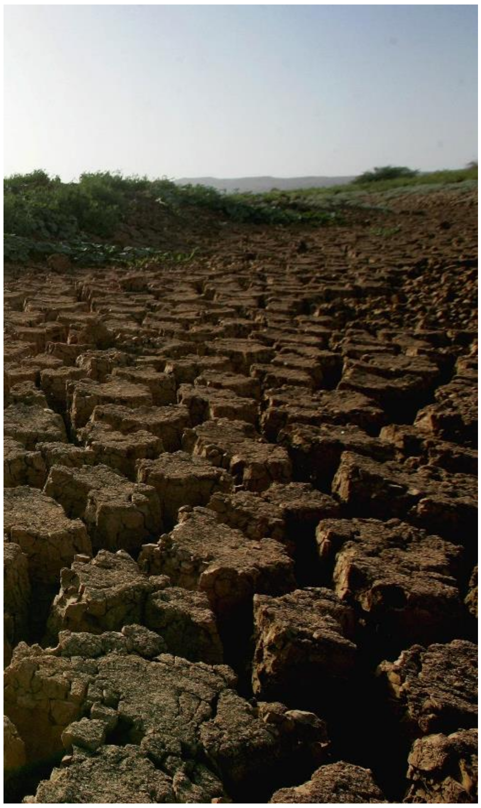
Food and Agriculture Organization of the United Nations

Ex-Ante Carbon-balance Tool (EX-ACT)

QUICK GUIDANCE



EX-ANTE CARBON-BALANCE TOOL ◢ EX-ACT

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QUICK GUIDANCE

by Uwe Grewer, Louis Bockel, Laure-Sophie Schiettecatte and Martial Bernoux

Food and Agriculture Organization of the United Nations

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Acknowledgments

This *Quick Guidance* was prepared by Uwe Grewer, Louis Bockel and Laure-Sophie Schiettecatte from the Agriculture Development Economics Division (ESA) of FAO and Martial Bernoux from Climate and Environment Division (FAO) & the Institut de Recherche pour le Développement (IRD).

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Acronyms

AFOLU	Agriculture Forestry and Other Land Uses
CSA	Climate Smart Agriculture
EX-ACT	EX-Ante Carbon-balance Tool
FUI	Fuel Use Intensity
GHG	GreenHouse Gas
IFI	International Financial Institution
IPCC	Intergovernmental Panel on Climate Change
FAO	Food and Agriculture Organization of the United Nations
tCO_2-e	tonne of CO_2 equivalents
UNFCCC	United Nations Framework Convention on Climate Change

Executive summary

This *Quick Guidance* material provides the reader with an overview and explanation of the methodology, data requirements, application and final use of the Ex-Ante Carbon-balance Tool (EX-ACT). It complements the more comprehensive EX-ACT *User Manual* that is designed to equip users with an independent and proficient understanding in the use of the tool. The *Quick Guidance* is composed of two sections. Section A, *Guide for decision makers* (10 pp.), discusses the rationale behind the tool, its utilization and its results. Section B, *Guide for tool users* (8 pp.), introduces the more technical aspects of data collection, data entry and methodology.

The Ex-Ante Carbon-balance Tool is an appraisal system developed by FAO providing ex-ante estimates of the impact of agriculture, forestry and fishery development projects, programmes and policies on the carbon-balance. The carbon-balance is defined as the net balance of all greenhouse gasses (GHGs), expressed in carbon dioxide (CO_2) equivalents, that were emitted or sequestered due to project implementation as compared to a business-as-usual scenario.

EX-ACT is a land-based accounting system, estimating carbon stock changes (i.e. emissions or sinks of CO_2) as well as GHG emissions per unit of land, expressed in equivalent tonnes of CO_2 per hectare and year. The tool helps project designers to estimate and prioritize project activities with the greatest economic benefit and potential for climate change mitigation. This GHG mitigation potential may also be used for economic analyses and for allocating additional project funds.

The tool can be applied on a wide range of development projects in all Agriculture, Forestry and Other Land Use (AFOLU) sub-sectors, as well as other projects concerned with climate change mitigation, watershed development, production intensification, food security, livestock, forest management or land use change. Furthermore, it is cost effective, requires a comparatively small amount of data, and is equipped with useful resources such as tables, maps and FAOSTAT data. While EX-ACT is mostly used at project level it can easily be scaled up to the programme or sector level and can also be used for policy analysis.

