1.19
Cost of Roasting	US$/kg	2.87
Price of green dry bean net of roasting cost	US$/kg - Dry Green	14.86
Conversion rate of green dry bean to roasted beans	%	84%
Processing cost of fresh cherry to Green Beans	% of FOB	6.15
Cost of processing	US$/kg - Dry Green	12.44
Conversion rate of fresh green to dry cherry bean	%	33%
Price of fresh green bean net of processing fresh beans (after applying 84% conversion)	US$/kg fresh beans	0.67
Transport from Mombasa (Port) to Project area (average)	US$/kg	0.1
Value of fresh beans net of transport	US$/kg fresh beans	0.57
Economic price at the Agent (at Off Exchange rate)	KSh/kg fresh beans	75.57
Transport from farm to the transport agent	KSh/kg fresh beans	2
Economic price at the Farm Gate	KSh/kg fresh beans	73.57

Avocado	Variable	Units	2024
	Free On Board (FOB) Price [Fuerte variety in 4 kg Box] - 88% for bulk supply	US $/kg	0.88
	Commission which include all cost at the port	% of Auction price	1.25
	Cost of Port Auction (handling, auction charges and all other cost)	US $/kg of fruits	0.011
	Price after after handling at the port	US $/kg of fruits	0.869
	Cost of grading, sorting and packaging	US $/kg of fruits	0.450
	Price net of grading and sorting	US $/kg of fruits	0.419
	Transport from Mombasa (Port) to Project area (average)	US $/kg of fruits	0.1
	Price at the Transport agent in the project area	US $/kg of fruits	0.319
	Rejection rate at grading etc	%	5%
	Economic price at the Agent	US $/kg of fruits	0.30
	Economic price at the Agent (at Shadow Exchange rate)	KSh/kg of fruit	44.93
	Transport from farm to the transport agent	KSh/kg of fruit	4
	Economic price at the Farm Gate	KSh/kg of fruit	40.93

Appendix 3

	Shadow price of Carbon (USD/tonne)	
	Low	Hig
2024	51.98080926	102.7802365
2025	53.16219128	105.1430005
2026	54.34357331	107.5057646
2027	55.52495534	111.0499107
2028	56.70633737	113.4126747
2029	57.8877194	115.7754388
2030	59.06910143	118.1382029
2031	60.25048346	120.5009669
2032	61.43186548	124.045113
2033	62.61324751	126.4078771
2034	64.97601157	128.7706411
2035	66.1573936	132.3147872
2036	67.33877563	134.6775513
2037	68.52015766	138.2216973
2038	70.88292171	141.7658434
2039	72.06430374	144.1286075
2040	74.4270678	147.6727536
2041	75.60844983	151.2168997
2042	76.78983186	154.7610457
2043	79.15259591	158.3051918

Appendix 4

Estimation of the overall average income increase of the project beneficiaries with 60% adoption rate – Average Level of Increase

Value chain	Number of Farm Units	% Increase in income (R8.5)	% Increase in income (R2.6)	Avg of the two	With 60% adoption rate
Tea cultivation	35,750	59%	29%	44%	
Coffee cultivation	35,750	63%	34%	48%	
African Leafy Vegetables	42,900	51%	64%	58%	
Avocado	14,300	50%	75%	63%	
Banana	14,300	54%	54%	54%	
Dairy Cows	42,900	17%	115%	66%	
Poultry	28,600	12%	200%	106%	
	214,500				
Overall weighted average				62%	37%

Estimation of the overall average income increase of the project beneficiaries with 60% adoption rate – Minimum Level of Increase

Value chain	Number of Farm Units	% Increase in income (R8.5)	% Increase in income (R2.6)	Avg of the two	With 60% adoption rate
Tea cultivation	35,750	27%	3%	15%	
Coffee cultivation	35,750	30%	7%	19%	
African Leafy Vegetables	42,900	21%	32%	26%	
Avocado	14,300	20%	40%	30%	
Banana	14,300	23%	23%	23%	
Dairy Cows	42,900	6%	72%	39%	
Poultry	28,600	29%	140%	85%	
	214,500				
Overall weighted average				34%	20%

