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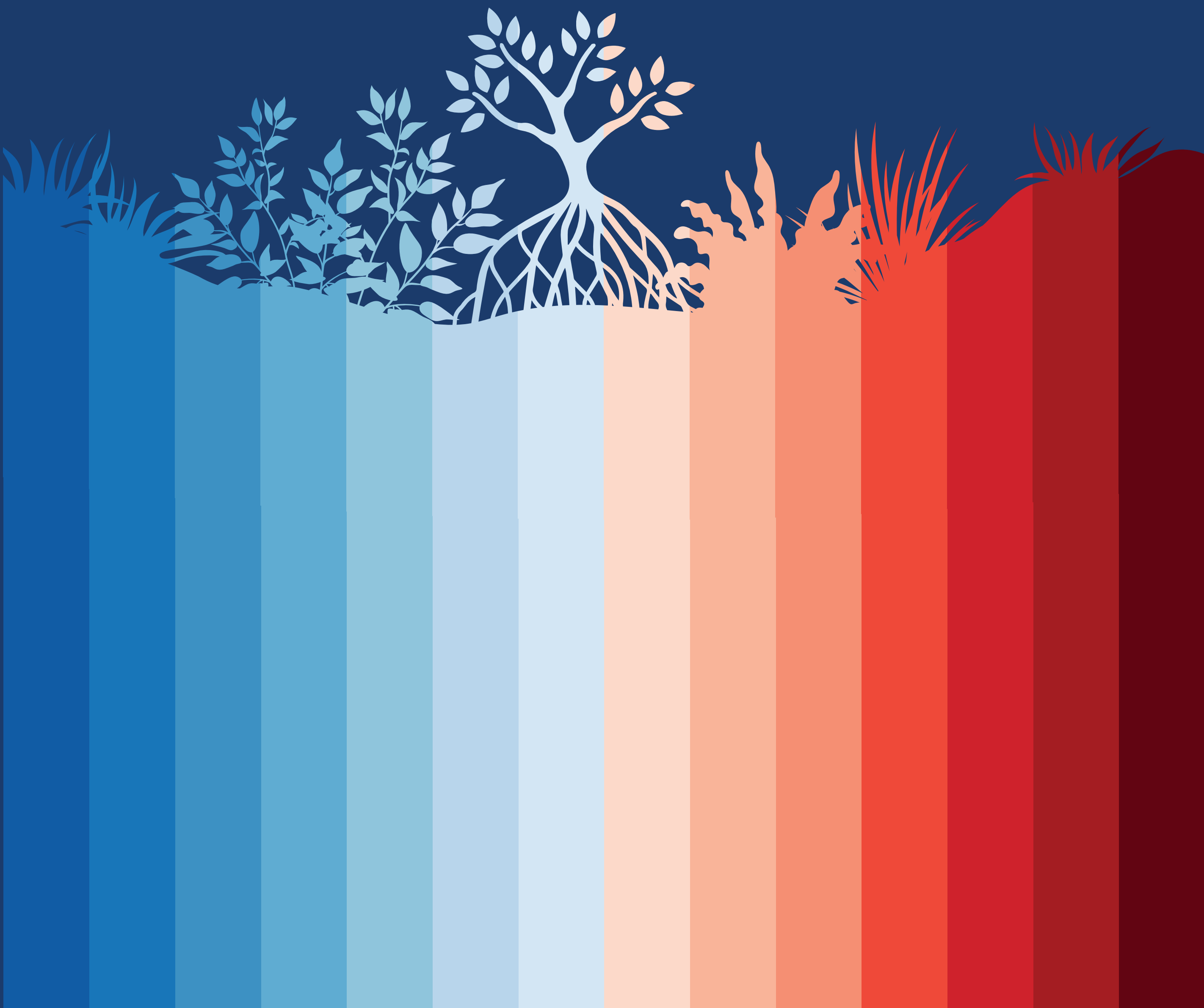
Investing in rural people

Paris Alignment

GREENHOUSE GAS ACCOUNTING ANALYSIS FOR IFAD'S INVESTMENT PORTFOLIO IN THE AFOLU SECTOR



The Greehouse Gas Accounting Analysis for IFAD's investment portfolio in the AFOLU sector was prepared by IFAD's Environment, Climate, Gender and Social Inclusion Division (ECG). The study considered the likely impact of IFAD projects on carbon stock changes and greenhouse gas emissions. Based on a representative sample analysis, IFAD's investment portfolio is a net carbon sink, with carbon-sequestrations and GHG emission reductions exceeding overall GHG emissions (using a Tier 1 approach for Scope 1 GHG emissions).

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Acknowledgements

The present GHG Accounting analysis for IFAD’s investment portfolio in the AFOLU sector was prepared by a multidisciplinary team from the International Fund for Agricultural Development, led by Philip Audebert and Eleanor Milne from the Environment, Climate, Gender and Social Inclusion Division (ECG), under the overall guidance of Hisham Zehni, ECG.

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Acronyms and Abbreviations

AF	Adaptation Fund
AFOLU	Agriculture Forestry and Other Land Use
APR	Asia and Pacific region
ASAP	Adaptation for Smallholder Agriculture Programme
ASAP+	Enhanced Adaptation for Smallholder Agriculture Programme
C	Carbon
°C	Degrees Celsius
CBP	Carbon Benefits Project
COP	Conference of the Parties
ECG	Environment, Climate, Gender and Social Inclusion Division at IFAD
EFA	Economic and Financial Assessment
ESA	Eastern and Southern Africa
EX-ACT	EX-Ante Carbon-balance Tool
FAO	Food and Agriculture Organisation
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Green House Gas
IFAD	International Fund for Agricultural Development
IFAD10	IFAD's 10th Replenishment Cycle
IFAD11	IFAD's 11th Replenishment Cycle
IPCC	Intergovernmental Panel on Climate Change
LAC	Latin America and Caribbean
MTR	Mid Term Review
NEN	Near East, North Africa, Europe and Central Asia
PMU	Project Management Unit
SDG	Sustainable Development Goal
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WCA	Western and Central Africa

Executive Summary

Human-induced climate change has already led to an increase in global temperatures of 1.09°C compared to the pre-industrial era (IPCC, 2021). While the Agriculture, Forestry and Other Land Use (AFOLU) sector is a source of approximately 22% of all global greenhouse gas emissions, the sector also offers significant mitigation potential and can provide 20-30% of the 2050 emissions reduction described in scenarios that likely limit warming to 2°C or lower. (IPCC, 2022). IFAD is currently working on a **Paris Alignment Roadmap**, to ensure that it can play a key role in supporting countries in realising their climate action plans in the small-scale agriculture and rural sphere through low-emission, climate-resilient and just transition pathways that contribute to the achievement of the Sustainable Development Goals (SDGs).

As part of these efforts a critical first step is the examination of IFAD's Greenhouse Gas Impact at portfolio level. A representative portfolio assessment has been undertaken to capture the overall trends and trajectory of IFAD's portfolio in terms of its impact on addressing climate change mitigation over time, and to identify best practices.

The present study considered the likely impact of IFAD projects on carbon stock changes and greenhouse gas emissions. In doing so, it considered the impact of IFAD's investments in project activities in the AFOLU sector, the sector on which IFAD's mandate is focussed. It used a representative sample of 27 projects based on the geographic distribution of IFAD's investments to estimate the likely portfolio-level impact.

The authors of the study found that the sampled IFAD investment projects had a negative projected carbon balance of -7,867,938 tCO_2eq over a 20-year period. When extrapolated to IFAD's current portfolio of ongoing projects, it translates to a mitigation potential of -20,536,334 tCO_2eq. In other words, **IFAD's investment portfolio is a net carbon sink, with carbon-sequestrations and GHG emission reductions exceeding overall GHG emissions**.

While the authors acknowledge that GHG assessments in the AFOLU sector are subject to uncertainty (activity data, variability in climate, management and emission factors), **sensitivity analyses confirm a high confidence in the direction of change of the overall GHG fluxes**, i.e. that IFAD's investment portfolio has a net negative carbon balance, and therefore, sequesters carbon and reduces GHG emissions on the whole.

These results are likely to under-estimate the carbon balance of newly designed IFAD projects, due to the fact that (i) the project sample analysed in this study comprises older generation projects that are less climate-focused compared to newer ones, and (ii) many projects reported additional activities which are likely to have an impact on climate change mitigation but, at the time of analysis had not yet collected sufficient information on them to be taken into account.

In the project sample analysed 97% of the land assessed was found to be agricultural land (annual cropland, grassland, flooded rice or perennial cropland). The strong focus on agricultural land is in line with expectations given IFAD's mandate to eradicate poverty and hunger by investing in poor rural people via programmes and projects that aim to increase agricultural productivity. Consequently, the management of annual croplands is the activity with the largest mitigation potential, with carbon sequestration in soils representing the largest sink. Increasing carbon in soils has a multitude of benefits in addition to climate change mitigation. As organic matter is primarily made up of carbon (>50%), increased soil organic carbon improves water infiltration, increases nutrient availability, can enhance soil biodiversity and reduces the risk of erosion, all of which are important for climate change adaptation and resilience in addition to mitigation.

The analysis also found that other activities with high carbon sequestration potential per hectare were: coastal wetlands management, afforestation, agroforestry and forest management. These activities, particularly agroforestry, feature strongly in projects supported by IFAD, especially ones financed through its Adaptation for Smallholder Agriculture Programme (ASAP and ASAP+), the Green Climate Fund (GCF), the Global Environment Facility (GEF) and the Adaptation Fund (AF). Such projects are likely to boost carbon-sequestration in both biomass and soils, hence providing a high climate change mitigation potential.

The findings of this report are important for two reasons, they: (i) provide a GHG baseline of IFAD's portfolio that will support the definition of future climate change mitigation commitments; and (ii) highlight the climate adaptation-mitigation synergies that can be realised through the kinds of investments in small-scale agriculture and rural development that IFAD promotes, which in turn strengthen the rationale for directing additional climate finance to the sector.

Going forward, IFAD's priority will be to maintain a net-negative investment portfolio, and hence continue to contribute to international efforts to curb GHG emissions. The final section of this study includes preliminary recommendations on the way forward regarding GHG accounting for IFAD. The overall recommendation is that consideration be given to adopting a systematic approach to GHG accounting for new projects supported by IFAD in order to promote closer attention to climate change mitigation best practices during project design and stronger accountability relative to climate change mitigation commitments.

Introduction

Background

In its recent assessment reports, the Intergovernmental Panel on Climate Change (IPCC) (2021) warned that human-induced climate change has already led to an increase in global temperatures of 1.09°C compared to the pre-industrial era, and that this increase is affecting many weather and climate extremes in every region across the globe (IPCC, 2022). Smallholder farmers and poor rural people bear the brunt of climate change and the degradation of natural resources. Extreme weather events, such as droughts, storms and floods, are putting pressure on the ecosystems that farmers depend on, as are gradual processes such as rising sea levels and melting glaciers.

While the Agriculture, Forestry and Other Land Use (AFOLU) sector is a source of approximately 22% of all global greenhouse gas (GHG) emissions (approximately 10–12 $GtCO_2e$./yr), accounting for 13% of all CO_2 emissions, 44% of methane (CH_4), and 69% of nitrous oxide (N_2O) emissions (IPCC, 2022). The sector also offers "significant near-term mitigation potential at relatively low cost and can provide 20-30% of the 2050 emissions reduction described in scenarios that likely limit warming to 2°C or lower" (IPCC 2022).

As an international financial institution with the specific mandate to eradicate poverty and hunger by investing in small-scale agriculture, IFAD has a direct impact on the AFOLU sector. With this responsibility in mind, IFAD is strongly committed to ensuring that its investments are consistent with development trajectories considered compatible with the temperature and climate resilience targets of the Paris Agreement. IFAD is therefore currently working on a Paris Alignment Roadmap. The goal of IFAD's Paris alignment roadmap will be to ensure that IFAD can play a key role in driving and enabling ambitious country-owned climate actions in the small-scale agriculture and rural sphere that deliver low-emission, climate-resilient and just transition pathways that contribute to the achievement of the SDGs.

As part of efforts towards a broader commitment to low-emission development pathways, a critical first step is the identification of IFAD's Greenhouse Gas Impact at portfolio level. A representative portfolio assessment has been undertaken to capture the overall trends and trajectory of IFAD's portfolio in terms of its impact on addressing climate change mitigation over time, identify best practices, and benchmark where possible the achievements with the current emissions.

AFOLU and Climate Change Mitigation

The impact of the AFOLU sector on GHG emissions is complex. Unlike other sectors, it encompasses a wide variety of both sources of GHG emissions and carbon sinks. The largest share of emissions come from the conversion of native vegetation to agricultural land, in particular conversion of forests to grazing land and annual cropland land. This results in the loss of carbon formerly stored in biomass and soils. The drainage of peatlands and conversion of native grasslands to annual cropland can also result in significant losses of carbon stored in soils. This is followed by emissions resulting from the management of agricultural soils (through tillage, crop residue and nutrient management) and emissions from livestock including those from enteric fermentation and manure management. Other sources in the sector include methane emissions from anaerobic respiration during cultivation of flooded rice and emissions associated with the use of fertilisers and pesticides. All of these emission sources can be reduced through appropriate agricultural management practices.

The AFOLU sector is unique among other economic sectors, as the mitigation potential is derived from both an enhancement of removals of greenhouse gases (GHG), as well as reduction of emissions through management of land and livestock. Land management practices which add trees and shrubs to the landscape such as afforestation, reforestation, introduction of perennial crops and agroforestry result in an increase in carbon stored in biomass and soils. In addition, management practices in annual croplands can increase soil carbon stocks by increasing inputs (residue incorporation, mulches and manure) and avoiding losses (appropriate tillage and mulching). Other practices such as the use of improved varieties can be used in croplands and grasslands to increase returns to the soil and therefore soil carbon sequestration. These are just some of the many examples of ways in which land use and management can play a significant role in the mitigation of climate change. Indeed, land-based mitigation measures represent some of the most important options currently available to directly address climate change. The third Working Group of IPCC (2022) found that "the rapid deployment of AFOLU measures is essential in all pathways to staying within the limits of the remaining budget for a 1.5°C target."

The role of IFAD

Many of the land management practices mentioned above are an integral part of IFAD's investment portfolio. This positions IFAD as a key player in the global effort to tackle climate change. As an international financial institution dedicated to eradicating rural poverty and hunger through financial and technical assistance to agriculture and rural development, the very nature of its investment interventions entail that IFAD can significantly contribute to GHG emissions as well as GHG emission removals or carbon sequestration.

The Aim of this Study

Against this backdrop an understanding of the current carbon balance of IFAD's AFOLU activities was deemed necessary. This study uses a representative sample to assess the overall trends and trajectory of IFAD's portfolio in terms of its impact on climate change mitigation over time. It also aims to provide an aggregated carbon balance alongside selected country and sector specific patterns and observations. In addition, the analysis has the aim of identifying best practices, and where possible benchmarking IFADs achievements in terms of current emissions. The study has been carried out by the Environment, Climate, Gender and Social Inclusion Division (ECG) of IFAD which is responsible for mainstreaming environment and climate into IFAD's portfolio.

Format of the Report

This report is the final product of a desk-based analysis of the climate change mitigation potential of IFAD projects. The term 'carbon balance' (or Carbon-balance) is used throughout this report to refer to the net greenhouse gas (GHG) balance (e.g. the net balance of all changes in GHG emissions and carbon stock changes both from biomass and soils, comparing a project with a baseline scenario).

Section 1 will provide an overview of the Technical Approach and Methodology and outlines methods used in sample project selection, data collection, analysis using the Exact GHG accounting tool and extrapolation of results to the wider IFAD portfolio. Section 2 will then present the main results of the analysis, providing *inter alia* the results of the overall Carbon-balance for the portfolio, regional Carbon-balance snapshots and insights on the sequestration potential of the various IFAD land-use activities. Section 3 provides conclusions based on the data and analysis presented in Section 2 and recommendations both in terms of future focus for IFAD investment, but also in terms of data collation to facilitate future analysis of climate change mitigation impact.

Section 1. Technical Approach and Methodology

The approach taken was a desk-based study which estimates the climate change mitigation impact of a representative sample of IFAD projects. Three steps were taken:

1.1 A process whereby a representative sample was chosen
1.2 GHG accounting analysis using the EX-Ante Carbon-balance Tool (EX-ACT) v.8
1.3 Aggregation of results and summary statistics
1.4 Extrapolation of findings to entire portfolio of ongoing projects

1.1 Process for choosing a representative sample

Practical constraints in terms of resources and time precluded an analysis of all IFAD projects. A representative sample of projects from IFAD's portfolio was therefore chosen, with the aim of extrapolating results to the entire portfolio of ongoing projects. All ongoing projects between Mid-Term Review (MTR) and Project Completion were considered for the representative sample analysis, which corresponded to a total of 95 projects. Of these 95 projects, 27 projects were chosen in a random way. Annex 1 contains a detailed description of the technical approach to the random sample selection. **Table 1** shows the 27 randomly selected projects.

Table 1. Representative projects chosen for the IFAD portfolio GHG assessment

Project ID	Region	Country	Project Short Name	IFAD Total financing
1100001706	APR	Indonesia	IPDMIP	$100,000,000
1100001464	APR	Cambodia	TSPRSDP	$23,380,092
1100001537	APR	Bangladesh	CDSP IV	$67,930,048
2000001184	APR	China	SPRAD-SS	$72,000,000
1100001743	APR	India	OPELIP	$51,208,000
2000000968	APR	Viet Nam	CSSP	$43,000,000
1100001703	APR	Cambodia	ASPIRE	$53,397,000
1100001723	APR	Nepal	ASHA	$24,999,000
1100001630	ESA	Uganda	PROFIRA	$29,000,343
1100001534	ESA	Malawi	SAPP	$60,030,792
2000000738	ESA	Burundi	PNSADR-IM	$1,000,000
2000000822	ESA	Zambia	E-SLIP	$20,044,000
2000001472	LAC	Guyana	Hinterland Project	$8,452,000
2000000897	LAC	Peru	PDTS	$28,500,000
1100001728	NEN	Bosnia and Herzegovina	RCDP	$12,750,000
1100001690	NEN	Armenia	IRFSP	$11,350,000
2000001159	NEN	Tunisia	PROFITS-Siliana	$24,112,401
1100001678	WCA	Ghana	GASIP	$46,600,000
1100001710	WCA	Sierra Leone	RFCIP2	$31,315,552
1100001757	WCA	Guinea-Bissau	PADES	$12,469,910
2000001071	WCA	Mauritania	PRODEFI	$28,084,803
1100001604	WCA	Cabo Verde	POSER	$21,271,531
1100001594	WCA	Nigeria	VCDP	$213,949,350

1.2 GHG accounting analysis

The 27 randomly selected projects (**Table 1**) were analysed for their potential impact on greenhouse gas emissions and carbon stocks changes according to the following method.

i. *Data Collation*

For each project, key project documents were accessed from IFAD X-Desk and data extracted. These included a minimum of: the Project Design document, the Mid Term Review and where available the most recent Supervision Report. Where necessary, data was also obtained from other project documents such as Economic and Financial Analysis (EFA)s and COSTABs. Data collated were those needed to carry out a Greenhouse Gas (GHG) impact assessment using the IPCC method (2006 IPCC Guidelines for National Greenhouse Gas Inventories). This included, but was not confined to:

- Types of land use and management activities implemented by the project
- Number of hectares of land in different IPCC land use categories (cropland, grassland, forestland etc.) with and without the project
- Details of land management activities with and without the project (tillage, water management, residue etc.)
- Numbers and types of livestock plus management with and without the project
- Inputs (fertiliser, pesticides) and investments (construction of infrastructure)

Where possible, data and assumptions were checked with the project management team and additional information from the PMU included in the analysis.

ii. *Assessment of net Carbon-balance using EX-ACT v.8*

An assessment was made of the impact of each project on net GHG balance using the EX-Ante Carbon-balance Tool (EX-ACT version 8)[1]. EX-ACT is a tool developed by FAO and provides ex-ante measurements of the climate mitigation impact of development projects in the agriculture, forestry and other land use (AFOLU) sector. The tool estimates the net GHG-balance from Greenhouse Gas (GHG) emissions and carbon-sequestration. EX-ACT is a land-based accounting system, measuring carbon stocks, stock changes per unit of land, and Methane (CH_4) and Nitrous Oxide (N_2O) emissions expressed in tonnes of Carbon Dioxide (CO_2) equivalent (tCO_2eq). The main output of the tool is an estimation of the net GHG-balance comparing a project scenario (with e.g. the adoption of improved land management practices), with a baseline scenario.