EX-ACT is based on Microsoft Excel (without macros) and is freely available from the FAO website.

- EX-ACT Website:
  www.fao.org/tc/exact
- Free Tool Access:
  www.fao.org/tc/exact/carbon-balance-tool-ex-act
- EX-ACT *User Manual* & EX-ACT *Quick Guidance*:
  www.fao.org/tc/exact/user-guidelines

Section A: Quick guidance for decision makers

1. Introduction

This *Quick Guidance* material is composed of two sections: The first is Section A, *Quick guidance for Decision Makers* (10 pp.), which discusses the rationale behind the tool, its utilization and its results. The following Section B, *Quick Guidance for Tool Users* (8 pp.), introduces more technical aspects of methodology data collection and data entry.

Quick Guidance for Decision Makers

Chapter 2 discusses the importance of targeting climate change mitigation in agricultural investment planning. It presents central facts to demonstrate the significance of agriculture sectors (e.g. crops, livestock, forestry and fisheries) as sources of carbon emissions and the potential therein for climate change mitigation. Subsequently *Chapter 3* briefly presents the Ex-Ante Carbon-balance Tool in its most essential characteristics. *Chapter 4* then describes the types of results obtained by EX-ACT and demonstrates how to use them for designing projects and prioritizing selected investments. *Chapter 5* summarises the advantages of engaging in carbon-balance appraisal and of using the EX-ACT tool.

Quick Guidance for Tool Users

Chapter 6 then describes the methodology employed by EX-ACT, followed by a description of its primary data requirements (*Chapter 7*) and the process for building a baseline scenario (*Chapter 8*). Lastly, users are provided with a short guide to entering data (*Chapter 9*).

2. Climate change mitigation in agriculture, forestry and fisheries

a) Why target GHG mitigation in agriculture, forestry and fisheries investment planning?

Agriculture, Forestry and Other Land Uses (AFOLU) contribute around 25 percent of global anthropogenic emissions, primarily through deforestation, livestock emissions and soil and nutrient management. Annual GHG emissions (mainly CH_4 and N_2O) from agricultural production in 2000-2010 were estimated at about 5.0-5.8 $GtCO_2$-e per year, or 10-12 percent of global anthropogenic emissions. Similarly GHG emissions from forestry and land-use change activities account for about 4.3-5.5 tCO_2-e per year, or 9-11 percent of total anthropogenic emissions (Smith *et al.*, 2014). Furthermore, recent attention has focused on the high rates of annual carbon sequestration in vegetated coastal ecosystems (such as mangroves, marshes and seagrasses) that may be lost through habitat conversion. Residing mostly in sediments, this "blue carbon" can be released to the atmosphere when these ecosystems are disturbed (i.e. converted or degraded). If these emissions were accounted for, it is estimated that global deforestation would increase by up to 19 percent (Pendelton *et al.*, 2012). The fishery sector also makes a minor, but still significant, contribution to global GHG emissions. The global fishing fleet is estimated to release about 0.13 $GtCO_2$-e per year during the catch phase (FAO, 2012). Currently, one third of global anthropogenic N_2O emissions are generated by aquatic systems, and by 2030 nearly 6 percent of all anthropogenic N_2O-N emission are anticipated to originate in aquaculture, at its current annual growth rate (Hu *et al.*, 2012).

Globally, the agricultural sector is the largest producer of anthropogenic non-CO_2 emissions, notably CH_4 from cattle, rice plantations, and wetlands, and N_2O from fertilizers and fish-fed farming systems. The scale of global emissions from agriculture, fisheries, land use change and land conversion for aquaculture (e.g. conversion of mangrove swamps) are increasing as a result of population growth, growing consumption of animal proteins and dairy products, and the rising use of nitrogenous fertilizers.