Appendix 5

Results of the sensitivity analyses on the financial and economic discount rates

Financial DR: 20%; RPC - 8.5						Financial DR: 25%; RPC - 8.5			
Sensitivity Analyses	FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)		FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	23.4%	1.07	766	6		23.4%	0.97	-252	-2
All cost increase by 10%	18.3%	0.97	-401	-3		18.3%	0.88	-1,171	-9
All cost increase by 20%	13.9%	0.89	-1,568	-12		13.9%	0.81	-2,090	-16
All benefits decrease by 10%	17.8%	0.96	-478	-4		17.8%	0.88	-1,146	-9
All benefits decrease by 20%	11.9%	0.85	-1,722	-13		11.9%	0.78	-2,039	-16
Cost increase by 10% and benefits decrease by 10%	13.0%	0.87	-1,645	-13		13.0%	0.80	-2,065	-16
1 year delay in getting benefits	15.1%	1.05	-1,430	-11		15.1%	0.97	-2,092	-16

Financial DR: 20%; RPC - 2.6						Financial DR: 25%; RPC - 2.6			
Sensitivity Analyses	FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)		FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	24.9%	1.09	1,042	8		24.9%	1.00	-17	0
All cost increase by 10%	19.5%	0.99	-125	-1		19.5%	0.91	-936	-7
All cost increase by 20%	14.8%	0.91	-1,292	-10		14.8%	0.83	-1,855	-14
All benefits decrease by 10%	18.9%	0.98	-229	-2		18.9%	0.90	-934	-7
All benefits decrease by 20%	12.7%	0.87	-1,500	-12		12.7%	0.80	-1,851	-14
Cost increase by 10% and benefits decrease by 10%	13.8%	0.89	-1,396	-11		13.8%	0.82	-1,853	-14
1 year delay in getting benefits	15.8%	1.08	-1,186	-9		15.8%	0.99	-1,898	-15

Economic DR: 15%; RPC - 8.5						Economic DR: 22%; RPC - 8.5			
Sensitivity Analyses	FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)		FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	21.2%	1.12	2,018	16		21.2%	0.98	-168	-1
All cost increase by 10%	16.1%	1.02	380	3		16.1%	0.90	-1,277	-10
All cost increase by 20%	11.6%	0.94	-1,257	-10		11.6%	0.82	-2,386	-18
All benefits decrease by 10%	15.6%	1.01	179	1		15.6%	0.89	-1,261	-10
All benefits decrease by 20%	9.5%	0.90	-1,661	-13		9.5%	0.79	-2,353	-18
Cost increase by 10% and benefits decrease by 10%	10.7%	0.92	-1,459	-11		10.7%	0.81	-2,370	-18
1 year delay in getting benefits	13.4%	1.10	-692	-5		13.4%	0.97	-2,228	-17

Economic DR: 15%; RPC - 2.6						Economic DR: 22%; RPC - 2.6			
Sensitivity Analyses	FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)		FIRR	B/C Ratio	NPV (KSh mn)	NPV (USD mn)
Base Case	22.4%	1.14	2,326	18		22.4%	1.01	77	1
All cost increase by 10%	17.0%	1.04	690	5		17.0%	0.92	-1,031	-8
All cost increase by 20%	12.3%	0.95	-946	-7		12.3%	0.84	-2,140	-16
All benefits decrease by 10%	16.5%	1.03	457	4		16.5%	0.91	-1,039	-8
All benefits decrease by 20%	10.2%	0.91	-1,412	-11		10.2%	0.81	-2,156	-17
Cost increase by 10% and benefits decrease by 10%	11.4%	0.93	-1,179	-9		11.4%	0.82	-2,148	-17
1 year delay in getting benefits	14.1%	1.12	-390	-3		14.1%	1.00	-2,017	-16

Appendix 6

Computation of the interest and capital repayments of debt financing

Project Year			Yr: 1	Yr: 2	Yr: 3	Yr: 4	Yr: 5	Yr: 6	Yr: 7	Yr: 8	Yr: 9	Yr: 10	Yr: 11
Debt financing	KSh 1000								1,300,000				
Years for having the loan										**1**	**2**	**3**	
Annual interest rate (%)	18.0%												
Loan repayment period (yrs)	3												
Payment of principal	KSh 1000									**-363,901**	**-429,403**	**-506,696**	-1,300,000
Interest payment (%)	KSh 1000									**-234,000**	**-168,498**	**-91,205**	-493,703
Total payment for the 1st loan	KSh 1000									**-597,901**	**-597,901**	**-597,901**	-1,793,703