EX-ACT has been developed in line with the internationally endorsed Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines for National Greenhouse Gas Inventories, complemented by other existing methodologies and reviews of default coefficients. Default values for mitigation options in the agriculture sector are mostly from the 4th Assessment Report of IPCC (2007). In 2019, the tool was updated using more accurate Tier 1 emission

[1] As "all countries are to report national GHG emissions and removals following the BTR guidelines, which incorporate the 2006 IPCC Guidelines (mandatory) and the Wetlands Supplement (encouraged)", IFAD chose to use EX-ACT v.8 over newer versions of the tool. This is mainly because future refinements to IPCC guidelines, including the 2019 Refinement to the 2006 IPCC Guidelines, are not yet agreed upon by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA).

factors for aboveground and belowground biomass carbon sequestration for different agroforestry systems stratified by climate and region (Cardinael et al., 2018).

The tool can be applied to development projects in the areas of crop management, sustainable land management, agroforestry, grassland restoration, production intensification, livestock management, fisheries and aquaculture, and coastal wetlands. EX-ACT covers the following sources and activities: deforestation, afforestation and reforestation, other land use changes, annual and perennial cropland management, flooded rice management practices, livestock and dairy (enteric CH_4 and CH_4 from manure), inputs and investments such as nutrient management (liming, fertilizers, pesticides, and herbicides).

EX-ACT reports a Carbon-balance in tCO_2eq. A positive carbon--balance means a net increase in GHG emissions, while a negative Carbon-balance indicates that there is net carbon-sequestration or GHG emission reductions.

EX-ACT and other GHG accounting tools in the AFOLU sector (e.g. NEXT or CBP) were developed according to the IPCC guidelines, as adopted by the UNFCCC (UNFCCC, 2021). While the concept of 'Scope' in emissions accounting has been developed in the context of estimating absolute emissions for the private sector in a whole value-chain perspective and can therefore not simply be transferred to investment projects in the AFOLU sector, EX-ACT and the other available GHG accounting tools are generally limited to Scope 1 emissions (as Scope 2 and 3 emissions are multi-source and with multiple geographical scopes) (US EPA, 2022).

iii. Analysis Timeframe

The analysis was carried out using data from the most recent report available (e.g. Mid Term Report, latest Supervision Report). The starting point for the analysis was taken as the date at which activities began. All Carbon-balances were calculated over a 20-year time period, comprised of an implementation phase (the length of time that the project was active) and a capitalization phase. This can be explained by the length of time that land remains in a conversion category after a change in land use, which is by default 20 years (IPCC, 2006). The analysis therefore presents a 'snap shot' of the impact of IFADs investment and an extrapolation of this 'snap shot' into the next 20 years.

iv. Area and number of beneficiaries considered

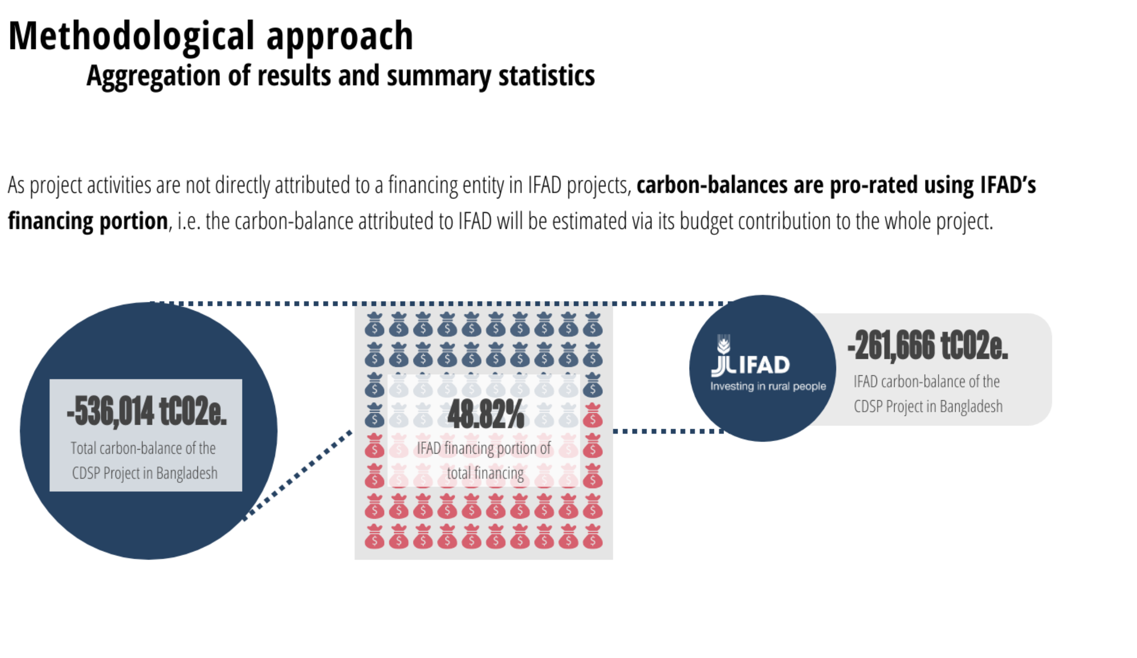
For this analysis, only the number of hectares on which the project had a direct impact in terms of carbon balance were considered, e.g. numbers of hectares were based on those reported to have been impacted by the project in the mid term review or latest supervision report.

1.3 Attribution of GHG impact to IFAD's investments

All projects involved funding from at least one source in addition to IFAD. In the majority of cases, it was not possible to disaggregate IFAD spending by project activity. Therefore, an analysis of the GHG impact of the entire project was carried out and the proportion attributable to IFAD was calculated by multiplying the project Carbon-balance by the percentage contribution made by IFAD funding to the total funding amount. For example, the CDSP IV project in Bangladesh has total funding of $139,152,001 of which $67,930,048 is contributed by IFAD (49 %). Therefore 49% of the total GHG balance is attributed to IFAD investment (see **Figure 1**).

In keeping with this approach, the number of hectares reported on in this document are the total (used for the analysis) multiplied by the proportion which can be attributed to IFAD investment. For example the CDSP IV project in Bangladesh had impacted 15,239 ha at the time of analysis, 49% (the proportion of total investment attributable to IFAD) of which equals 7,467 ha.

Figure 1. Method for attribution of GHG impact to IFADs investment



1.4 Extrapolation of findings to entire portfolio of ongoing projects

In a final step, the results of the Carbon-balance results of the representative sample were extrapolated to the entire portfolio of ongoing projects that are passed MTR stage. This extrapolation consisted of multiplying the aggregated regional Carbon-balance for the sample regions with a so-called financing multiplier, which represents the total amount of IFAD financing for ongoing projects in that region divided by total amount of financing for the sample projects in that region. The sum of all extrapolated regional Carbon-balances constitutes IFAD's extrapolated Carbon-balance for all ongoing projects passed MTR stage.

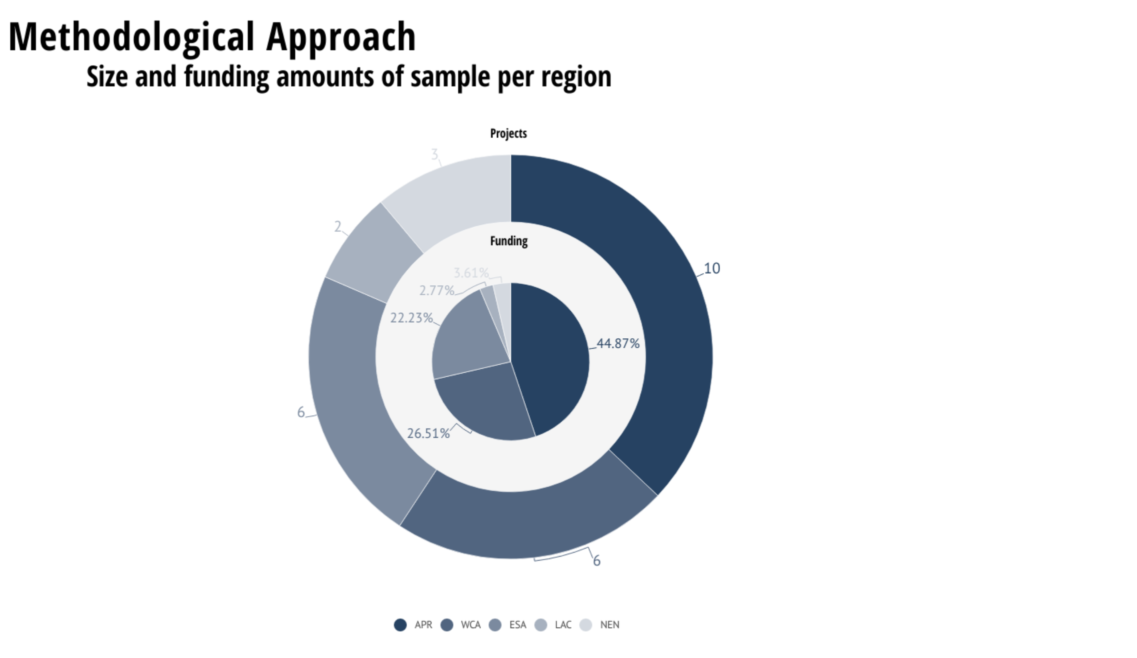
Section 2. Results

2.1 Global Statistics

2.1.1 Descriptive statistics for the global sample

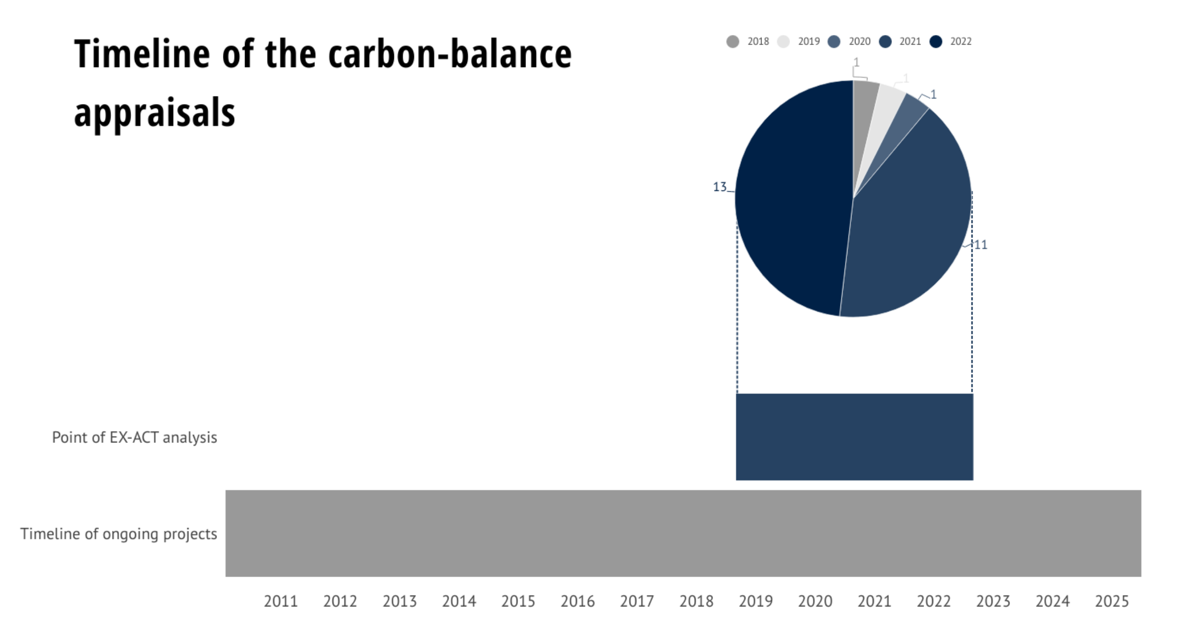
IFAD investment covers the five IFAD operating regions: Western and Central Africa (WCA), Eastern and Southern Africa (ESA), Asia and Pacific Region (APR), Latin America and Caribbean (LAC) and Near East, North Africa, Europe and Central Asia (NEN). As outlined in Section 1.1, a representative random sample of 27 IFAD projects was chosen. The number of projects chosen from a given region reflected the proportion of IFAD's investments in that region (Figure 3). Just under half (44.87%) of IFAD investment occurred in APR resulting in ten projects being chosen from the region, just over a quarter (26.51%) from WCA and just under a quarter from ESA resulting in 6 projects from each of these regions. This left 3 projects from NEN and 2 from LAC reflecting just under and just over 3% of IFADs investment respectively (see **Figure 2**).

Figure 2. Proportion of IFAD investment and number of sampled projects by region



Timeline
As outlined in Section 1.1, sample projects were chosen from those projects between Mid-Term Review (MTR) and Project Completion. The point of analysis was actual achievement as reported in the latest project report (data allowing). This gave a snapshot of the impact of IFAD projects in a 4-year window between 2018 and 2022. The majority of analyses (24 projects) was for impact to date in 2021 or 2022. The three remaining projects were analysed for impact to date in 2019, 2018 and 2020 (see **Figure 3**). All analyses were run for a 20 year-period for all projects, in order to allow long term soil carbon impacts to be estimated and project impacts to be compared and aggregated.

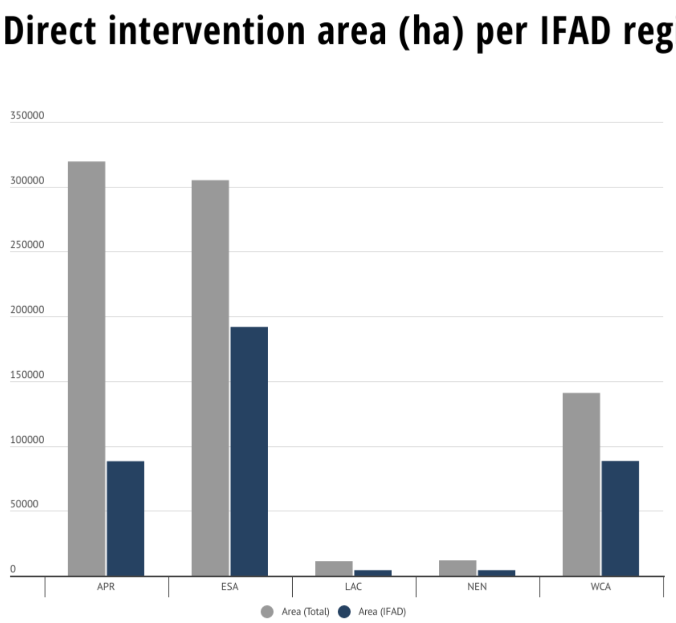
Figure 3. Timeline of the Carbon-balance appraisal



Number of Hectares analysed

For each project, only the area on which the project had directly affected carbon stock changes and GHG emissions at the time of analysis were considered and only the proportion attributable to IFAD investment is reported here. For all projects, this number was lower than the total number of hectares the project aimed to have impact on in the project design document. This was mainly due to the fact that the GHG analysis came before project completion and that many projects included activities which could not be translated into land-based carbon impact (for example setting up financial organisations which cover a given area). The total number of hectares included in this analysis for the 27 sample projects which can be attributed to IFAD investment is 377,058 ha. A breakdown of total number of hectares per region is given in **Figure 4**.

Figure 4. Direct intervention area (ha) per IFAD region

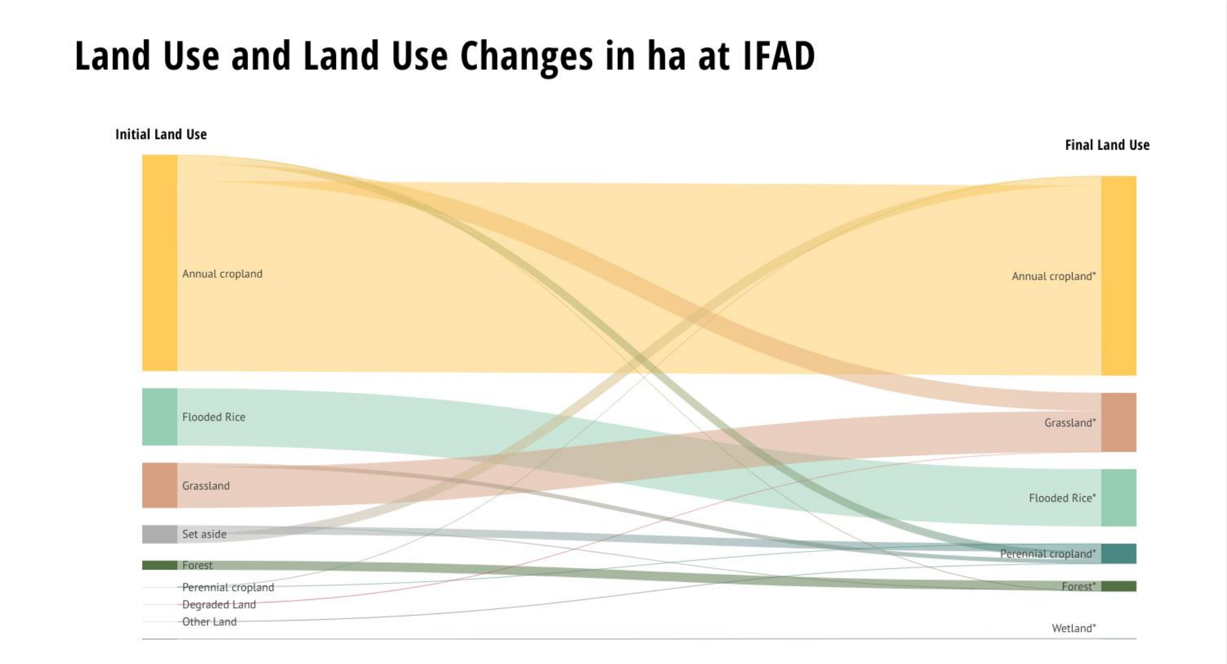


	Area (Total)	**Area (IFAD)**
APR	319,497	**88,335**
ESA	305,040	**191,907**
LAC	11,084	**4,249**
NEN	11,839	**4,154**
WCA	140,931	**88,413**

Land use categories and activities covered by the sample

The sample projects were chosen at random. IFAD projects occur in a wide range of land covers/uses and the sample covered a representative selection of these including: annual cropland, flooded rice, perennial cropland, forestland (native and plantation), grassland and coastal wetlands. Projects worked mainly in annual croplands followed by flooded rice, grasslands, set aside land and forests (see **Figure 5**). Some projects included a change in land use, which led to i) an overall increase in grassland areas, ii) significant increases in the use of perennial croplands/agroforestry, and iii) the rehabilitation and use of set aside land for agricultural purposes (see **Figure 5**).

Figure 5. Land use and land use changes in ha at IFAD.



The sample projects dealt with a wide range of land management activities including: cropland management (annual, perennial and flooded rice), afforestation, forestland management, grassland management, coastal land management and livestock management. In addition, several projects included input and investment activities such as use of fertilisers and building of agricultural infrastructure (irrigation systems, agricultural buildings). Some projects also included construction of non-agricultural buildings and roads and emissions associated with these were included in the analysis. **Figure 6** and **Figure 7** summarize activities associated with carbon sinks/emissions reductions activities and emissions sources associated with the sample project activities.