Nevertheless, the potential for climate change mitigation in agriculture is high. The IPCC estimates the global technical mitigation potential of agriculture and forestry to be between 7.18 and 10.60 $GtCO_2$-e per year at carbon prices up to US$ 100 per tonne of CO_2-e, about a third of which can be achieved at prices up to US$ 20 (Smith *et al.*, 2014). Thus mitigation in agriculture and forestry is a cost effective mitigation strategy when compared with non-agriculture sectors. Within agriculture, the crop and livestock subsectors have been identified as the most cost effective areas for abatement (Smith *et al.*, 2014).

Evidence suggests that climate change will lead to decreases in the efficiency and resilience of global agricultural production[1]. This will occur in tandem with an increasing demand from a growing population. Thus agriculture is not only a cause of climate change, but also heavily impacted by it. When considering their overall economic importance as well, agricultural systems are directly linked to food security and the livelihoods of vulnerable people more than any other sector.

Therefore, if targeted appropriately, actions that promote climate change mitigation have the potential to benefit both climate adaptation and food security. The consideration of all these elements constitutes the paradigm of Climate Smart Agriculture (CSA) (FAO, 2013).

The above reasons demonstrate the importance of striving for climate change mitigation in agriculture. Structural planning decisions in AFOLU, coastal wetlands and fishery projects, and programme and policy design are all scenarios where is essential that climate change mitigation objectives complement other development goals.

b) GHG accounting tools in agriculture

Today, decision makers have a wide range of GHG and climate change mitigation tools at their disposal. Each one has different objectives (raising awareness, national reporting, (ex-ante) project evaluation, etc.) and are varied in their GHGs and agricultural activities and are adapted to different geographical scales (farm, landscape, project, national scale, etc).

EX-ACT aims to provide ex-ante project evaluations, requiring relatively little data and few cost requirements in order to suit the cost-effective investment project design processes that are commonplace in agricultural planning. The tool is able to accommodate location specificity (Tier 2) and so exceeds pure Tier 1 functionality. EX-ACT can also accommodate all agricultural sub-sectors, a wide range of agricultural management practices and all types of GHGs and emission processes in both the AFOLU and fishery sectors.

Nevertheless each GHG tool possesses certain unique advantages. If you are searching for a GHG tool with functionalities other than those described here, please consult the online multi-criteria selector for GHG tools in agriculture, available here: http://www.fao.org/tc/exact/review-of-ghg-tools-in-agriculture.

3. The EX-Ante Carbon-balance Tool

a) What is EX-ACT?

The EX-Ante Carbon-balance Tool (EX-ACT) is aimed at providing ex-ante estimations of the impact of development programmes, projects and policies in the AFOLU sector on GHG emissions from carbon stock changes and/or carbon changes rate, constituting the carbon-balance.

EX-ACT is a land-based accounting system, measuring GHG impacts per unit of land, expressed in tCO_2-e per ha and year. A selected functionality accounting for the carbon-balance per unit of produce (carbon footprint) is also available.

b) Tagert users

International Financial Institutions (IFIs) commit themselves increasingly to structurally consider the impact of projects and programmes on the GHG-balance as one directly targeted objective of their investment decisions. The identification of investments that are climate smart while leading to equally high socio-economic outcomes, requires an accepted methodology and practical tools for project and programme level GHG accounting.

EX-ACT targets investment planners and project designers in IFIs and national planning institutions that aim at estimating the GHG-balance of investment proposals in the AFOLU sectors. The main target users should be involved during the project design stage and pursue the objective of aligning ex-ante programme and project documents in accordance with the results obtained from the EX-ACT appraisal.

[1] Cf. Gornall (2010), IPCC (2007a), Beddington *et al.*, (2012b), HLPE (2012a), Thornton *et al.*, (2012).

c) Basic structure of EX-ACT

EX-ACT is an accounting tool consisting of a set of eight linked Microsoft Excel sheets, covering different activity areas of the AFOLU sector. They allow users to specify information concerning land-use change activities and agricultural management practices, and a few geographical, climatic and agro-ecological variables. The eight modules are:

1. **General description of the project**
   (Geographic area, climate and soil characteristics, duration of the project)

2. **Land use change**
   (Deforestation, afforestation/reforestation, non-forest LUC)

3. **Crop production and management**
   (Agronomic practices, tillage practices, water & nutrient management, manure application)

4. **Grassland and livestock**
   (Grassland management practices, livestock feeding practices)

5. **Land degradation**
   (Forest degradation, drainage of organic soils, peat extraction)