Figure 6. Activities associated with carbon sinks/GHG emission reductions

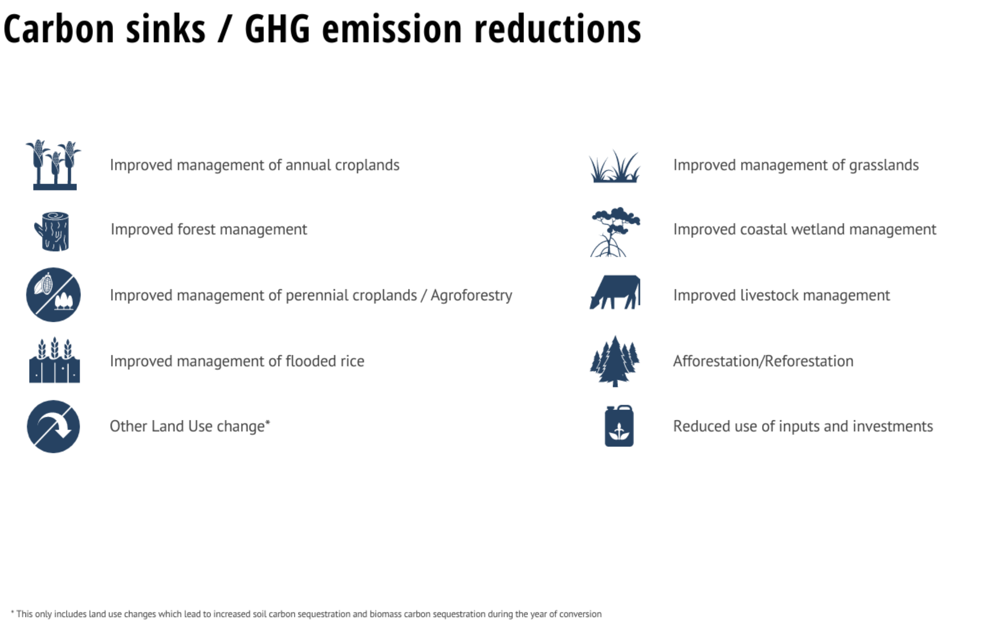
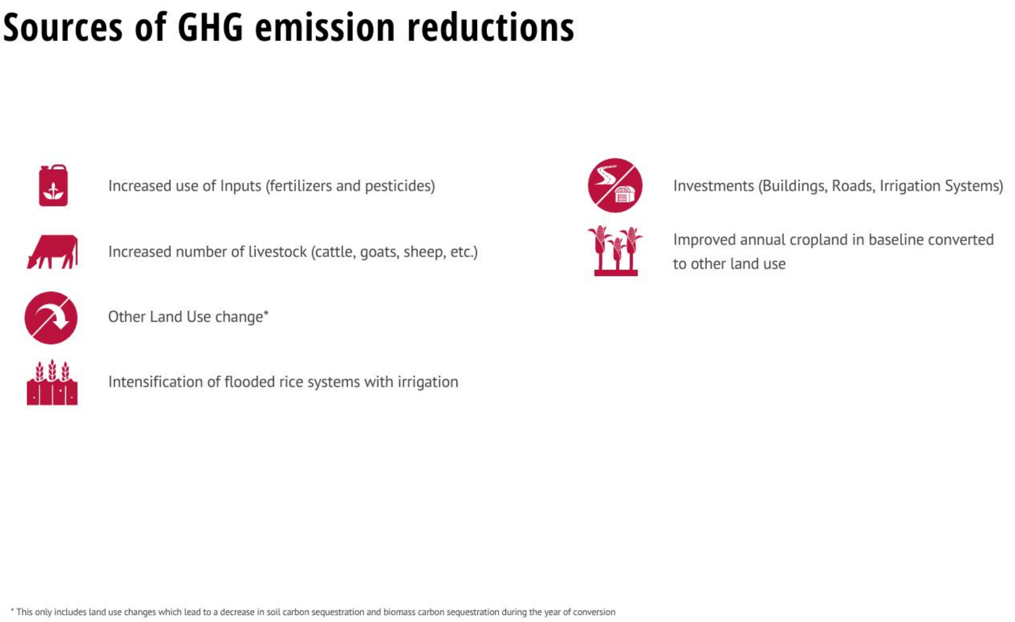


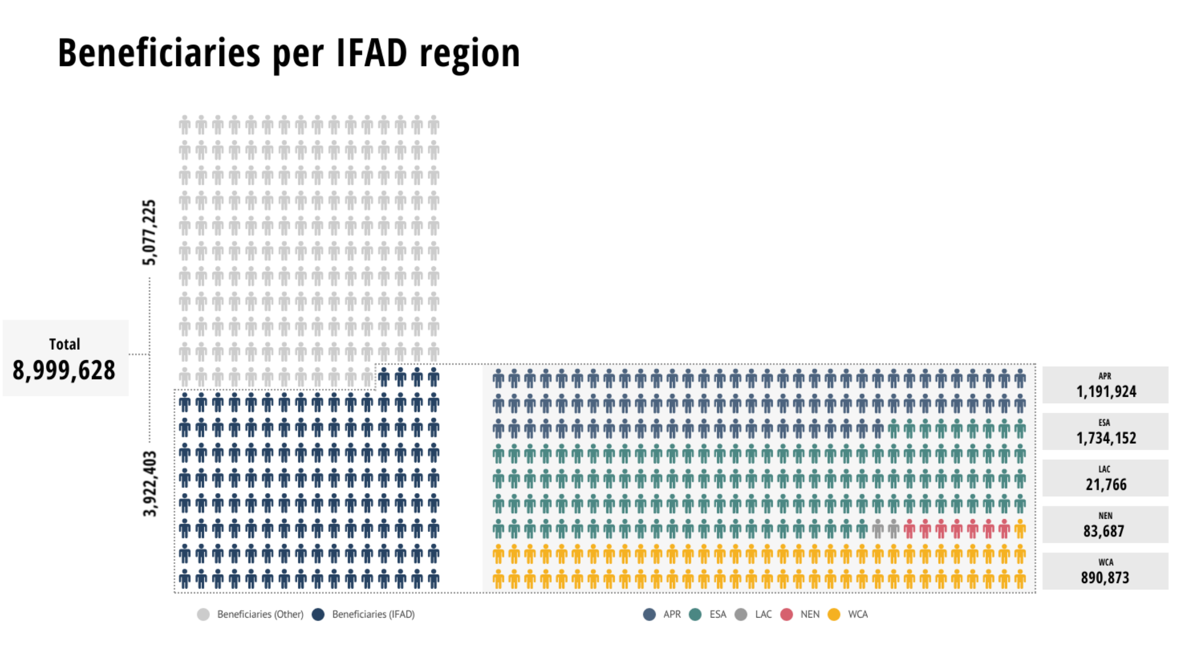
Figure 7. Activities associated with GHG emissions



Number of beneficiaries

For the 27 sample projects, the total number of people who had benefited from project activities at the point of analysis was 8,999,628. The number of these estimated to have been impacted by IFAD investment was 3,922,403. **Figure 8** shows the proportion of beneficiaries in each IFAD region for the portfolio sample at the time of analysis. Those in ESA and APR accounted for 44 and 30% of the total respectively.

Figure 8. Number of beneficiaries per IFAD region

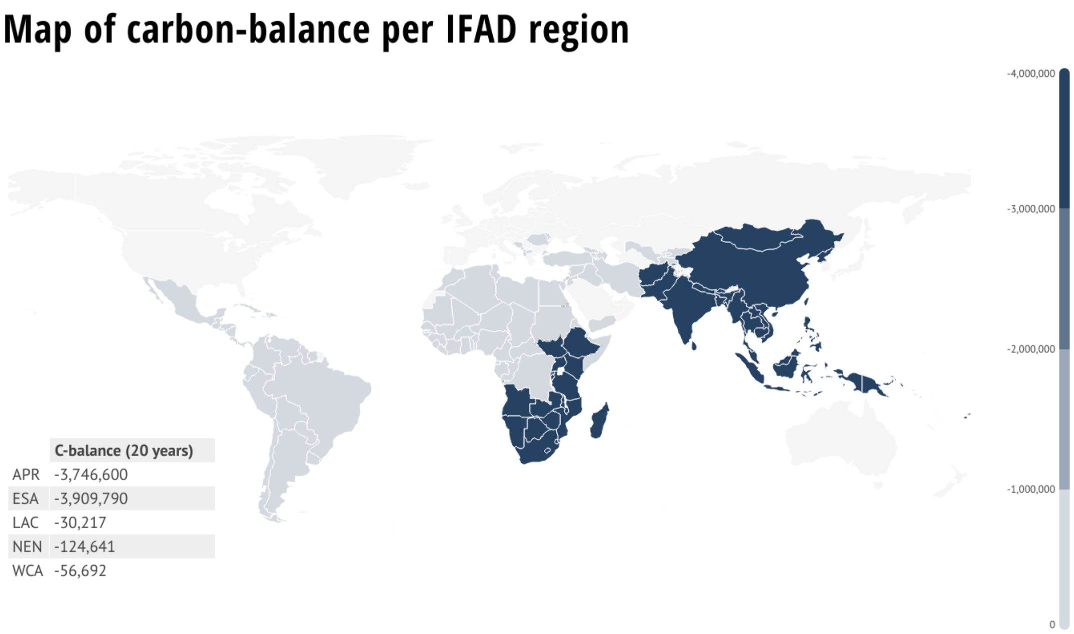


2.1.2 Carbon balance for the global sample

Over a 20-year analysis period, the overall Carbon-balance for the entire 27 project sample was -17,828,987 t CO_2e of which -7,867,938 t CO_2e is attributable to IFAD investment. Negative numbers denote carbon sequestration or GHG emissions reductions and positive numbers denote GHG emissions. The net balance of all carbon stock changes and GHG emissions (referred to as Carbon-balance) from the IFAD sample projects can therefore be said to be having a favourable impact on climate change mitigation and will likely continue to have a favourable impact in the next 20 years.

Figure 9 shows the Carbon-balance per IFAD region based on the sample project analysis. All regions showed an overall negative balance denoting that IFAD sample projects in all 5 regions are contributing to climate change mitigation. The largest mitigation potential came from the Eastern and Southern Africa (ESA) region with a balance of -3,909,790 t CO_2e. This is despite the fact that this region only had the second highest number of projects in the sample meaning it appears to be making a good return for IFAD investment in terms of climate change mitigation. The Asia and Pacific region (APR) had a similar mitigation potential with a total of -3,746,600 t CO_2e. These two regions together accounted for 97% of the total mitigation potential of the sample. Of the remaining 3 regions, Near East, North Africa, Europe and Central Asia (NEN) had a balance of -124,641 t CO_2e, Western Central Africa (WCA) a balance of -56,692 t CO_2e and Latin America and the Caribbean –30,217 CO_2e (it should be noted that for LAC and NEN, only two and three projects respectively were included in the project sample analysed).

Figure 9. Map of carbon balance per IFAD region



2.1.3 Carbon balance by sector

Of the -7,867,938 t CO_2e, 5.35 million can be attributed to carbon sequestration/maintenance of stocks in soils, -2.95 million to carbon sequestration/ maintenance of stocks in biomass and -0.39 million t CO_2e to reductions in methane emissions from paddy rice and livestock. This is offset slightly by a 0.40 million t CO_2e increase in emissions of N_2O from livestock and inputs and a 0.4 million t CO_2e increase in CO_2 emissions from other sources such as construction of buildings and other infrastructure (**Figure 10**). The lower part of **Figure 10** also shows the activities associated with these stock changes and emissions. These activities are represented by symbols underneath the source/sink category and sorted in order of their respective magnitude towards the total emission reductions/carbon sinks per gas.

- Carbon sequestrations in the soils can be attributed to annual cropland management, followed by grassland management, other land use changes, forest management, wetland management and afforestation.
- Carbon sequestrations in the biomass can be attributed to perennial cropland management/agroforestry, followed by forest management, wetland management and afforestation. These carbon sequestrations are slightly offset by emissions from other land use changes.
- Methane emission reductions are separated into emission reductions from improved paddy rice management, improved annual cropland management and perennial cropland management (both with improved residue management) which are slightly offset by emissions from livestock (overall increase of livestock herd).
- Nitrous oxide emissions can be attributed to the use of inputs, followed by annual cropland management (residue retention and burning), livestock and other land use changes.
- Other carbon dioxide emissions coming from the use of inputs and investments (roads, buildings, irrigation systems).

Figure 11 then presents carbon stock changes and GHG emissions by activity, which is then further explored in this section.

Figure 10. GHG sources and emissions reductions/carbon sinks

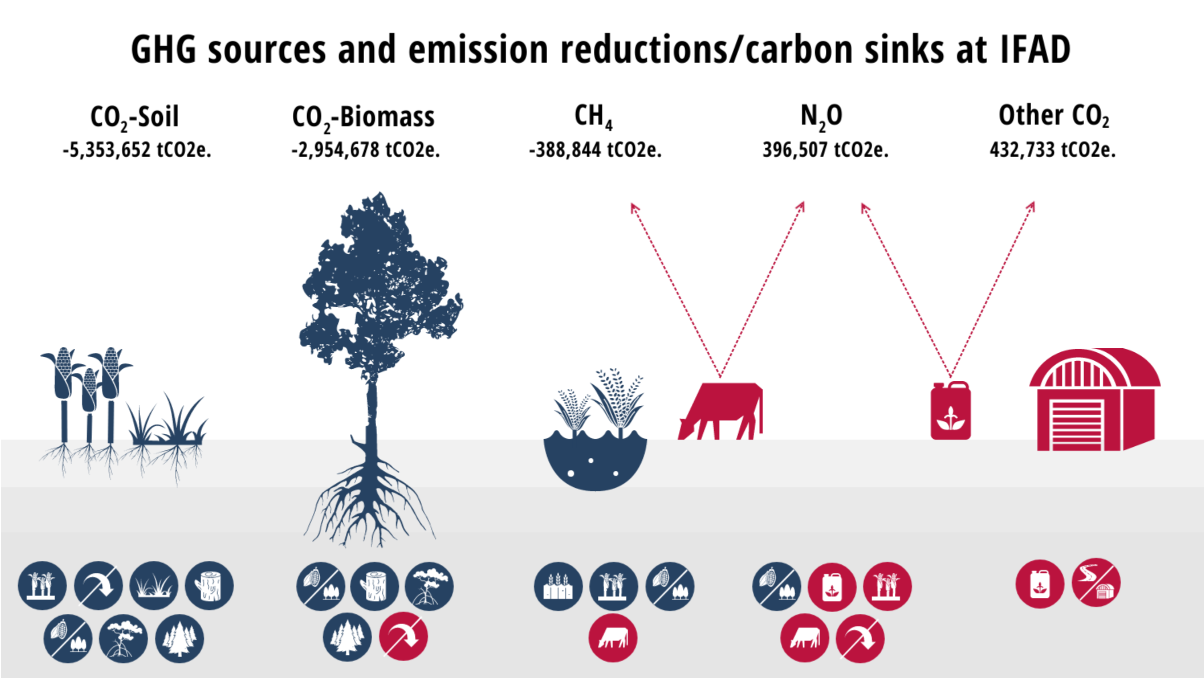
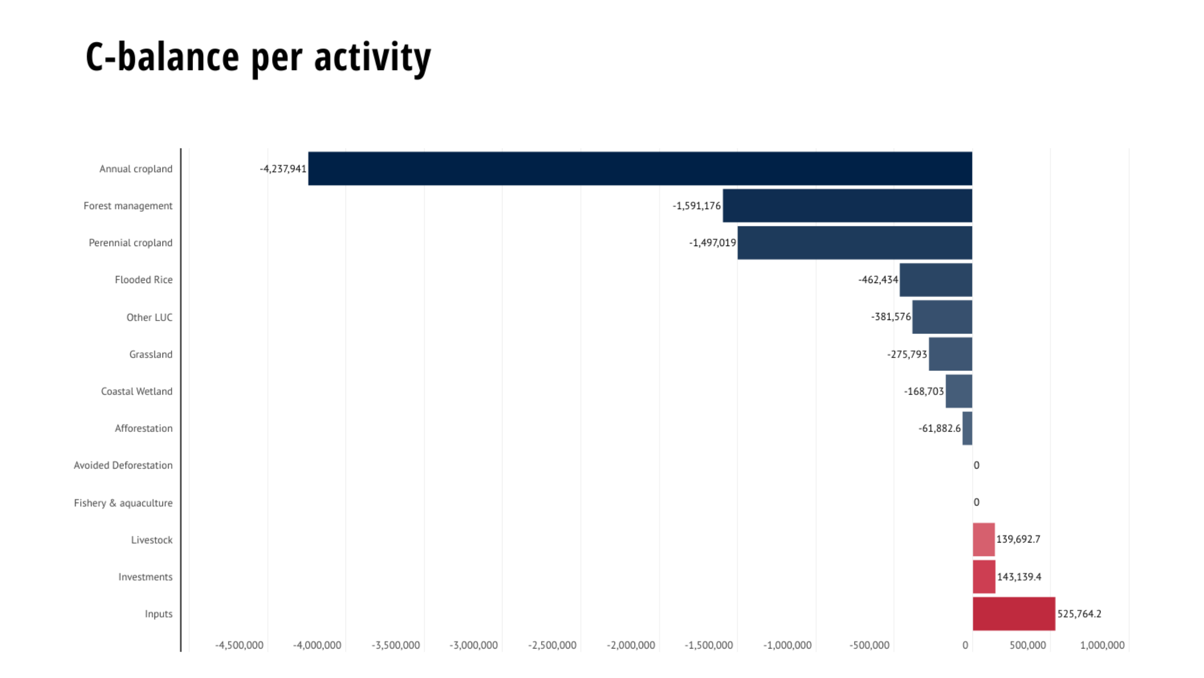


Figure 11. Carbon balance per activity in the IFAD sample analysis



i) Coastal wetlands

Restoration of coastal wetlands offers an important potential for climate change mitigation, especially of those dominated by woody species such as mangroves. Ecosystem carbon in mangrove dominated coastal wetlands can be almost double that found in temperate, boreal and even tropical terrestrial ecosystems (Ouyang et al. 2022). Only one of the sample projects considered in this analysis included coastal wetland restoration, the CDSPIV project in Bangladesh, representing a 20-year mitigation potential of -168,703 t CO_2 e (Figure 7.). This gave coastal wetland restoration the highest carbon sequestration potential per ha per year of all activities reported in the IFAD portfolio sample (Figure 8.).

ii) Afforestation

Afforestation has perhaps received the most global attention in terms of ways to remove excess carbon from the atmosphere. Afforestation can indeed be an efficient way of increasing carbon in a landscape both above and belowground, and in the litter and deadwood with additional benefits for erosion control, watershed management and biodiversity. Five projects in the portfolio sample included some afforestation, two in APR, one in LAC and one in WCA. Together, they accounted for a 20-year mitigation potential of -61,882 t CO_2 e.

iii) Perennial cropland

Perennial woody crops can provide multiple benefits for smallholders. They can diversify incomes, extend the period over which income is generated and in some cases, be used as a source of fuel. They also have a number of environmental benefits, especially when used in conjunction with annual crops in agroforestry systems. These include protection from the sun, wind, rain and drought (by utilising a different part of the water table) and increasing inputs to the soil, which leads to carbon sequestration. This is in addition to the sequestration benefits of adding woody biomass to an agricultural system, leading to the addition of above and below ground carbon stores. Just under half (13) of the IFAD sample projects lead to increased carbon sequestration through the introduction or management of perennial crops. The total 20-year mitigation potential for these projects was -1,497,019 t CO_2-e making it the third most important activity for climate change mitigation after annual cropland management. The potential permanence of activities involving perennial crops should also be taken into account, when considering investment for climate change mitigation.

iv) Forest management

The management of existing forests can be an effective way of protecting existing carbon stocks in biomass and soils and increasing CO_2 removal from the atmosphere. Management activities can include restrictions on wood removals through timber harvesting and fuelwood gathering, planting of different species, thinning and use of fertilisers. In this analysis, forest management was the second most important activity in terms of 20-year mitigation potential accounting for -1,591,176 t CO_2 e. The majority of this came from projects in Asia, with the rest from projects in Latin America and West Africa.

v) Grassland management

Restoring and managing grasslands can lead to increased carbon stored in soils. Practices that sequester carbon in grasslands can enhance productivity thereby, improving livelihoods, increasing biodiversity and benefitting multiple ecosystem services (Milne et al. 2016). Carbon sequestration in grasslands is highest in areas where mineralisation rates are low (cold, moist) or input rates are high (warm, wet). In the IFAD portfolio sample, four projects led to carbon sequestration in grasslands all in high input areas, i.e. Tropical Moist or Tropical Montane climates. Together these projects accounted for a 20-year mitigation potential of -275,793 t CO2-e, about 4% of the total potential of the IFAD portfolio sample. From a biophysical point of view, IFAD investments in grasslands in tropical moist areas represents a good potential option in terms of carbon sequestration on a per hectares basis. Investment in grasslands in arid or semi arid areas (where grasslands dominate) would have to involve much larger areas as sequestration on a t C ha-1 basis is much lower.

vi) Annual cropland

IFAD finances programmes and projects that increase agricultural productivity and raise rural incomes (Section 1.). It is therefore no surprise that activities in annual croplands resulted in the largest mitigation potential in the IFAD portfolio sample with a 20-year mitigation potential of -4,237,941 t CO_2 e, accounting for 54% of the total portfolio Carbon-balance. Twenty of the 27 sample projects involved activities in annual croplands including the introduction of conservation agriculture, use of high yielding varieties and use of manure. All of these activities led to increased inputs of organic matter to the soil either directly (manure) or indirectly through increased plant productivity. Gains in soil carbon in annual croplands can have benefits not only in terms of climate change mitigation but also in terms of adaptation and resilience, as increased soil organic matter improves water holding capacity in soils.

vii) Flooded rice

The management of flooded rice can lead to both increases and decreases in CH_4 emissions as a result of increased or decreased anaerobic respiration. Increases in the cultivation period and inputs of manure can lead to an increase in emissions and the reverse a decrease. Of the sample projects considered, four involved changes to flooded rice management with the impact overall four being emissions reductions (-462,434) mainly due to one project in Indonesia leading to reduced methane emissions from improved water management during the cultivation (alternate wetting and drying) on a very large area (151,805 ha). Project activities led to significantly reduced emissions in APR and smaller increases in emissions in East and West Africa.

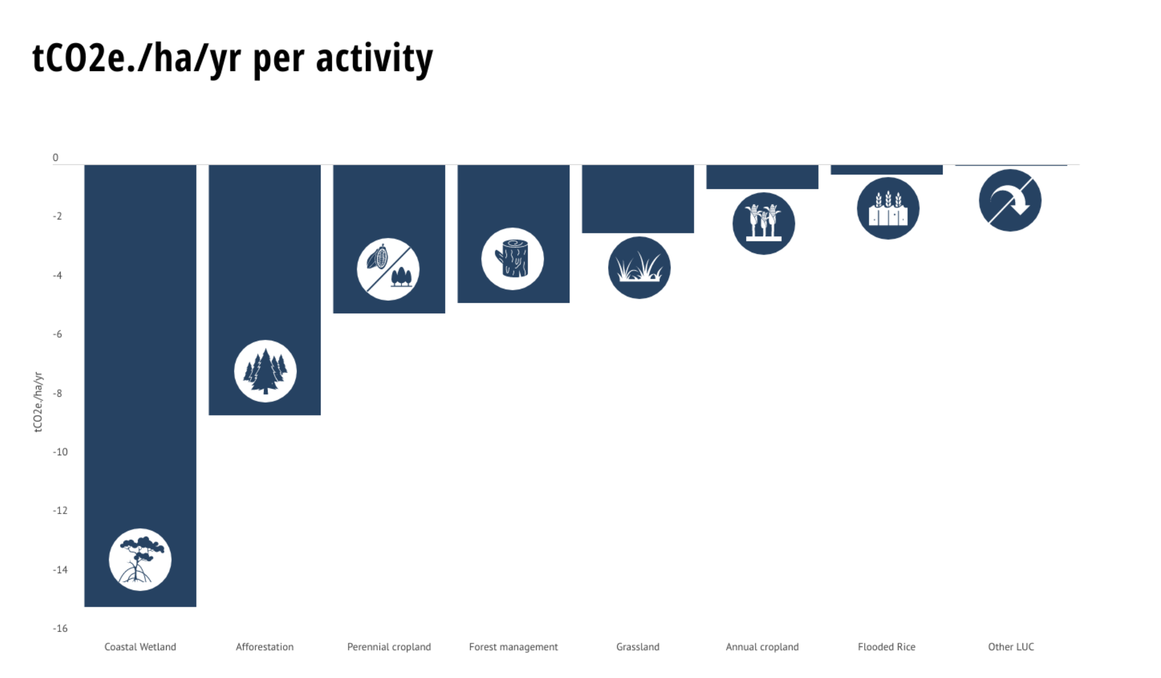
viii) Other land use change

Other land use change refers to any land use change which isn't afforestation or deforestation. In terms of the Carbon-balance, this particular category only reports on the first year of biomass change plus change in soil carbon that result from the replacement of one land use with another. Emissions and sequestrations associated with the new land use going forward are dealt with in the categories above. In the IFAD portfolio sample, other land use change included establishment of annual and perennial crops on degraded land or grassland and change from annual to perennial cropland. This is an important category for IFAD as the promotion of agroforestry and establishment of new annual cropland features in many of its projects. Overall other land use change resulted in net carbon sequestration of -381,576 t CO_2 e.

Effectiveness of activities per area

Figure 12 shows the effectiveness of IFAD activities in terms of climate change mitigation. The restoration of coastal wetlands has the highest mitigation potential, leading to sequestration/emissions reductions of approximately -15 t CO_2 e ha^{-1} yr^{-1}. This is followed by the three other categories involving woody biomass: afforestation, perennial cropland and woody biomass. Grasslands represented a significant sequestration potential at ~ 3 t CO_2 e ha_{-1} yr_{-1} which is high but reflects the fact that all the sample projects involving grassland activities were situated in tropical moist or wet climates. Annual cropland provided the 6th most effective option in terms of sequestration/emissions reductions potential, however as activities in annual croplands account for such a large part of the IFAD portfolio this is a key focus activity for IFAD.

Figure 12. Climate change mitigation potential of activities of the portfolio sample.



2.2 Regional analysis

In this section, a closer look is taken at the carbon balance for each IFAD region starting with the region with the largest mitigation potential based on this sample analysis.

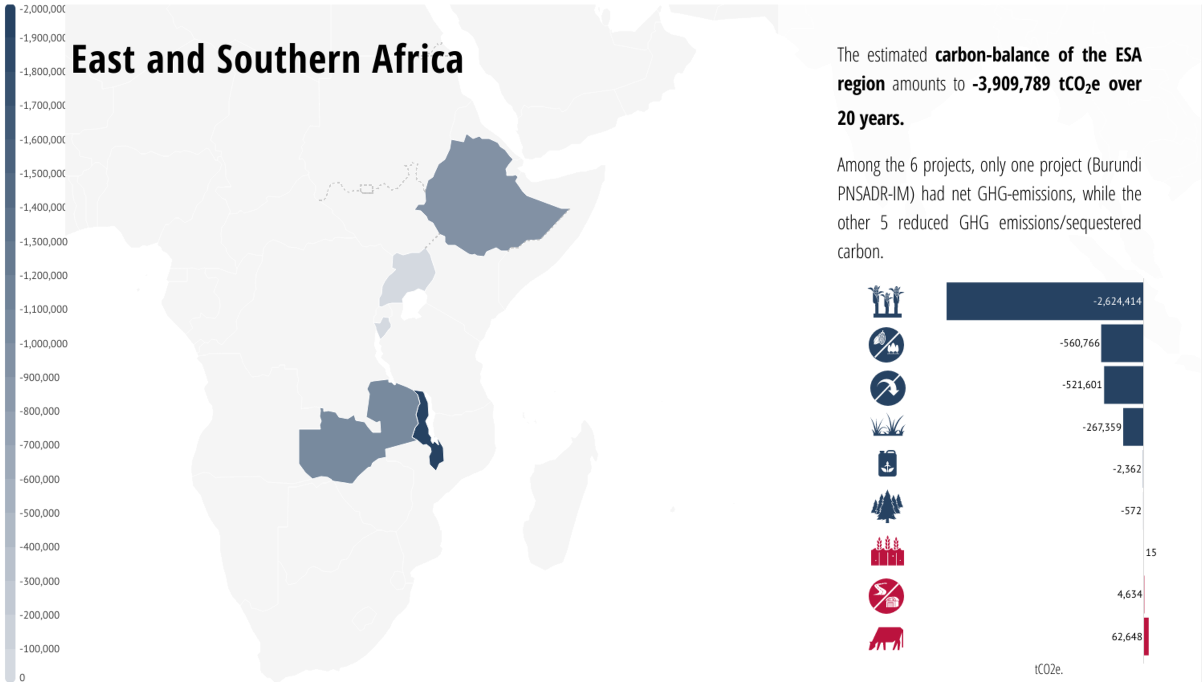
2.2.1 Eastern and Southern Africa (ESA)

The IFAD portfolio sample included 6 projects from the Eastern and Southern Africa region. The total climate change mitigation potential of these projects together was -3,909,780 t CO_2-e. over 20 years (see **Figure 13**) Projects consisted of: The PNSADR-IM project in Burundi aimed at strengthening food security and rural development in two regions of the country by introducing irrigation and other water management structures and promoting rice production. The project had a small positive carbon balance (6,229 tCO_2eq over 20 years) mainly due to emissions from the introduction of livestock. The PASIDP II project in Ethiopia built on previous IFAD investments working towards food security and improved rural incomes; activities included introducing irrigation to annual cropland and improving grasslands. The project had a significant negative carbon balance (-910,558 tCO_2eq) showing good mitigation potential.

The random selection procedure chose two projects from Malawi SAPP and FARMSE. The SAPP project aimed to produce a viable smallholder agricultural sector in the country and included the large scale introduction of conservation agriculture practices (CSA). The SAPP project had the largest CC mitigation potential of all the sample projects with a Carbon-balance of -2,003,979 tCO_2eq over 20 years, accounting for just over 50% of the ESA regional potential. The second project in Malawi (FARMSE) in common with the PROFIRA project in Uganda, focused on setting up financial training and outreach. This meant it was not possible to assess any impacts on land based GHG emissions for either project. The final project in the sample from ESA was the Zambian ESLIP project. This project is working to improve livestock production systems by improving grazing lands, croplands and livestock. The E-SLIP project had a significant negative carbon balance of -1,001,502 t CO_2 e over 20 years.

From Figure 13 it can be seen that by far the largest mitigation potential in the ESA region came from activities in annual croplands. Livestock management, inputs (fertilisers) and investments (construction of buildings) alongside flooded rice production were net sources of emissions but these were small compared to the significant mitigation potential provided by other activities.

Figure 13. IFAD Portfolio sample carbon balance for the ESA region



2.2.2 Asia and Pacific Region (APR)

Being the largest region for IFAD investment, APR included the largest number of sampled projects (10). Of these projects, all but one had a negative Carbon-balance (denoting potential for climate change mitigation). The overall mitigation potential for the region was -3,746,598 tCO_2eq over 20 years (see **Figure 14**) which was the second largest mitigation potential of all the regions considered. Together ESA and APR accounted for just over 97% of the entire sample mitigation potential.

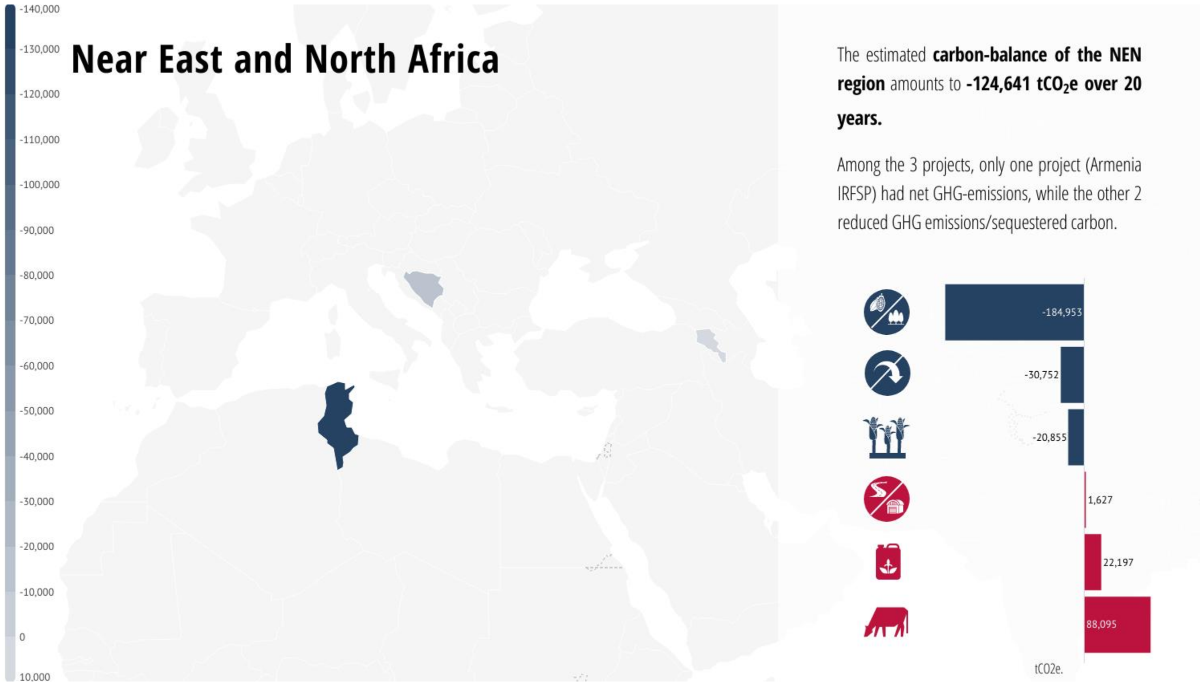
Sample projects in the APR region included the following: Two projects from Bangladesh, the CDSPIV project dealing with mangrove restoration and conservation agriculture and the PACE project which brought land into cultivation. Both projects involved some wetland soils and both had overall negative carbon balances (-261,667 and -323,918 t CO_2 –e. respectively over 20 years). The single project with the largest mitigation potential was the CSSP project in Vietnam. This project included a wide range of activities including forest management, forest plantation and grassland management. It had an overall Carbon-balance of -1,578,301 tCO_2eq over 20 years, accounting for 42% of APRs regional mitigation potential. The ten sampled projects also included projects in Cambodia, India, Nepal and Pakistan all of which had positive mitigation potentials, the first three significant ones. The Indonesian IPDMIP project, which focused on improved rice production, had the second highest mitigation potential for the APR sample with a Carbon-balance of -654,788 tCO_2eq over 20 years. Only one project (the SPRAD-SS in China) in the sample had a positive Carbon-balance with 108,800 tCO_2eq however data for many activities in this project have yet to be collated so the Carbon-balance results can be expected to change by project completion. **Figure 14** shows that in the APR sample, forest management gave the largest mitigation potential followed by the management of annual cropland.

Figure 14. IFAD Portfolio sample carbon balance for the APR region

2.2.3 Near East and North Africa

The sample analysis included three projects from the NEN region. The IRFSP project in Armenia involved the introduction of irrigation to both perennial and annual cropland, plus the expansion of perennial cropland. However, the positive mitigation impacts of these activities were offset by emissions from increased numbers of livestock giving a net positive Carbon-balance (29,632 tCO_2eq over 20 years). This project also included a GEF component which hadn't started at the time of analysis and is likely to lead to climate change mitigation. The second project was the RCDP project in Bosnia and Hertzegovina. This project focused on the expansion of fruit and vegetable production and had a net negative Carbon-balance of -10,996 tCO_2eq over 20 years. The third project, PROFITS- Siliana focused on fruit production, improving livestock production and infrastructure development. It also had a net negative balance of -143,277 tCO_2eq over 20 years. Overall, this gave the region a carbon balance of -124,641 tCO_2eq over 20 years with the majority of the mitigation potential due to improved management of perennial croplands (see **Figure 15**)

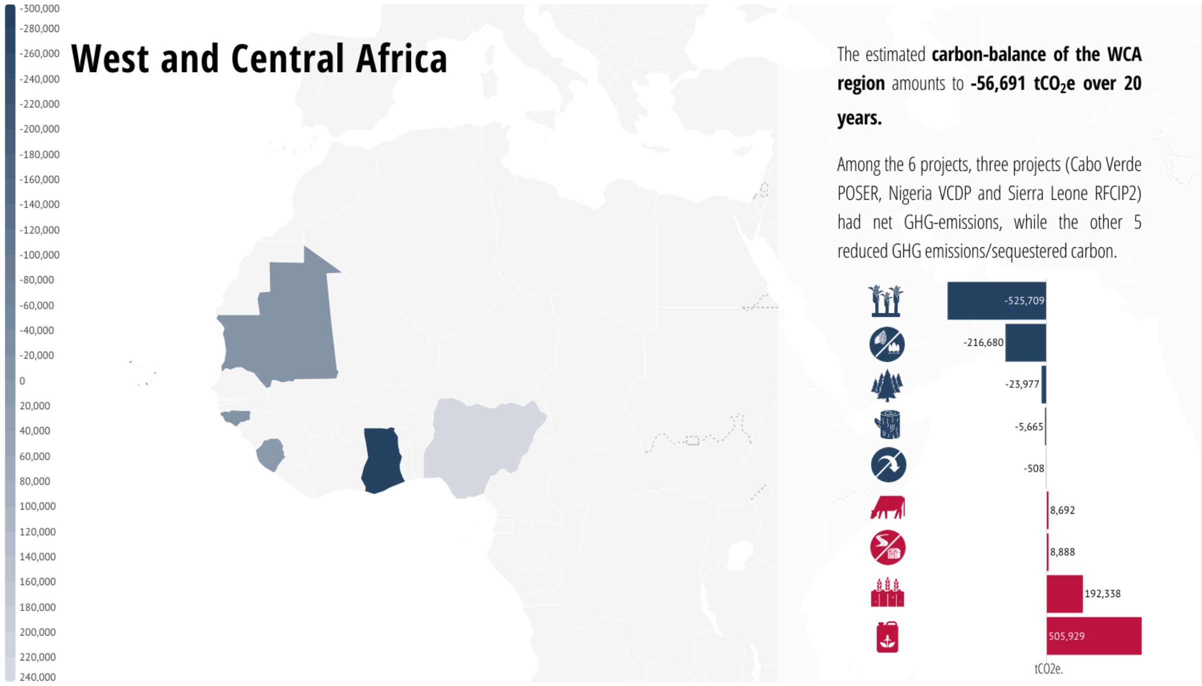
Figure 15. IFAD Portfolio sample carbon balance for the NEN region



2.2.4 West and Central Africa

Six projects from West Africa were included in the sample analysis. Of these, the GASIP project in Ghana showed the largest mitigation potential with a negative carbon balance of -299,427 tCO_2eq over 20 years. GASIP introduced conservation agriculture and improved varieties to annual cropland. Two other projects PADES in Guinea Bissau and PRODEFI in Mauritania also led to negative carbon balances (-4,835 tCO_2eq and -4,457 tCO_2eq respectively). Two projects, POSER in Cabo Verde, VCDP in Nigeria, had net emissions of GHG due to land use change and emissions from inputs/investments respectively (**Figure 16**). The remaining project, RFCIP2 in Sierra Leone, also had a small positive Carbon-balance due to construction of a financial building.

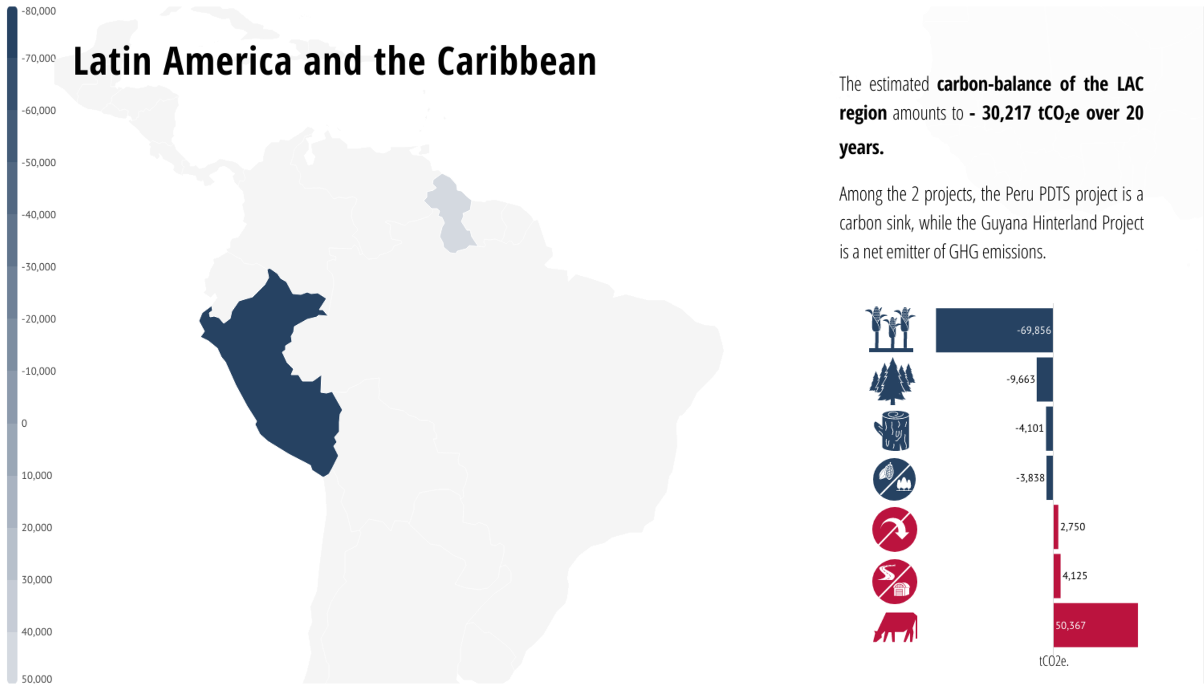
Figure 16. IFAD Portfolio sample carbon balance for the WCA region



2.2.5 Latin America and the Caribbean

IFAD investment in the LAC region is relatively small representing just 2.77% of IFAD investment. Therefore, only 2 projects from LAC were included in the sample analysis. These were the PDTS project from Peru and the Hinterland project from Guyana. Together these two projects gave a regional carbon balance of -30,217 tCO_2eq over 20 years. This was comprised of a negative balance for the Peru PDTS project with a balance of -81,247 tCO_2eq and overall emission from the Guyana Hinterland project of 51,030 tCO_2eq. The Guyana project involved increased emissions from livestock, whilst the Peru project included significant carbon sequestration in annual croplands which accounted for the majority of the balance (see **Figure 17**).