6. **Coastal wetlands**
   (Extraction/excavation, drainage and restoration in coastal wetlands)

7. **Inputs and further investments**
   (Fertilizers and agro-chemical use, fuel consumption, electricity use, infrastructure establishment)

8. **Fishery & aquaculture**
   (Marine capture and associated fuel consumption, ice production, aquaculture production and emissions from feed)

The wide coverage of these eight modules ensures that EX-ACT is capable of analysing a wide range of agricultural, forestry and fishery development projects, including:

- Livestock and aquaculture development
- Crop production intensification
- Food security
- Forest and coastal wetlands protection and management
- Watershed development
- Land and coastal wetlands rehabilitation
- Climate change mitigation (forestry, etc.)
- Management activities within coastal wetlands
- Fishery management

Depending on the project, data collection and model completion is necessary only in the modules relevant to the project. Thereby data is only required from the focal areas of the project. Indeed, rather than choosing modules according to project type, they should be chosen in regards to project impacts, i.e. what is affected by the project. This is summarized in table 1.

Table 1: Some practical principles for the easy use of EX-ACT

- Only modules that are directly impacted by project activities have to be filled.
- Sophisticated data is only required for the focal areas of the project.
- It is normal for many data entry cells to not be used and remain empty.
- Information is entered on changes occurring *With Project vis a vis Without Project* situation.

This flexibility allows for adequate consideration of multi-faceted projects and encourages project designers to consider possible impacts on non-target areas, e.g. increased pressure for deforestation or grassland degradation.

d) Scenario building

Ex-ante project evaluation compares the impacts of a planned intervention to the business-as-usual scenario. Thus for each of the variables identified as relevant to the project, data is required for the following three situations:

- The baseline situation
- The With-Project scenario
- The Without-Project scenario (business-as-usual)

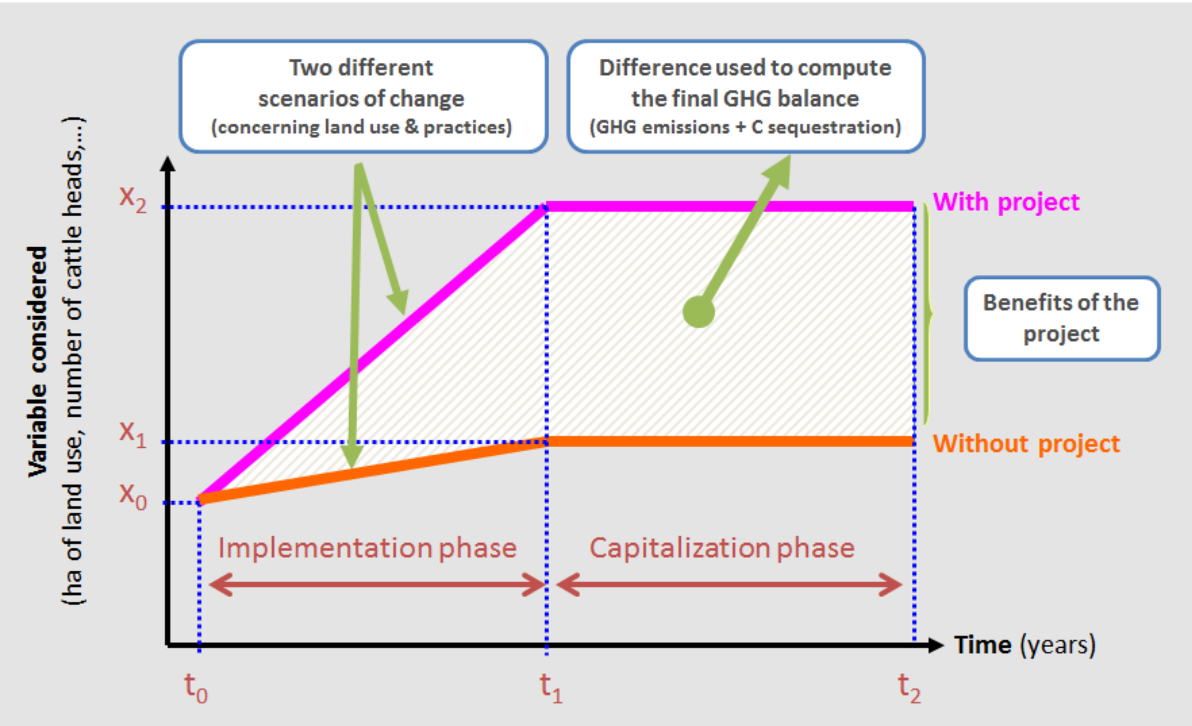
Thus the data requirements of EX-ACT are very similar to the usual data required for ex-ante economic project analyses. Figure 1 below illustrates the essential differentiation that is crucial for the correct understanding of EX-ACT and its application:

Thus x_o denotes the **initial situation** of land use and management practices in the project area, (e.g. the amount of cropland managed under improved nutrient management). Intervention due to the project (**With-Project scenario**) will result in an increase in the area that benefits from improved management, to x_2. In the absence of project intervention (**Without-Project scenario**) this increase will likely be smaller – only x_1 hectares will benefit from improved management (see Baseline scenario building).

Thus EX-ACT differentiates between two time periods. The first is the **implementation phase** which defines the time period in which active project activities are carried out. This phase runs from t_0 until t_1. Thus the period covered by the analysis does not necessarily end with the termination of the active project intervention. Once an equilibrium in land use and agricultural practices is reached at t_1, further changes may occur due to the prior intervention, for instance in soil carbon content or in biomass. This period is defined as the **capitalization phase** and lasts from t_1 until t_2.

The difference in activity data between the With- and Without-Project scenarios serves as the input data for calculating the carbon-balance of the project.

Figure 1: Visualising the development scenarios used in EX-ACT



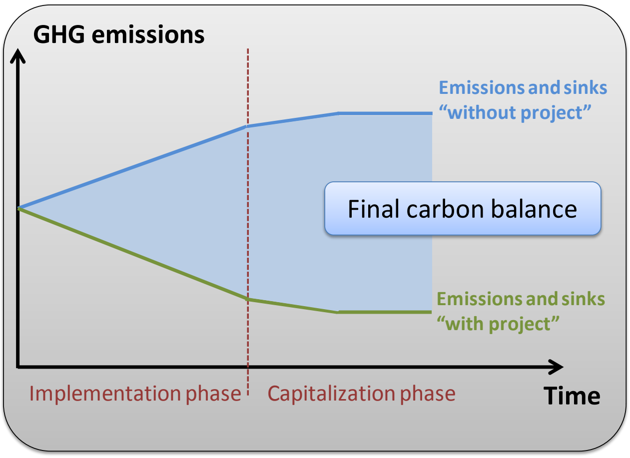
4. EX-ACT results

a) Interpretation of the results

All agro-ecological conditions and activity data specified for each of the chosen EX-ACT modules are used in the calculation of GHG emissions and carbon stock changes.

The comparison of net emissions reveals the difference between the With- and Without-Project scenarios. This difference is then used to determine the overall carbon-balance following project implementation (see Figure 2).

Figure 2: The final carbon-balance



The main results EX-ACT results are shown in the screenshot below (Figure 3). The example project is designed for an area that experiences strong deforestation and land degradation. The project is foreseen to lower the pace of deforestation and other land use changes, while establishing agroforestry and increasing productivity through increased use of fertilizers. The EX-ACT results section may be interpreted as follows:

1. *__Overall gross results__*: Users are first presented with the gross emission and sequestration results of the Without-project scenario (left column) and With-project scenario (right column). The values are given in tonnes of CO_2 equivalents (tCO_2-e) as totalled over the entire period of analysis, but also per hectare and per hectare and year.
In the example given in Figure 3 the Without-project scenario results in a net carbon flux (combining the positive values from GHG emissions and the negative values from carbon sequestration) of up to 4.9 million tCO_2-e. This translates as 246 tCO_2-e per hectare over the full timescale of the analysis, or as 12.3 tCO_2-e per hectare per year. In this example both the With-project and Without-project scenarios are, overall, sources ofof GHG emissions. However as the With-project scenario only has a net carbon flux of 718 860 tCO_2-e, implementation of the project will have considerably more favourable carbon impact than the Without-project scenario.