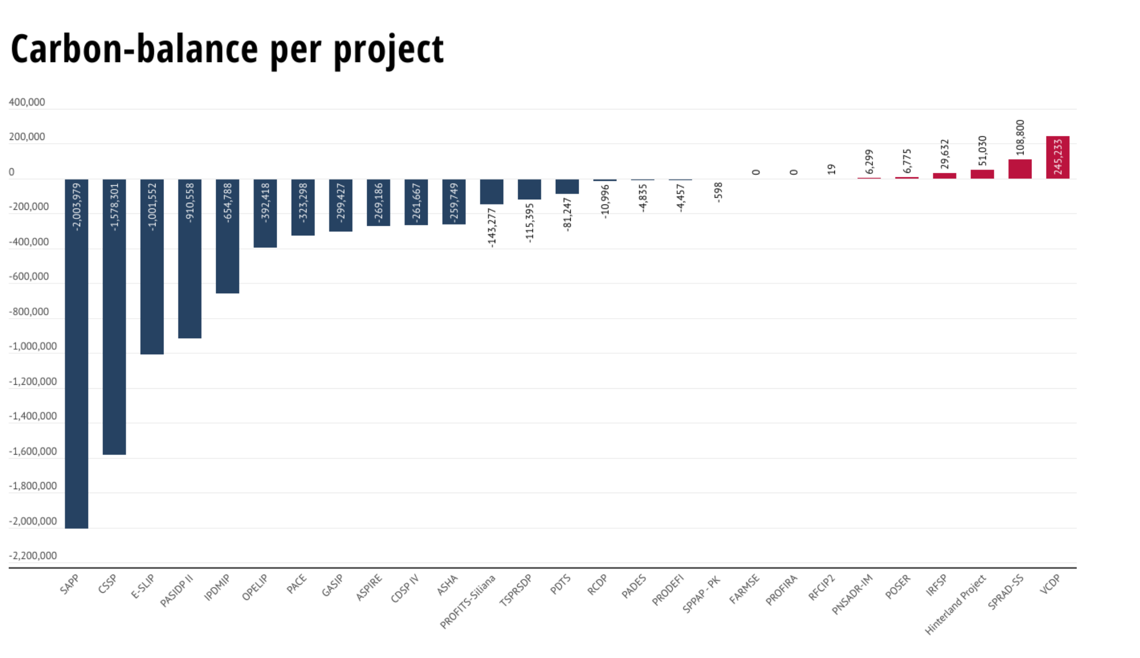
Figure 17. IFAD Portfolio sample carbon balance for the LAC region



2.3 Project analysis and case studies

Of the 27 projects in the portfolio sample, 18 resulted in net emissions reductions/carbon sequestration, seven projects resulted in projected net increases of emissions (although relatively small) and two were found not to be relevant projects on which to make a carbon assessment (see **Figure 18**). Therefore 67% of the sample projects were found to be highly likely to make a positive contribution to climate change mitigation in the next 20 years, based on activities they have carried out to date.

Figure 18. Carbon balance per project for the IFAD portfolio sample analysis



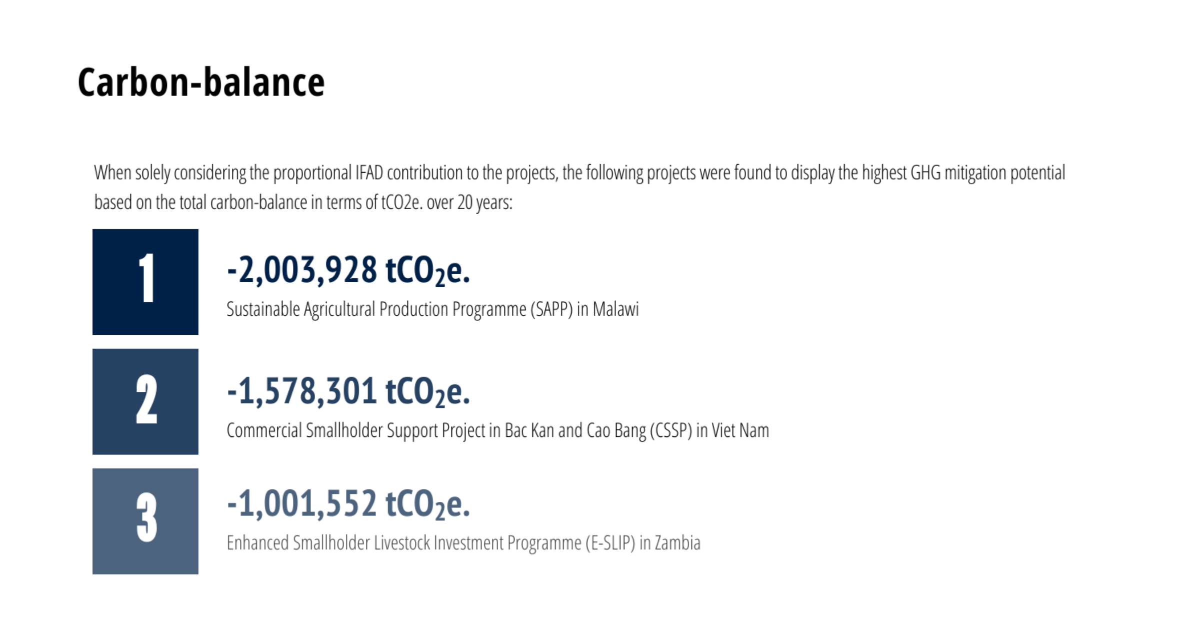
The three projects with the largest potential for climate change mitigation were the Sustainable Agricultural Production Programme (SAPP) project in Malawi with a Carbon-balance of -2,003,928 tCO_2eq, the Commercial Smallholder Support Project (CSSP) in Vietnam with a Carbon-balance of -1,578,301 tCO_2eq and the Enhanced Smallholder Livestock Investment Programme (ESLIP) in Zambia with a Carbon-balance of -1,001,552 tCO_2eq (all balances are for 20 years) (see **Figure 19**).

The SAPP project in Malawi aimed to develop 'A viable and sustainable smallholder agricultural sector employing good agricultural practices'. The project reported having introduced various improved agricultural practices to ~95,070 ha of land. These practices included using manure, pit planting for water conservation and other conservation agriculture practices. In conjunction with the introduction of 2,740 ha of agroforestry this led to significant sequestration in soils, which was projected to total -220,488 tCO_2eq over a 20-year period (for all donor activities). The project also involved the distribution of goats and chickens to smallholder farmers to improve livelihoods and resilience which resulted in a small increase in emissions slightly offsetting gains from cropland management. Once the proportion of the mitigation attributable to IFAD were considered, the balance for the project came to a considerable mitigation potential of -2,003,928 t CO_2e over 20 years. The project also included reports of a much larger area of land (605,273 ha) being brought under climate resilient practices. However, as detail was lacking and it was not possible to verify this activity, it was excluded from the analysis. It does however imply that the climate change mitigation potential of this project has most likely been underestimated.

The project with the second largest climate change mitigation potential was the CSSP project in Vietnam. In contrast to the SAPP project, CSSP included an area of forest management (18,127 ha), which accounted for the majority of its mitigation potential showing the importance of forestry activities in mitigation projects. Other activities included changing set aside land to grazing land and annual cropland, and introducing a small chestnut plantation.

The E-SLIP project in Zambia which had the third largest mitigation potential, was, in common with the SAPP project, from the ESA area. This project was focused on smallholder livestock systems and involved improving a large area of rangeland (79,820 ha) and introducing forage production and agroforestry to other areas. An increase in soil carbon stocks accounted for the largest part of the project's mitigation potential. The project management unit at E-SLIP were highly engaged in the analysis for this project and have requested ongoing support from IFAD to continue monitoring mitigation potential.

Figure 19. Three projects with the largest climate change mitigation potential



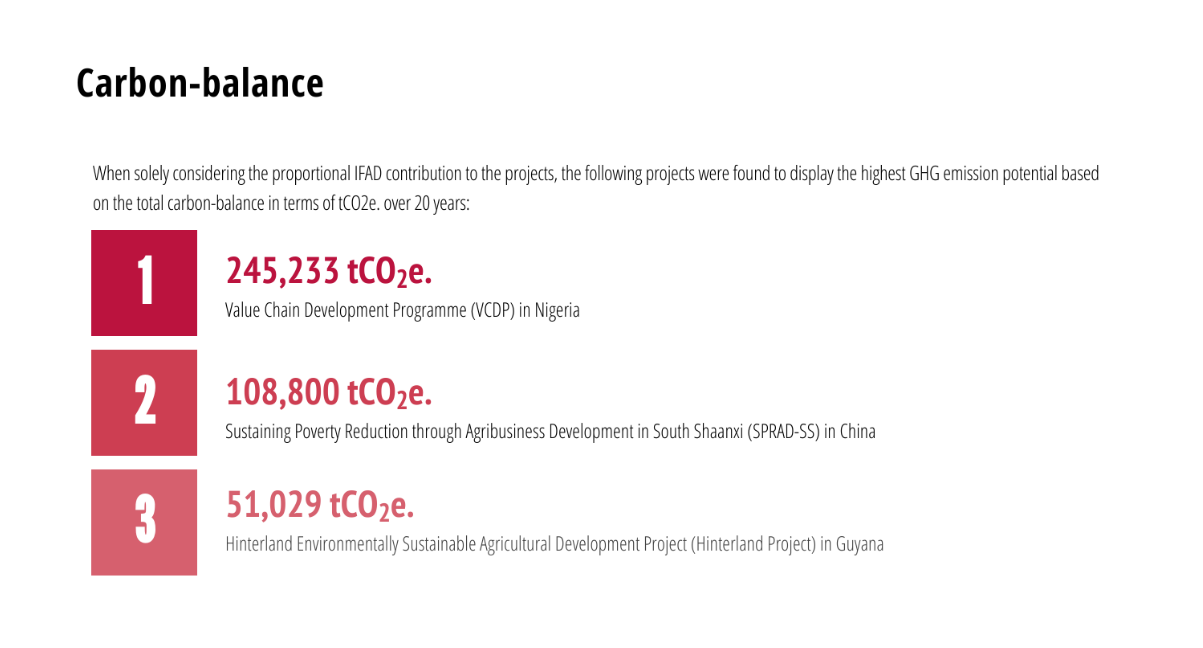
The three projects which showed the greatest overall emissions were the Value Chain Development Programme (VCDP) in Nigeria (245,233 tCO_2eq), the Sustaining Poverty Reduction through Agribusiness Development (SPRAD) in South Shaanxi project (108,800 tCO_2eq) and the Hinterland project in Guyana (51,029 tCO_2eq) (all figure over 20 years) (**Figure 20**). It should be noted that all three projects had special circumstances at the time of analysis.

The first component of the VCDP project provided support to value chain infrastructure. The component was very successful and involved the construction of bridges, culverts (water tunnels), markets, agro-processing facilities and storage buildings. Emissions associated with all of the construction activity formed part for the overall analysis leading to a positive carbon balance. The project also involved the introduction of climate resilient production practices for cassava on 24,447 ha of land and tree planting on a further 115 ha of land. When considered in isolation, these practices had an overall climate change mitigation potential of more than -680,000 tCO_2eq, however this was offset by the emissions from construction in component 1. Therefore, it can be said that the fact that this project led to emissions rather than sequestration or emissions reduction is due to the nature of the project.

The project with the second highest level of emissions was the SPRAD-SS project in China. This project was a large and complex project focusing on value chain development through the approval and subsequent support for implementation of business plans, many of which had a high climate change mitigation potential. At the time of analysis, 63 business plans involving different agricultural and land management activities were operational. However, as it was outside of the agreed Logframe and remit of the project, no data on area affected by these plans or specific activities had been collected. The only data available was for the building of access roads by the project and therefore the mitigation analysis was based solely on this. The PMU requested guidance and support going forward on collating appropriate data to be able to carry out a more realistic GHG assessment.

The project with the third highest emissions (although they were fairly moderate) was the Hinterland Project in Guyana. This project had experienced significant delays in set up, with activities only starting in 2021. Investment plans for activities had been submitted by local groups and accepted by the project but at time of analysis, data for most had yet to be collected. Activities which could be included were introduction of irrigation and improved cropping practices to ~27 ha of land plus introduction of cattle, poultry and pigs by the project. As most of the emissions were a result of the addition of livestock, this led to the project having an overall carbon balance of 51,029 tCO_2eq. As the project progresses, there is the possibility that these emissions will be offset via activities leading to increased carbon-sequestration.

Figure 20. Three projects with the largest GHG emissions



2.4 Estimated carbon balance for the whole IFAD portfolio

Results presented so far are for the 27 sample projects chosen randomly from the IFAD portfolio. In order to make an estimate of the impact of the entire portfolio of ongoing projects, the carbon balance for the sample projects in a given region was multiplied by the total amount of IFAD financing for ongoing projects in that region divided by total amount of financing for the sample projects in that region (see **Figure 21**). This gave an estimated balance for the entire portfolio of -20,536,334 t CO_2e over 20 years.

Figure 21. Estimated carbon balance for the whole IFAD portfolio

Section 3. Conclusions and recommendations

3.1 Conclusions

This study considered the likely impact of IFAD projects on carbon stock changes and greenhouse gas emissions. In doing so, it only considered the impact of IFAD's investments in project activities in the AFOLU sector, a sector which is the focus of IFAD's mandate. It used a representative sample of 27 projects based on the geographic distribution of IFAD's investments to estimate likely GHG impact at portfolio-level.

Overall, the sample chosen was found to have a negative carbon balance of -7,867,938 tCO_2eq over a 20-year period. This essentially means that the sample projects had an overall positive (or good) impact in terms of climate change mitigation at the point in time when the analysis was taken. If the impacts of all activities continue over the next 20 years, these 27 projects would lead to the mitigation of -7,867,938 tCO_2 equivalents. When extrapolated to IFAD's current portfolio of ongoing projects, it translates to a mitigation potential of -20,536,334 tCO_2eq. In other words, **IFAD's investment portfolio is a net carbon sink, with carbon-sequestrations and GHG emission reductions exceeding overall GHG emissions**.

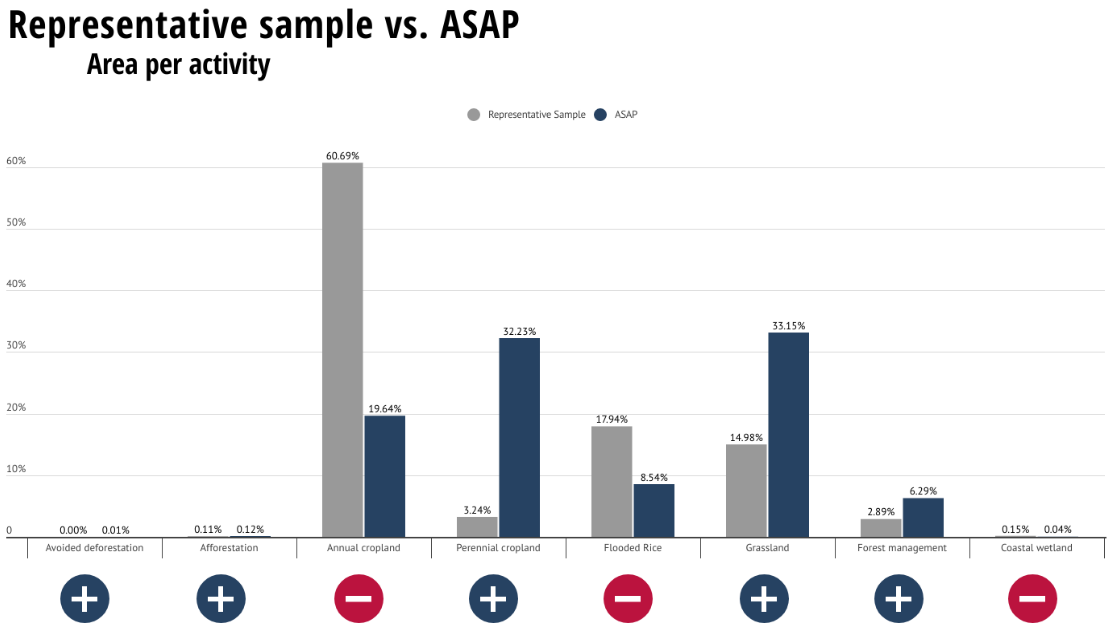
These results are likely to under-estimate the carbon balance of newly designed IFAD projects, due to the fact that (i) the project sample analysed in this study comprises older generation projects that are less climate-focussed compared to newer ones, and (ii) many projects reported additional activities which are likely to have an impact on climate change mitigation but, at the time of analysis had not yet collected sufficient information for these activities to be taken into account.

<u>Activities, sink and sources</u>

In the project sample analysed 97% of the land was found to be agricultural land (annual cropland, grassland, flooded rice or perennial cropland). The strong focus on agricultural land is in line with expectations given IFAD's mandate to eradicate poverty and hunger by investing in poor rural people via programmes and projects that aim to increase agricultural productivity. Consequently, the management of annual croplands is the activity with the largest mitigation potential, with carbon sequestration in soils representing the largest sink. Increasing carbon in soils has a multitude of benefits in addition to climate change mitigation. As organic matter is primarily made up of carbon (>50%), increased soil organic carbon improves water infiltration, increases nutrient availability, can enhance soil biodiversity and reduces the risk of erosion, all of which are important for climate change adaptation and resilience in addition to mitigation.

The analysis also found that other activities with high carbon sequestration potential per hectare were: coastal wetlands management, afforestation, agroforestry and forest management. These activities, particularly agroforestry, feature strongly in projects supported by IFAD, especially ones financed through its Adaptation for Smallholder Agriculture Programme (ASAP and ASAP+), the Green Climate Fund (GCF), the Global Environment Facility (GEF) and the Adaptation Fund (AF). **Figure 22** shows a comparison of the area per activity for projects of the representative sample and ASAP-funded projects. ASAP funded-projects cover considerably more activities on perennial cropland/agroforestry, compared to the projects of the representative sample. This suggests that additional funding for ASAP+ is likely to boost carbon-sequestrations in both the biomass and soils, hence providing a higher climate change mitigation potential.

Figure 22. Area per activity of representative sample and ASAP-funded projects



Significance of results for IFAD

The findings of this report are important for two reasons, they: (i) provide a GHG baseline of IFAD's portfolio that will support the definition of future climate change mitigation commitments; and (ii) highlight the climate adaptation-mitigation synergies that can be realised through the kinds of investments in small-scale agriculture and rural development that IFAD promotes, which in turn strengthen the rationale for directing additional climate finance to the sector.

The final section of this study includes preliminary recommendations on the way forward regarding GHG accounting for IFAD. The overall recommendation is that consideration be given to adopting a systematic approach to GHG accounting for new projects supported by IFAD in order to promote closer attention to climate change mitigation best practices during project design and stronger accountability relative to its climate change mitigation commitments.