Figure 3: Main EX-ACT results

Components of the project	Gross fluxes Without	With	Balance
	[illegible]G in tCO2eq		
	[illegible]e = source / negative = sink		
Land use changes			
Deforestation	3,740,693	481,117	-3,259,576
Afforestation	-61,922	-59,994	1,928
Other LUC	398,762	-51,877	-450,639
Agriculture			
Annual	55,507	-27,852	-83,359
Perennial	-7,000	-304,467	-297,467
Rice	44,898	17,973	-26,925
Grassland & Livestocks			
Grassland	121,601	-113,685	-235,286
Livestocks	12,563	9,699	-2,864
Degradation & Management	[illegible]9,722	103,011	[illegible]96,711
Coastal wetlands	0	0	0
Inputs & Investments	[illegible]2,352	664,934	[illegible]2,582
Fishery & Aquaculture	0	0	0
Total	4,967,176	718,859	**-4,248,317**
Per hectare	246	36	-210
Per hectare per year	12.3	1.8	-10.5

2. *__Overall carbon-balance__*: Comparing the gross results of the With- and Without-project scenarios demonstrates the difference that may be achieved through the project. This is referred to as the project's carbon-balance. In the above example the project accounts for a total of -4 248 318 tCO_2-e of avoided emissions or increased carbon sequestration over the 20 year timescale of the analysis. This is equivalent to -210 tCO_2-e per hectare of reduced emissions over the full timescale or -10.5 tCO_2-e per hectare annually.

3. *__Gross results and carbon-balance by module__*: These columns in the table allow the gross results and carbon-balance to be broken down by module.

This is an essential functionality to identify those practices and activities that are the strongest sources of emissions or the most important carbon sinks.

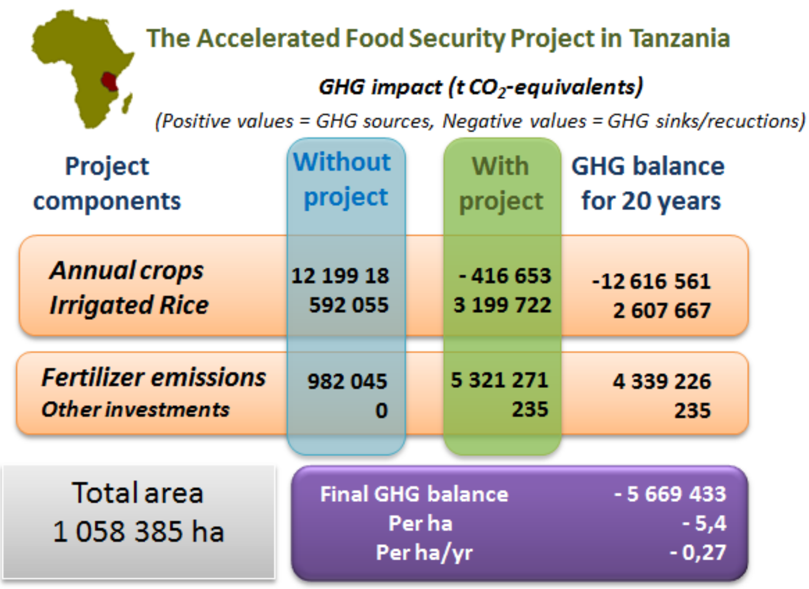
In the example in Figure 3, to the primary sequesters of carbon are the establishment of perennial crop land (-304 467 tCO_2-e) and the rehabilitation of degraded grassland (-113 685 tCO_2-e). The leading causes of carbon loss and GHG emissions are the use of fertilizers and other inputs (664 934 tCO_2-e) and ongoing deforestation (481 117 tCO_2-e).

However it should be noted that the greatest contributors of gross emissions are not necessarily the strongest determinants of the carbon-balance. For instance, the most signficicant factor that leads to the overall favourable carbon-balance of the With-project scenario is the considerable reduction in the rate of deforestation (-3 259 576 tCO_2-e), which is alone responsible for more than 75 percent of the project's carbon-balance. After deforestation, the most significant activities contributing to the favourable carbon-balance of the project are the non-forest land use change activities (-450 639 tCO_2-e) and the rehabilitation of degraded land (-396 711 tCO_2-e).

b) A case study from Tanzania

EX-ACT allows project designer to prioritize components that hold the greatest climate change mitigation potential, while allowing them to deliver the same development goals.