(i) Mobilizing additional climate finance

International environment and climate funds are increasingly asking to see their entities' Paris alignment plans during re-accreditation processes. For example, in decision B.10/06, GCF states that "the re- accreditation decision by the Board will take into account the Secretariat and Accreditation Panel's assessment of the extent to which the accredited entity's overall portfolio of activities beyond those funded by the GCF has evolved in [the] direction [of low-emission and climate-resilient development pathways] during the accreditation period." This means that "assessment and evaluation over time of the overall portfolio of an AE and any other entity accredited in the future addresses two related attributes: (a) The greenhouse gas (GHG) emissions directly associated with the assets on its balance sheet, not just those that have attracted GCF finance, on the one hand; and (b) The resilience to the climate change that those assets are expected to be exposed to, on the other. The present GHG baseline can be an important cornerstone for such re-accreditation processes.

(ii) Setting future commitments for climate change mitigation

International Financial Institutions increasingly commit to ensuring that their investments/financing flows are consistent with development trajectories considered compatible with the temperature and climate resilience targets of the Paris Agreement. This report provides a GHG baseline of IFAD's portfolio that supports the definition of future commitments it can aim to achieve for climate change mitigation; such commitments will help underscore IFAD's Paris Alignment ambitions.

3.2 Limitations

Limitations of the approach

The results of this study have to be taken in context and viewed in terms of the following limitations of the approach taken:

- Firstly, the findings came from a 6-month desk-based study which used data from project documents. All of the data that was used had been collated for purposes other than GHG accounting. For most projects, there was also follow up with the project management unit to confirm data and fill gaps and resolve any data inconsistencies between documents. For a more comprehensive analysis some data collection targeted at GHG accounting would be needed.
- Due to the nature of most of the projects and how they are funded, it was not possible to attribute specific GHG emissions and carbon stock changes to IFAD's investments. Therefore, the percentage of investment was used to estimate the percentage of emissions/sequestration attributable to IFAD.

Technical limitations

In addition, the following technical limitations should be taken into account:

- This representative sample analysis gives a projected Carbon-balance for the next 20 years using an ex-ante carbon-balance calculator (the EX-ACT tool). It does not therefore reflect the 'real' or 'actual' emissions/sequestration for the projects over this period. This could only be achieved by a wide ranging monitoring system. However, modelling tools can be useful for estimating potential impacts as has been done here.
- The EX-ACT tool was used in this analysis. EX-ACT uses the IPCC equations to estimate carbon stock changes and GHG emissions. These equations include default Tier 1 data on the GHG impacts of different activities in different climate regions and soil types. As Tier 1 data are very generalised, users can input their own Tier 2 (site specific) factors if available. Due to the constraints of time and the nature of the study, the majority of analysis carried out for the assessment used Tier 1 factors. To improve the analysis, Tier 2 factors could be collected from relevant literature and the project sites.
- Sample projects were chosen based on the proportion of IFAD investment in a given region. For some regions, such as LAC and NEN, this led to small sample numbers (2 and 3 respectively) making extrapolation of findings to the region inappropriate.
- Several of the projects in the sample had experienced delays in operation due to Covid restrictions. They had therefore implemented fewer activities than would have been expected by mid-term under normal circumstances.

Sensitivity analysis

Emission estimates in the AFOLU sector are subject to uncertainty. To address this limitation, the authors undertook a sensitivity analysis of the Carbon-balance results for five selected projects (including two of the three projects with the highest climate change mitigation potential) using other relevant GHG accounting tools of the AFOLU sector, notably the Nationally Determined Contributions Expert Tool (NEXT) and the UNEP GEF CBP tool[2] (see Annex 2). The summed Carbon-balance for the 5 selected projects show overall GHG emission reductions/carbon sequestrations for both EX-ACT and NEXT. EX-ACT shows a higher overall Carbon-balance (-6,394,712 tCO_2eq over 20 years) compared to NEXT (-5,647,429 tCO_2eq over 20 years). While the lower Carbon-balance for NEXT may suggest that the extrapolated overall GHG emission reductions for IFAD's portfolio of ongoing projects with MTR is slightly lower than estimated above (approximately 12% lower than the –20,536,334 tCO_2eq over 20 years), **this sensitivity analysis reaffirms the direction of change of GHG fluxes, i.e. that IFAD's investment portfolio has a net negative carbon balance** (sequesters carbon/reduces GHG emissions).

3.3 Recommendations

Way forward on GHG accounting for IFAD

In 2019, IFAD carried out selective GHG accounting for climate-financed projects through an IFAD FAO grant. This gave an indication of the climate change mitigation potential of a select sub-set of mostly climate-financed projects (most of the 75 projects are either ASAP, GCF, GEF or AF-funded projects), but did not provide representative information for the IFAD-specific investment portfolio under it's Programme of Loans and Grants (PoLG). That is why, against the backdrop of Paris Alignment, IFAD decided to undertake a portfolio assessment on climate change mitigation.

The present study (2022) used a representative sample of IFAD projects to make an estimate of the impact of IFAD's portfolio of active projects. As described above, the overall Carbon-balance for IFAD's portfolio of ongoing projects is net-negative. While the representative sample study provides a good first overview of IFAD's contribution to climate change mitigation, the sample of projects was too low to make inferences about the Carbon-balances at regional or country level. This shows the need for further future GHG accounting and analysis for IFAD projects.

Systematic GHG accounting for new investment projects in the AFOLU sector provides several advantages:

(i) Avoiding to retro-fit Carbon-balance assessments, which can be difficult with patchy project information and limited time capacity, and this leads to an under-estimation of overall Carbon-balance impacts;
(ii) Simplifying the monitoring of projected (or actual) GHG emissions and emission reductions/carbon sequestrations throughout the project cycle;
(iii) Where investment projects happen to include wetlands, agroforestry or afforestation, it is worthwhile investing extra resources for climate change mitigation monitoring and reporting as these projects will have the largest mitigation potential;
(iv) Inform projects of possible climate change mitigation opportunities and trade-offs, hence maximising efforts to address climate change mitigation as a co-benefit of global public value in investments;

[2] The CBP comparison was done in a qualitative way.

(v) Report on GHG emissions and emission reductions/carbon sequestrations at portfolio level aligning with UNFCCC guidance, which would provide more systematic support to countries in updating their NDCs.

(vi) Place IFAD in good stead in terms of Paris Alignment and ensure that IFAD maintains a net-negative investment portfolio in the future;

(vii) This analysis is an ex-ante projection of real achievements and cannot be used for issuance of carbon credits via carbon markets. However, going forward, systematic GHG accounting (when carried out with a monitoring and measurement campaign that meets the requirements of a specific certification scheme[3]) could open up possibilities to access carbon markets and generate additional revenues for smallholders.

[3] Certification schemes often require project developers to determine specific project boundaries, set baselines, assess additionality and ultimately quantifying, monitoring and tracking the real greenhouse gas (GHG) benefits of a project.

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Annexes

Annex 1. Detailed description of the technical approach to the random selection.

Practical constraints in terms of resources and time precluded an analysis of all IFAD projects. A representative sample of projects from IFAD's portfolio was therefore chosen, with the aim of extrapolating results to the entire portfolio of ongoing projects. The following approach was followed:

i. *Project sample selection*

All ongoing projects between Mid-Term Review (MTR) and Project Completion were considered for the representative sample analysis. This gave an adjusted project list of 95 potential ongoing projects. Conservativeness and data availability are the two main reasons for IFAD to limit the projects to a period between MTR stage and completion. In terms of conservativeness, firstly, projects between MTR and completion stage will more closely reflect the actual GHG impact they will achieve, and secondly, the sample would comprise older generation projects that are less climate-focussed compared to newer ones.[4] With regard to data availability, data required for Carbon-balance assessments is more easily available for projects at advanced stage of implementation.

ii. *Selecting the right sample size*

To ensure a good geographical coverage of the random sample selection, the adjusted project list was first disaggregated by IFAD operating region. There are five IFAD regions, namely: Western and Central Africa (WCA), Eastern and Southern Africa (ESA), Asia and Pacific Region (APR), Latin America and Caribbean (LAC) and Near East, North Africa, Europe and Central Asia (NEN). **Table *2*** shows each region's finance share to the adjusted project list.

Table 2. Financing share of regions in adjusted project list.

Region	APR	ESA	LAC	NEN	WCA
Percent	37.27%	21.87%	7.57%	11.08%	22.21%

From **Error! Reference source not found.**, a matrix (**Matrix 2.a.1.** Projects per project t ype) was created to multiply the project numbers (from 15 to 75[5]) with the percentage distribution of each of the project types.

Mathematically, the authors calculated the following:

[4] For the study, all ongoing projects in IFADs portfolio were considered. This is an important distinction, because some ongoing projects were designed several years ago. This can be due to a number of reasons, not least the project receiving additional financing. This presents an issue, however, as older projects were not designed to today's standards (especially with regards to 1) climate finance as the IFAD11 replenishment cycle (2019-2021) was the first time IFAD committed to ensuring that at least 25 per cent of the Programme of Loans and Grants (PoLG) is "specifically climate-focused", and 2) the Social, Environment and Climate Assessment Procedures (SECAP) were only introduced starting from 2015. These older projects are still included to ensure that the breadth and depth of IFADs portfolio are counted and accounted for.

[5] Aligning with standard practices for IFAD impact assessments, the minimum number of the sample was 15% of the adjusted project list. This would correspond to a minimum number of 15 projects. The maximum number of projects was set at 75 due to the limited time available for the representative sample analysis (approximately 6 months).

$$(2.a.1) \qquad [AB]_{i,j} = a_{i,1} + b_{1,j} + a_{i,2} + b_{2,j} + \dots + a_{i,n} + b_{n,j} = \sum_{r=1}^{n} a_{i,r} + b_{r,j} \; ,$$

where 15 ≤ i ≤ 75 and 1 ≤ j ≤ 5.

This can be translated into the following matrix calculations:

$$(2.a.2) \qquad projectsPerRegion_{i,j} = projectNumber_{i,j} * regionalFinancingShare_{i,j},$$

$$(2.a.3) \qquad projectsPerRegion_{i,j} = \begin{bmatrix} 15 \\ \vdots \\ 75 \end{bmatrix} [37.27\% \quad \dots \quad 22.21\%] = \begin{bmatrix} 5.59 & \dots & 3.33 \\ \vdots & \ddots & \vdots \\ 27.95 & \dots & 16.66 \end{bmatrix},$$

where $projectsPerRegion_{i,j}$ is the total number of projects per project type.

As the main objective is to know the exact integer number of projects of the sample (and of projects per project type), this involves replacing a number with an approximate value that has a more explicit representation (hereafter referred to as *rounding*). In a second matrix (**Matrix 2.a.2.** Projects per region (rounded)), **Matrix 2.a.1.** is therefore rounded to the nearest integer. Rounding can however lead to an over- or under-representation of the aggregate results. Consider the first four rows of **Matrix 2.a.2.** in **Table *3***. In the case of the row with 19 projects, the sum of the rounded projects is 18 projects. This shows hence an under-representation of the total number of projects.

Table 3. Matrix 2.a.2. Projects per region (rounded)

Project #	APR	ESA	LAC	NEN	WCA	Rounded sum
15	6	3	1	2	3	15
16	6	3	1	2	4	16
17	6	4	1	2	4	17
18	7	4	1	2	4	18
19	7	4	1	2	4	18
…	…	…	…	…	…	…
75	28	16	6	8	17	75

To adjust for these rounding problems, three intermediary steps were taken. The first step was to identify all projects with rounding problems and quantify the difference of the rounded sum to the project numbers (summed rounding difference, see Formula 2.a.4). In a second step, another matrix is created, which calculates the difference between **Matrix 2.a.2** and **Matrix 2.a.1.** This **Matrix 2.a.3** represents the Rounding deviation for Projects per region (see Formula 2.a.5).

$$(2.a.4) \qquad summedRoundingDifference_{i,j} = \sum_{j=1}^{5} \text{nint}(projects_{i,j}) - projectNumber_{i,j},$$

where $summedRoundingDifference_{i,j}$ is the difference of the sum of the nearest integer of projects per region and the project numbers.

$$(2.a.5) \qquad roundingDeviation_{i,j} = [\text{nint}(projects) - projects]_{i,j}$$

where rounding $Deviation_{i,j}$ is the deviation between the nearest integer of projects per project number i and project region j, and the exact number of projects per project number i and project region j (with 15 ≤ i ≤ 75 and 1 ≤ j ≤ 5).

The third step consists of calculating the additional or reduced projects per region based on the following condition:

- If there is an underrepresentation of one project in the summed rounding difference, one project will be added to a project region. This region is identified by looking at the maximum value in the deviation matrix **Matrix 2.a.3.** for a given project number**.**
- If there is an underrepresentation of two projects in the summed rounding difference, two projects will be added to the project regions. The regions are identified by looking at the largest and second-largest value in the deviation matrix **Matrix 2.a.3.** for a given project number**.**
- If there is an overrepresentation of one project in the summed rounding difference, one project will be subtracted from a project region. This region is identified by looking at the maximum value in the deviation matrix **Matrix 2.a.3.** for a given project number**.**
- If there is an overrepresentation of two projects in the summed rounding difference, two projects will be subtracted from the project regions. The regions are identified by looking at the largest and second-largest value in the deviation matrix **Matrix 2.a.3.** for a given project number**.**

This can be expressed as follows:

(2.a.6)

If $summedRoundingDifference_{i,j} = 1,$
then $\max(roundingDeviation_{i,j}) = projects_{i,j} + 1$
If else $summedRoundingDifference_{i,j} = 2,$
then $\max(roundingDeviation_{i,j}) = projects_{i,j} + 2$
If else $summedRoundingDifference_{i,j} = -1,$
then $\max(roundingDeviation_{i,j}) = projects_{i,j} - 1$
If else $summedRoundingDifference_{i,j} = -2,$
then $\max(roundingDeviation_{i,j}) = projects_{i,j} - 2$
Else $summedRoundingDifference_{i,j} =,$
then $\max(roundingDeviation_{i,j}) = projects_{i,j}$

with i as the number of projects and j the project region.

Applying above condition on the addition or subtraction of projects from the project types will give a matrix on the Final projects per project region adjusted for the exact number of projects (**Matrix 2.a.4.**, see Formula 2.a.6).

As stated above, efficiency is important for the selection of the right sample size. Efficiency can be translated into cost and output. Assuming that the number of projects equals the cost, and the distance from the original distribution equals the output, this would mean that one is looking for the least number of projects (minimum cost) and the least deviation from the original distribution (maximum output).

As the rounding changes the project distribution, **Matrix 2.a.4.** can be used to recalculate the rounded project distribution per region (**Matrix 2.a.5**). This is shown in formula (3.a.7)

(2.a.7) $$roundedProjectDistribution_{i,j} = \frac{projects_{i,j}}{\sum_{j=1}^{5} projects_{i,j}}$$

In a next step, the absolute deviation between the rounded project distribution and the original project distribution is calculated (**Matrix 2.a.6.**). This can be expressed as follows:

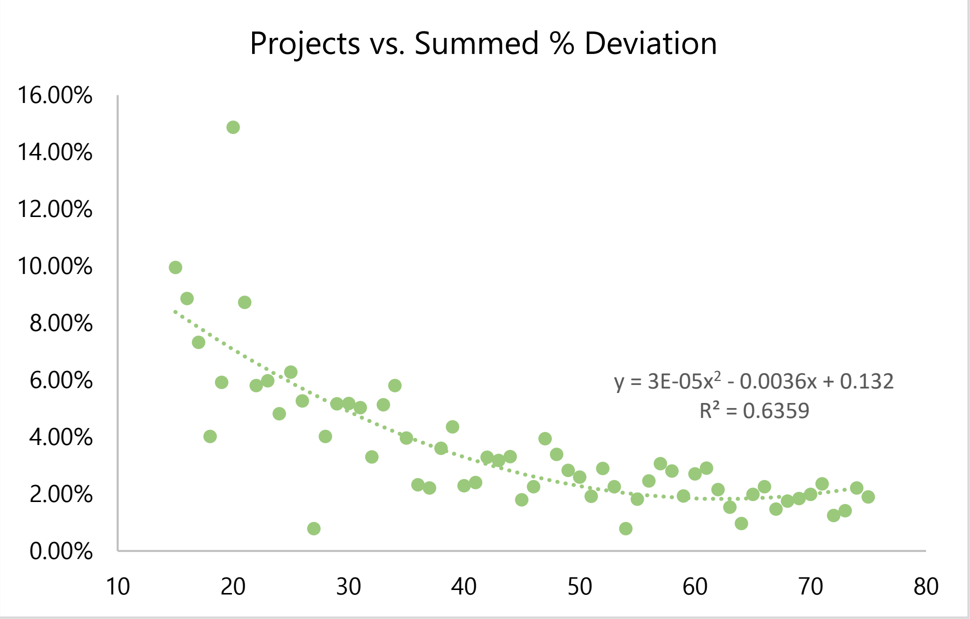
(2.a.8) $$absoluteDistributionDeviation_{i,j} = \left|roundedProjectDistribution_{i,j} - projectDistribution_{i,j}\right|$$

The sum of the region deviations is then calculated to give a simplified matrix (**Matrix 2.a.7.** Summed absolute distribution deviations).

(2.a.9) $$summedAbsoluteDistributionDeviation_i = \sum_{j=1}^{8} absoluteDistributionDeviation_{i,j}$$

Table *5* shows a graph in which the number of projects are plotted against **Matrix 2.a.7.** The most efficient sample size would be the one featuring in the most bottom-left corner of the graph.

Figure 23. Projects vs. Summed absolute distribution deviations.



Mathematically, the most efficient sample size can be estimated by calculating the largest negative value of the difference between each of the data points and a fitted polynomial regression line (dotted line).

(2.a.10) $$optimalSampleSize_i = \min[summedAbsoluteDistributionDeviation_i - (3e^{-5} - 0.0036x + 0.132)]$$

In the case of the original distribution, the most efficient sample size would be 27 projects. These 27 projects would be distributed across the different regions as shown in Error! Reference source not found..

Table 4. Projects per regions for the original distribution.

Region	APR	ESA	LAC	NEN	WCA
Projects	10	6	2	3	6

iii. *Random selection of projects*

Based on the final project matrix, the projects were randomly selected from the project list according to their regional representation.

Table 5. Representative projects chosen for the IFAD portfolio GHG assessment

Project ID	Region	Country	Project Short Name	IFAD Total financing
1100001706	APR	Indonesia	IPDMIP	$100,000,000
1100001464	APR	Cambodia	TSPRSDP	$23,380,092
1100001537	APR	Bangladesh	CDSP IV	$67,930,048
2000001184	APR	China	SPRAD-SS	$72,000,000
1100001743	APR	India	OPELIP	$51,208,000
2000000968	APR	Viet Nam	CSSP	$43,000,000
1100001703	APR	Cambodia	ASPIRE	$53,397,000
1100001723	APR	Nepal	ASHA	$24,999,000
1100001630	ESA	Uganda	PROFIRA	$29,000,343
1100001534	ESA	Malawi	SAPP	$60,030,792
2000000738	ESA	Burundi	PNSADR-IM	$1,000,000
2000000822	ESA	Zambia	E-SLIP	$20,044,000
2000001472	LAC	Guyana	Hinterland Project	$8,452,000
2000000897	LAC	Peru	PDTS	$28,500,000
1100001728	NEN	Bosnia and Herzegovina	RCDP	$12,750,000
1100001690	NEN	Armenia	IRFSP	$11,350,000
2000001159	NEN	Tunisia	PROFITS-Siliana	$24,112,401
1100001678	WCA	Ghana	GASIP	$46,600,000
1100001710	WCA	Sierra Leone	RFCIP2	$31,315,552
1100001757	WCA	Guinea-Bissau	PADES	$12,469,910
2000001071	WCA	Mauritania	PRODEFI	$28,084,803
1100001604	WCA	Cabo Verde	POSER	$21,271,531
1100001594	WCA	Nigeria	VCDP	$213,949,350

Annex 2. Sensitivity analysis via comparison of results of GHG accounting tools

Emission estimates in the AFOLU sector are subject to a large amount of uncertainty. Gibbons et al. (2006) and Toudert et al. (2018) identify three main sources of uncertainty as being associated with GHG emissions: uncertainties in activity data (inventory), uncertainty due to variability in climate and management factors, and uncertainty in Emission Factors (characterization). In the limitations section, the present study already acknowledges uncertainties related to activity data and recommends that IFAD projects be required to make at least an estimate of numbers of hectares of land impacted by different project activities. The use of spatial GHG cadastres (via GIS), and higher level tier methods (Tier 2 or even Tier 3) can furthermore be key to reduce uncertainty in emission estimates or carbon sequestration rates.

Since uncertainty in emissions data reduces confidence in the results of system-level models, the authors decided to compare the Carbon-balance results of the Ex-Ante Carbon-balance Tool with other relevant GHG accounting tools for the AFOLU sector, notably FAO's new Nationally Determined Contributions Expert Tool (NEXT) and the UNEP GEFs Carbon Benefits Project (CBP) tool.

The Nationally Determined Contributions Expert Tool (NEXT)

NEXT is a comprehensive GHG accounting tool developed by the Food and Agriculture Organization of the United Nations to assess national and subnational GHG emission reduction and carbon removals of actions and policies. The tool estimates annual carbon stock changes per unit of land (in hectare, ha), and emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), all expressed in metric tons of carbon dioxide equivalent per year (tCO_2eq/year). The main output of the tool is the annual, and cumulated, estimation of the potential changes in GHG emissions from a set of climate actions against their counterfactual scenarios over a 30-year reading framework. NEXT was developed using the Intergovernmental Panel on Climate Change (IPCC) methodologies, and estimates can be made using either the IPCC 2006 guidelines or the IPCC 2019 refinement to the IPCC 2006 which are both complemented with the IPCC 2013 Wetlands Supplement.

NEXT aligns with the ETF requirements and its modalities, procedures and guidelines (MPGs) II on "national inventory report of anthropogenic emissions by sources and removals by sink of greenhouse gases (GHGs)" and MPG III on "tracking progress of implementation and achievement of NDC under Article 4 of the Paris Agreement".

Carbon Benefits Project (CBP) tool

Other available tools include the Carbon Benefits Project (CBP) tool. The CBP was developed by Colorado State University under a UNEP, Global Environment Facility (GEF) co-financed project. It is a web-based tool which takes the user through a set of modules to estimates C stock changes and GHG emission and emission reduction resulting from AFOLU activities. The CBP uses the IPCC and methods, mainly employing the IPCC 2006 guidelines, stock change and emission factors but supplemented in places by the IPCC 2003 guidelines. The tool includes a spatial component and can therefore be used to make complex landscape-scale assessments which involve a wide range of land uses and land management activities (Milne et al, 2010). It was developed using projects from landscape (80,000 km^2) to plot-scale (12 km^2) in different parts of the world including Kenya, China, Brazil, Niger and Nigeria (Milne et al., 2010).

The CBP is a scenario comparison tool comparing net GHG balance from a baseline (business as usual) scenario with the alternative intervention or project scenario. The tool provides a summary report which shows GHG balances in United Nations Framework Convention on Climate Change (UNFCCC) and IPCC AFOLU formats, accompanied by measures of the uncertainty associated with each calculation. All output is therefore expressed as t CO2 e ha-1 yr-1 for the major GHG gases (CO2, N20, Ch4), for all land based source and sink categories. Users can also create a detailed report which is an Excel file which provides the equations used for all calculations and breaks down all GHG emission and stock changes by all strata used including sink/source categories, climate, soil type, land management category and sub-category.

One of the main differences from Ex-Act, is that the tool has a spatial component, allowing analysis of multiple spatial areas at the same time. This can be particularly useful for large projects such as those funded by IFAD as it allows multiple soil/climate combinations to be taken into account in one model run, rather than just using the dominant soil type as is the case with a single Ex-Act analysis. For example the PASDIPII project in Ethiopia spans 15 soil/climate combinations with only the dominant type being used in the Ex-Act analysis.

The CBP has a Simple Assessment and a Detailed Assessment tool. In the Detailed Assessment there is scope to describe crops and cropping systems in detail by creating specific rotations and creating 'crop types' using Tier 2 factors. Although Ex-Act does allow Tier 2 factors to be added, these apply to the entire cropping system rather than individual crops. In the majority of projects this doesn't create an issue, however for projects which are heavily focused on changing crop management practices and crop type it may be an advantage. However, it should be kept in mind that the CBP provides fewer options than Ex-Act for flooded rice.

i. <u>Comparison of Carbon-balance results between EX-ACT and NEXT tools</u>

Five projects with different activities and regional coverage were selected for a detailed comparison of Carbon-balance results. These projects or programmes are the Ethiopia Participatory Small-scale Irrigation Development Programme II (PASIDP II), the Zambia Enhanced Smallholder Livestock Investment Programme (E-SLIP), the Nigeria Value Chain Development Programme (VCDP), the Peru Public Services Improvement for Sust. Territorial Development in the Apurimac, Ene, and Mantaro River Basins (PDTS) project, and the Viet Nam Commercial Smallholder Support Project in Bac Kan and Cao Bang (CSSP).

The same project activities of the EX-ACT analysis were also used for NEXT.[6]

ii. <u>General observations</u>

The summed Carbon-balance for the 5 projects of both the EX-ACT and NEXT analyses show overall GHG emission reductions/carbon sequestrations. EX-ACT shows a higher overall Carbon-balance (-6,394,712 tCO_2eq over 20 years) compared to NEXT (-5,647,429 tCO_2eq over 20 years). While the lower Carbon-balance for NEXT may suggest that the extrapolated overall GHG emission reductions for IFAD's portfolio of ongoing projects with MTR is slightly lower than estimated above (approximately 12% lower than the –20,536,334 tCO_2eq over 20 years), **this sensitivity analysis also reaffirms that IFAD's investment portfolio has a net negative carbon balance** (sequesters carbon/reduces GHG emissions).

The main reasons for the differences in Carbon-balance results between EX-ACT and NEXT are summarized below:

[6] For the underlying assumptions of the carbon-balance assessments, please contact the authors.

(i) EX-ACT provides ex-ante estimates of the Carbon-balance for projects **using a single calibration for soil and climate**, which pre-defines the emission factors and carbon stocks for all project activities. In reality, however, project activities are very unlikely to occur in the same climate zone and (even less) on the same types of soil. While these single calibrations were also applied to the Carbon-balance assessments with NEXT to ensure better comparability of results, both the CBP Tool and NEXT offer users the possibility to adjust the soils and climate per activity.

(ii) EX-ACT v.8 uses **carbon sequestration rates from Smith et al. (2007) for 5 default management options** (improved agronomic practices, nutrient management, no-tillage and residue management, water management, and manure application). In comparison, NEXT uses the IPCC guidelines with its dimensionless stock change factors for land use systems, management regimes and inputs of organic amendments.[7]

(iii) EX-ACT v.8 uses biomass carbon sequestration rates for agroforestry systems from Cardinael et al. (2019), which were later incorporated into the IPCC 2019 guidelines. This version of **EX-ACT should therefore be considered as a hybrid version between the IPCC 2006 and IPCC 2019 guidelines**, while NEXT only uses the IPCC 2006 default values for agroforestry systems.

(iv) EX-ACT v.8 **does not account for a maximum maturity for agroforestry system**s, i.e. agroforestry carbon sequestrations in the biomass continue at the same rate throughout the user-defined period of analysis (usually 20 years). This leads to an overestimation of carbon-sequestrations. The authors tried to address this shortcoming in EX-ACT by looking up IPCC maximum maturity rates and adjusting the biomass carbon sequestration rates in the Tier 2 section.

(v) The authors have **refrained from using the yearly Carbon-balance of EX-ACT, as it only provides average annual Carbon-balance results**. NEXT shows that annual GHG emissions and emission reductions do not follow linear dynamics of change, but rather dynamic flows. If IFAD were to report on annual emission reductions with flexible dynamics of change for its investment projects in the AFOLU sector, the organisation may want to consider the use of NEXT.

(vi) For **projects with multiple activities entailing land use changes towards cropland (annual, perennial or flooded rice) and/or grasslands, EX-ACT limits the user to a single management option** for these newly generated areas. This may lead to an over- or under-estimation of the Carbon-balance.

(vii) **NEXT does not take into account emissions from investments, such as roads, the construction of buildings and introduction of irrigation systems**. It is, however, important to note that these emissions do not belong to the AFOLU sector, but should rather be accounted for as energy emissions. In addition, the emission factors related to these activities are derived from default values (from AFD's Carbon Footprint calculator) and are associated with large uncertainties.

[7] The authors acknowledge that the new EX-ACT v.9 also uses the IPCC methodology on stock change factors for land uses, management regimes and inputs of organic amendments. Yet, this tool is entirely based on IPCC 2019 emission factors, while EX-ACT v.8 is built on the IPCC 2006 guidelines. NEXT allows the user to choose between both IPCC 2006 and IPCC 2019, both complemented by the 2013 Wetland Supplement.

iii. Project observations in detail

(a) Ethiopia Participatory Small-scale Irrigation Development Programme II (PASIDP II)

The main activities of the Ethiopia Participatory Small-scale Irrigation Development Programme II impacting the Carbon-balance are: (i) introduction of improved agronomic practices and water management on annual cropland and (ii) improvements of the management of grasslands, both leading to increased carbon sequestrations in the soils. The introduction of irrigation schemes leads to a slight increase of emissions, which are, however, largely offset by the carbon sequestrations in croplands and grasslands.

Both EX-ACT and NEXT show a net-negative Carbon-balance with the implementation of PASIDP II. While EX-ACT reports a Carbon-balance of -1,185,119 tCO_2eq over a 20-year period (**Figure 24**), the Carbon-balance estimate of NEXT is slightly higher with -1,348,682 tCO_2eq over a 20-year period (**Figure 25**). Two main differences in the Carbon-balance assessment of the EX-ACT and NEXT tools are worth highlighting: lower carbon sequestrations in EX-ACT for (i) improved grassland management, and (ii) the improvement of annual croplands.

Grassland management differences: While both NEXT and EX-ACT use the same climate and soil parameters, as well as IPCC relative stock change factors for grassland management, the authors identified differences in the default reference soil organic carbon (SOC) stocks for mineral soils. EX-ACT v.8 seems to use default SOC stocks for high activity clay soils in a tropical moist climate (65 tC/ha). Yet, the climate identified in both the EX-ACT and NEXT analyses is a tropical mountain climate, and IPCC estimates for SOC stock on high activity clay soils correspond to 88 tC/ha. This SOC difference explains the difference in results, with slightly higher carbon sequestration rates for NEXT (and a more conservative value for EX-ACT).

Annual cropland differences: EX-ACT v.8 uses carbon sequestration rates from Smith et al. (2007) for 5 default management options (improved agronomic practices, nutrient management, no-tillage and residue management, water management, and manure application).The IPCC guidelines do not make reference to these default management options, but rather offer dimensionless stock change factors for land use systems, management regimes (notably on tillage management) and inputs of organic amendments (low, medium, high without manure and high with manure). The combination of these three stock change factors determines carbon stocks for both the baseline and project scenario. As one of the activities on improved cropland management of the PASIDPII project was the introduction of improved seeds on 46,029 ha (which corresponds to improved agronomic practices for Smith et al. (2007), and to high inputs without manure in the IPCC guidelines), EX-ACT v.8 shows lower soil carbon sequestrations for this annual cropland management activity.

Figure 24. EX-ACT Carbon-balance results for PASIDP II.

Project Name	*Ethiopia PASIDP II*	**Climate**	*Tropical Mountain (Moist)*	**Duration of the Project (Years)**	*20*
Continent	*Africa*	**Dominant Regional Soil Type**	*HAC Soils*	**Total area (ha)**	*89929*

Components of the project	Gross fluxes: Without (All GHG in tCO2eq; Positive = source / negative = sink)	With	Balance	Share per GHG of the Balance (All GHG in tCO2eq): CO_2 Biomass	CO_2 Soil	CO_2 Other	N_2O	CH_4	Result per year: Without	With	Balance
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	0	0	0	0		0	0	0	0	0
Agriculture											
Annual	0	-1,053,046	-1,053,046	0	-1,053,908		863	0	0	-52,652	-52,652
Perennial	0	0	0	0	0		0	0	0	0	0
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	-138,043	-138,043	0	-138,043		0	0	0	-6,902	-6,902
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management											
Forest degradation	0	0	0	0	0		0	0	0	0	0
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0	0				0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	0	5,970	5,970			5,970	0	0	0	298	298
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	0	-1,185,119	-1,185,119	0	-1,191,951	5,970	863	0	0	-59,256	-59,256
Per hectare	0.0	-13.2	-13.2	0.1	-13.3	0.1	0.0	0.0			
Per hectare per year	0.0	-0.7	-0.7	0.0	-0.7	0.0	0.0	0.0	0.0	-0.7	-0.7

Figure 25. NEXT Carbon-balance results for PASIDP II.

Ethiopia

IPCC methodologies

IPCC 2006 & IPCC 2013

Global warming potential

Carbon dioxide | CO2 1
Methane | CH4 34
Nitrous oxide | N2O 298

Period covered: 2017-2047

Final year of last planned activity: 2024

Land distribution by 2047

Forest | 0 ha
Cropland | 66527 ha
Grassland | 23402 ha
Wetlands | 0 ha
Settlement | 0 ha
Other land | 0 ha

Total area | 89929 ha

NEXT indicators*

* Indicators from the strategies implemented in the present analysis

Cumulated emissions - Emissions expected by:	**2024**		**2036**		**2047**	
Reference scenario:	0	tCO2-e	0	tCO2-e	0	tCO2-e
Target scenario:	-337,171	tCO2-e	-1,348,682	tCO2-e	-1,685,853	tCO2-e
Emissions avoided or reduced:	-337,171 ▼	tCO2-e	-1,348,682 ▼	tCO2-e	-1,685,853 ▼	tCO2-e
Forest carbon stock preserved (balance):	0	tCO2-e	0	tCO2-e	0	tCO2-e
Land-based carbon sequestered (balance):	-337,171	tCO2-e	-1,348,682	tCO2-e	-1,685,853	tCO2-e

Annual emissions - Emissions expected by:	**2024**		**2036**		**2047**	
Reference scenario:	0	tCO2-e	0	tCO2-e	0	tCO2-e
Target scenario:	-84,293	tCO2-e	-84,293	tCO2-e	0	tCO2-e
Forest cover (balance, cumulated area):	0	ha	0	ha	0	ha
Net-zero deforestation (target*) expected by:	N/A					

(b) *Zambia Enhanced Smallholder Livestock Investment Programme (E-SLIP)*

The main activities of the Zambia Enhanced Smallholder Livestock Investment Programme impacting the Carbon-balance are: (i) the conversion of annual cropland to grassland and improved grassland management, and (ii) the introduction of agroforestry systems. Both activities lead to increased carbon sequestrations in the soils, and, for agroforestry also of biomass carbon sequestrations. The introduction of livestock, and the use of synthetic fertilizers leads to an increase of GHG emissions, which are, however, offset by the carbon sequestrations in croplands and grasslands.

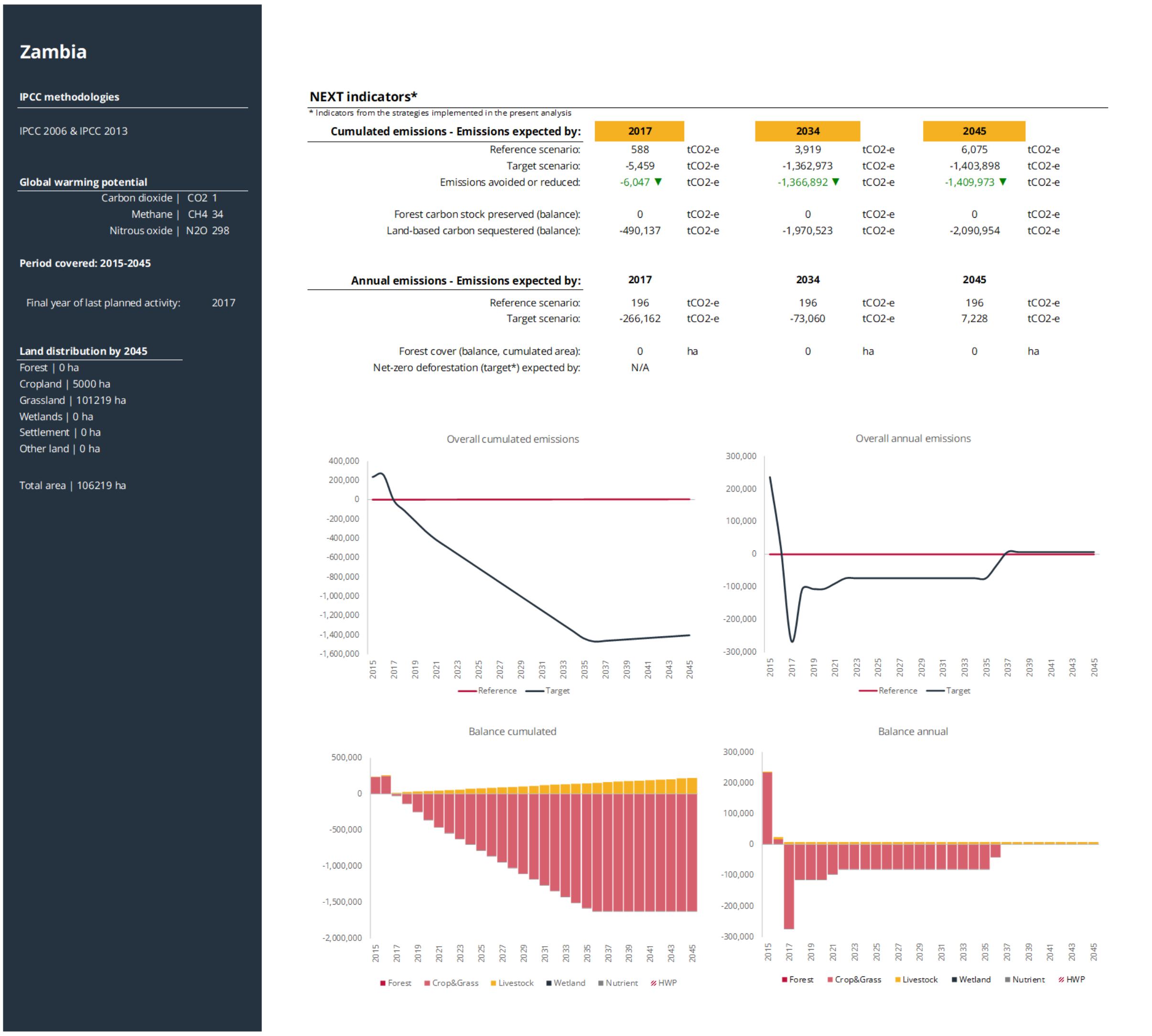
Both EX-ACT and NEXT show a net-negative Carbon-balance with the implementation of E-SLIP. While EX-ACT reports a Carbon-balance of –2,647,470 tCO_2eq over a 20-year period (**Figure 26**), the Carbon-balance estimate of NEXT is much lower with –1,366,892 tCO_2eq over a 20-year period (**Figure 27**). This large difference between EX-ACT and NEXT can mainly be attributed to differences in the estimation of biomass sequestrations of agroforestry systems (hedgerows are introduced on 5,000 ha). EX-ACT v.8 uses biomass carbon sequestration rates from Cardinael et al. (2019), which were later incorporated into the IPCC 2019 guidelines. Total carbon-sequestrations of this activity alone correspond to -1,329,167 tCO_2eq over 20 years. EX-ACT v.8 therefore uses a hybrid approach to carbon sequestrations from agroforestry/perennial cropland (biomass carbon sequestration rates for silvopasture systems amount to 3.07 tC/ha/yr). In comparison, NEXT uses the IPCC 2006 default values for agroforestry systems, i.e. carbon sequestration rates are 1.8 tC/ha/yr for tropical dry climates and High Activity Clay (HAC) Soils. In other words, the introduction of silvopasture systems lead to carbon sequestrations of –109,368 tCO_2eq over 20 years.

Figure 26. EX-ACT Carbon-balance results for E-SLIP.

Project Name	*ESLIP Zambia*	**Climate**	*Tropical (Dry)*
Continent	*Africa*	**Dominant Regional Soil Type**	*HAC Soils*
Duration of the Project (Years)	*20*	**Total area (ha)**	*106218.5*

Components of the project	Gross fluxes (All GHG in tCO2eq; Positive = source / negative = sink)			Share per GHG of the Balance (All GHG in tCO2eq)					Result per year		
	Without	With	Balance	CO_2 Biomass	CO_2 Soil	CO_2 Other	N_2O	CH_4	Without	With	Balance
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	-1,403,907	-1,403,907	74,621	-1,478,528		0	0	0	-70,195	-70,195
Agriculture											
Annual	-111,056	-5,553	105,504	0	105,504		0	0	-5,553	-278	5,275
Perennial	0	-1,041,242	-1,041,242	-1,041,242	0		0	0	0	-52,062	-52,062
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	-423,862	-423,862	0	-423,862		0	0	0	-21,193	-21,193
Livestocks	0	122,742	122,742				60,539	62,203	0	6,137	6,137
Degradation & Management											
Forest degradation	0	0	0	0	0		0	0	0	0	0
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0		0			0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	7,190	485	-6,705			-3,320	-3,385	0	359	24	-335
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	-103,867	-2,751,336	-2,647,470	-966,621	-1,796,886	-3,320	57,155	62,203	-5,193	-137,567	-132,373
Per hectare	-1.0	-25.9	-24.9	-9.1	-16.9	0.0	0.5	0.6			
Per hectare per year	0.0	-1.3	-1.2	-0.5	-0.8	0.0	0.0	0.0	0.0	-1.3	-1.2

Figure 27. NEXT Carbon-balance results for E-SLIP.



(c) Nigeria Value Chain Development Programme (VCDP)

The main activities of the Nigeria Value Chain Development Programme leading to carbon sequestrations/GHG emission reductions are (i) improved management of annual croplands, and (ii) the introduction of hedgerow agroforestry systems. VCDP did however also have significant GHG emissions via an intensification of flooded rice production and the application of farm yard manure as organic amendment.

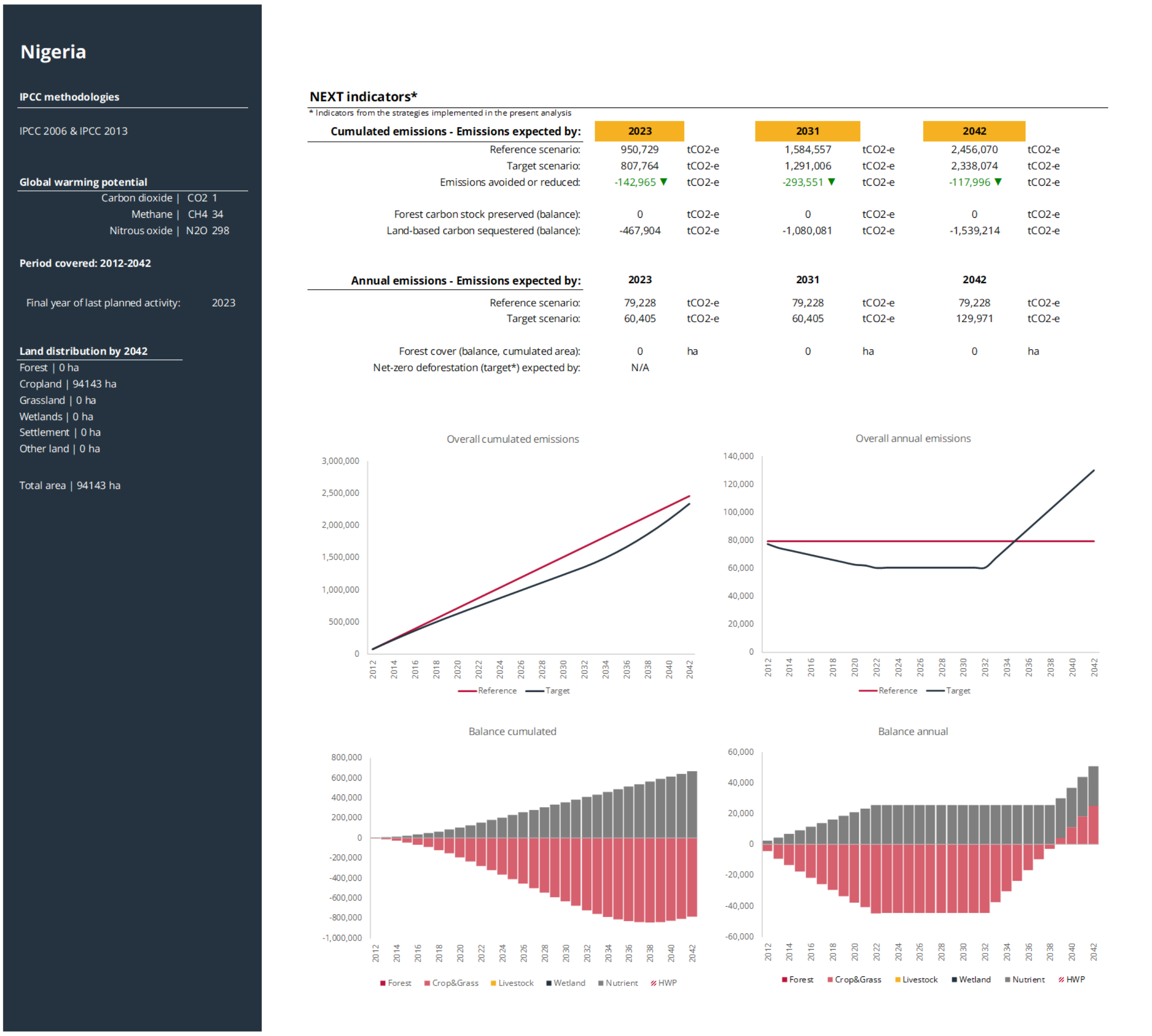
EX-ACT shows a net positive Carbon-balance with the implementation of VCDP with a total Carbon-balance of +378,854 tCO_2eq over 20 years (**Figure 28**). On the other hand, NEXT shows a net-negative Carbon-balance which amounts to –293,551 tCO_2eq (**Figure 29**). This difference in the final Carbon-balance can mainly be explained via differences in the accounting of carbon-sequestrations of annual croplands. As mentioned above, EX-ACT v.8 uses carbon sequestration rates from Smith et al (2007) for 5 default management options (improved agronomic practices, nutrient management, No-tillage and residue management, water management, and manure application), of which all were selected for the activity on improved annual croplands. The corresponding Carbon-balance for annual croplands was -645,833 tCO_2eq over 20 years. NEXT, in turn, aligns with the IPCC 2006 guidelines by using dimensionless stock change factors for land use systems, management regimes and inputs of organic amendments. When selecting high soil inputs with manure application, NEXT reports higher soil carbon-sequestrations of –831,022 tCO_2eq over a 20-year period. In addition, there are minor differences in the GHG emissions related to flooded rice, with NEXT reporting slightly lower methane emissions (162,359 tCO_2eq) compared to EX-ACT (272,091 tCO_2eq) due to the introduction of farm yard manure as organic amendment. These differences can be explained via slight differences in the emission factors for the daily emission factors in methane.

Figure 28. EX-ACT Carbon-balance results for VCDP.

Project Name	VCDP Nigeria	Climate	Tropical (Moist)	Duration of the Project (Years)	20
Continent	Africa	Dominant Regional Soil Type	LAC Soils	Total area (ha)	94143

Components of the project	Gross fluxes Without	With	Balance	Share per GHG of the Balance, All GHG in tCO_2eq: CO_2 Biomass	CO_2 Soil	CO_2 Other	N_2O	CH_4	Result per year Without	With	Balance
	All GHG in tCO_2eq Positive = source / negative = sink										
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	-443	-443	-245	-198		0	0	0	-22	-22
Agriculture											
Annual	-268,917	-914,750	-645,833	0	-794,039		148,206	0	-13,446	-45,737	-32,292
Perennial	0	-4,933	-4,933	-3,765	-1,167		0	0	0	-247	-247
Rice	936,914	1,209,005	272,091	0	0		0	272,091	46,846	60,450	13,605
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management											
Forest degradation	0	0	0	0	0		0	0	0	0	0
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0		0			0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	986,341	1,744,312	757,971			422,421	335,550	0	49,317	87,216	37,899
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	1,654,339	2,033,192	378,854	-4,010	-795,404	422,421	483,755	272,091	82,717	101,660	18,943
Per hectare	17.6	21.6	4.0	4.4	-8.4	4.5	5.1	2.9			
Per hectare per year	0.9	1.1	0.2	0.2	-0.4	0.2	0.3	0.1	0.9	1.1	0.2

Figure 29. NEXT Carbon-balance results for VCDP.



(d) *Peru Public Services Improvement for Sust. Territorial Development in the Apurimac, Ene, and Mantaro River Basins (PDTS) project*

The main activities of the PDTS project impacting the carbon-balance are (i) the improved management of annual cropland, (ii) afforestation, (iii) the introduction of silvoarable agroforestry systems on set-aside land, and (iv) forest management, which lead to increased carbon sequestrations in soils, and partially the biomass. EX-ACT also takes into account GHG emissions related to the construction of roads.

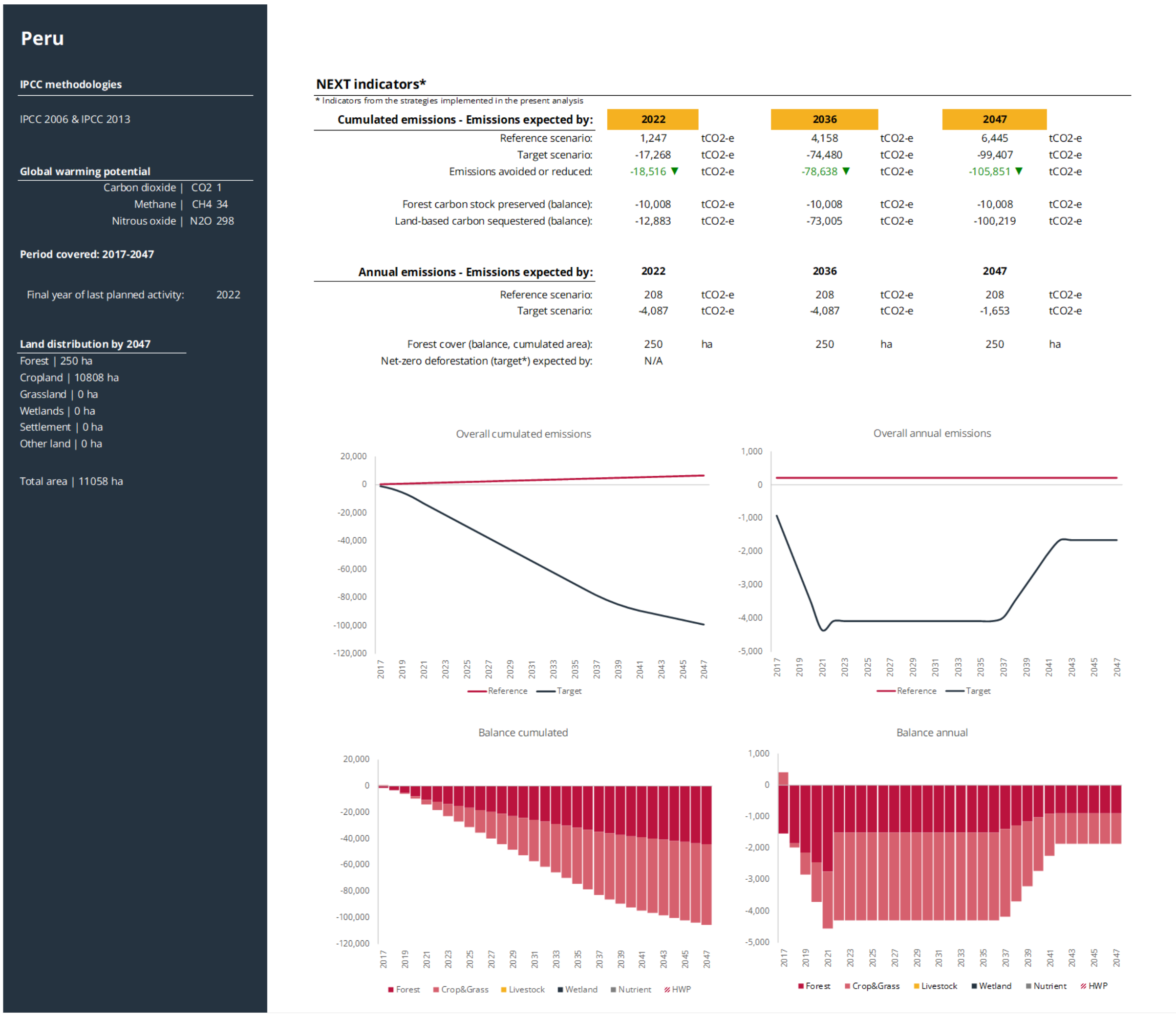
While both EX-ACT and NEXT show a net-negative Carbon-balance with the implementation of the PDTS project, EX-ACT shows a higher carbon-sequestration potential with -212,418 tCO_2eq (**Figure 30**) compared to –78,638 tCO_2eq over a 20-year period (**Figure 31**) with NEXT. The main reason for the difference in results are carbon sequestrations from annual croplands through improved water management (but no manure application), which represents most of the intervention area (9,153 ha of a total of 11,058 ha). While the comparison for the VCDP project has shown that EX-ACT is slightly more conservative on improved annual croplands with manure application, NEXT (and hence the IPCC methodologies) is more conservative for carbon sequestrations stemming from other improvements to annual croplands that are not linked to manure application.

Figure 30. EX-ACT Carbon-balance results for PDTS.

Project Name	Peru PDTS	Climate	Cool Temperate (Dry)	Duration of the Project (Years)	20
Continent	South America	Dominant Regional Soil Type	LAC Soils	Total area (ha)	11058

Components of the project	Gross fluxes: Without	With	Balance	Share per GHG of the Balance (All GHG in tCO2eq): CO_2 Biomass	CO_2 Soil	CO_2 Other	N_2O	CH_4	Result per year: Without	With	Balance
	All GHG in tCO2eq; Positive = source / negative = sink										
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	-25,266	-25,266	-24,339	-926		0	0	0	-1,263	-1,263
Other LUC	0	4,443	4,443	1,650	2,779		14	0	0	222	222
Agriculture											
Annual	-45,687	-228,290	-182,602	0	-182,602		0	0	-2,284	-11,414	-9,130
Perennial	0	-9,055	-9,055	-8,727	-328		0	0	0	-453	-453
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management											
Forest degradation	0	-10,723	-10,723	-9,400	-1,323		0	0	0	-536	-536
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0		0			0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	0	10,785	10,785			10,785	0	0	0	539	539
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	-45,687	-258,105	-212,418	-40,815	-182,401	10,785	14	0	-2,284	-12,905	-10,621
Per hectare	-4.1	-23.3	-19.2	-2.7	-16.5	1.0	0.0	0.0			
Per hectare per year	-0.2	-1.2	-1.0	-0.1	-0.8	0.0	0.0	0.0	-0.2	-1.2	-1.0

Figure 31. NEXT Carbon-balance results for PDTS.



(e) *Viet Nam Commercial Smallholder Support Project in Bac Kan and Cao Bang (CSSP)*

The activities of the Commercial Smallholder Support Project lead to increased carbon sequestrations and include, in order of magnitude, (i) the improved management of forests, (ii) the improved management of grasslands, (iii) improved management of annual croplands, and (iv) the introduction of alley cropping agroforestry systems.

Both EX-ACT and NEXT show a significant net-negative Carbon-balance with the implementation of CSSP. While EX-ACT reports a Carbon-balance of -2,728,559 tCO_2eq over a 20-year period (**Figure 32**), the Carbon-balance estimate of NEXT is slightly lower with -2,559,666 tCO_2eq over a 20-year period (**Figure *33***). The differences in the Carbon-balance are mainly due to differences in carbon sequestrations in both biomass and soils via the improved forest management. While EX-ACT reports combined carbon sequestrations of -2,710,696 tCO_2eq over a 20-year period, NEXT estimates carbon sequestrations to be slightly lower at -2,566,997 tCO_2eq over the same period of analysis.

Figure 32. EX-ACT Carbon-balance results for CSSP.

Project Name	Vietnam	Climate	Tropical (Moist)	Duration of the Project (Years)	20
Continent	Asia (Continental)	Dominant Regional Soil Type	LAC Soils	Total area (ha)	18421.1

Components of the project	Gross fluxes (All GHG in tCO2eq; Positive = source / negative = sink) Without	With	Balance	Share per GHG of the Balance (All GHG in tCO2eq) CO_2 Biomass	CO_2 Soil	CO_2 Other	N_2O	CH_4	Result per year Without	With	Balance
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	-435	-435	-2,028	1,542		51	0	0	-22	-22
Agriculture											
Annual	0	-1,999	-1,999	0	-2,416		417	0	0	-100	-100
Perennial	0	-850	-850	-787	-63		0	0	0	-42	-42
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	-14,579	-14,579	0	-14,579		0	0	0	-729	-729
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management											
Forest degradation	0	-2,710,696	-2,710,696	-2,445,166	-265,530		0	0	0	-135,535	-135,535
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0		0			0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	0	0	0			0	0	0	0	0	0
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	0	-2,728,559	-2,728,559	-2,447,980	-281,046	0	467	0	0	-136,428	-136,428
Per hectare	0.0	-148.1	-148.1	-132.9	-15.3	0.0	0.0	0.0			
Per hectare per year	0.0	-7.4	-7.4	-6.6	-0.8	0.0	0.0	0.0	0.0	-7.4	-7.4

Figure 33. NEXT Carbon-balance results for CSSP.

Viet Nam

IPCC methodologies

IPCC 2006 & IPCC 2013

Global warming potential

Carbon dioxide	CO_2 1
Methane	CH_4 34
Nitrous oxide	N_2O 298

Period covered: 2017-2047

Final year of last planned activity: 2023

Land distribution by 2047

Forest | 18127 ha
Cropland | 208 ha
Grassland | 86 ha
Wetlands | 0 ha
Settlement | 0 ha
Other land | 0 ha

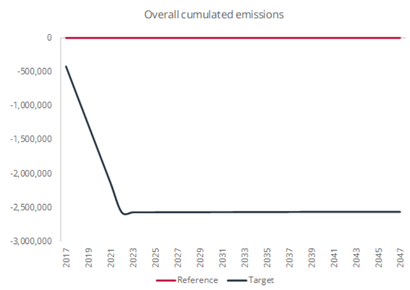
Total area | 18421 ha

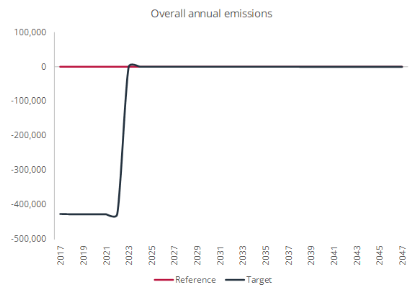
NEXT indicators*

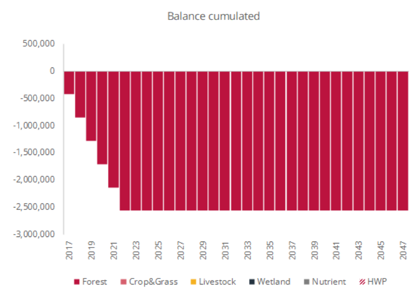
* Indicators from the strategies implemented in the present analysis

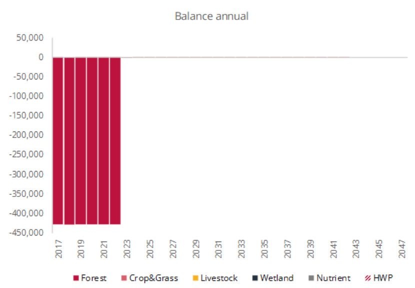
Cumulated emissions - Emissions expected by:	2023		2036		2047	
Reference scenario:	0	tCO2-e	0	tCO2-e	0	tCO2-e
Target scenario:	-2,566,002	tCO2-e	-2,559,666	tCO2-e	-2,557,960	tCO2-e
Emissions avoided or reduced:	-2,566,002 ▼	tCO2-e	-2,559,666 ▼	tCO2-e	-2,557,960 ▼	tCO2-e
Forest carbon stock preserved (balance):	-2,566,997	tCO2-e	-2,566,997	tCO2-e	-2,566,997	tCO2-e
Land-based carbon sequestered (balance):	-6,764	tCO2-e	-9,220	tCO2-e	-9,882	tCO2-e

Annual emissions - Emissions expected by:	2023		2036		2047	
Reference scenario:	0	tCO2-e	0	tCO2-e	0	tCO2-e
Target scenario:	-530	tCO2-e	487	tCO2-e	0	tCO2-e
Forest cover (balance, cumulated area):	18,127	ha	18,127	ha	18,127	ha
Net-zero deforestation (target*) expected by:	N/A					









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