Figure 4: Exemplary results of an EX-ACT appraisal



The *Accelerated Food Security Project* (FAO/World Bank) consists of components that bear antagonistic impacts on GHGs. On the one hand the project introduces greater use of fertilizers which contribute to emissions, whilst on the other hand encouraging and incentivising sustainable land management practices, such as the incorporation of crop residues. An EX-ACT analysis was carried out to clarify the overall dimension of these opposing effects in order to determine whether the project classifies as carbon sink or a carbon source.

Figure 4 above shows that increased fertilizer use and the expansion of flooded rice systems ("Irrigated rice"), which are essential components of the project's food security objectives, both lead to substantial increases in GHG emissions. The With-Project scenario (shown in green) shows that with project implementation, the irrigated rice systems emit 3.2 million tCO_2-e and agricultural inputs cause 5.3 million tCO_2-e. Thus the area remains a net source of carbon emissions. The enhanced land and crop management practices, which were identified as favourable technological investments for intensified systems and are not expected to compromise on yields, are instead carbon sinks of -0.4 million tCO_2-e. Thus the carbon emitted from source activities is considerably greater than the carbon sequestered in sink activities.

Although certain With-project scenario components result in a significant increase in GHG emissions, this scenario must be compared to the baseline scenario (shown in blue), i.e. the continuation of prevailing agricultural practices, such as burning of crop residues.

A comparison of the With- and Without-Project scenarios reveals that implementation of this project would lead to a reduction in GHG emissions as compared to the business-as-usual scenario. Over the full 20 year timescale of the analysis, the project results in a carbon-balance of -5.6 million tCO_2-e, equal to -0.27 million tCO_2-e per hectare per year. This project analysis used the EX-ACT modules: *Description, Crop Production and Inputs*.

c) Using the results

Whilst EX-ACT may be used for analysis of completed project proposals, the tool is also often used at a stage when still several project options are being considered for implementation.

To illustrate, consider this example in which the *Irrigation and Watershed Development Project* in Madagascar was appraised. The two different designs of the watershed component were compared: one smaller watershed component focussing on the diffusion of irrigation infrastructure, and one larger watershed component with a greater focus on natural conservation aspects.

Specifically, the smaller watershed option would cover 8 250 ha, while the up-scaled project would cover 65 000 ha and support the afforestation, reduced deforestation and agroforestry components. These options are broken down in Table 2.

Table 2: break down of the smaller and up-scaled watershed components

	Small watershed component (ha)	Up-scaled watershed component (ha)
Afforested areas	2 250	15 000
Avoided deforestation	2 000	6 000
Improved pasture	2 5000	34 000
Agroforestry	1 500	10 000
Total area of watershed component	8 250	**65 000**

The incremental improvements under the up-scaled scenario will require additional funding. These costs are estimated at: US$1500 per ha reforested area, US$300 per ha of deforestation avoided, US$400 per ha of improved pasture, US$1 000 per ha of agroforestry. In total the additional watershed components are estimated to require funding of US$47.9 million. The total project budget for the project would therefore increase to US$83 million (an increase of 103 percent). By doubling the budget of the project, the resultant benefits in terms of GHG mitigation rise from 2.4 million tCO_2-e to 12.4 million tCO_2-e over the 20 years of analysis (see Table 3 below). Therefore, while the costs are doubled, the benefits are in fact multiplied by a factor of six.

Table 3: Budget and carbon-balance of the two scenarios

	Small watershed component Surface area 112 500 ha	Up-scaled watershed component Surface area 134 200 ha
Budget (US$ million)	40.5	83
Carbon-balance (million tCO_2-e)	2.4	12.5
Carbon-balance per ha (tCO_2-e, 20 years)	21	93
Carbon-balance per ha/yr (tCO_2-e)	1 500	10 000
Total area of watershed component	1.05	**4.6**

Thus EX-ACT can be used in this way to compare different project scenarios for their mitigation benefits. However this mitigation analysis should only complement other performance indicators, such as socio-economic analyses, and should not replace them. Investment decisions should then be taken in joint consultation of the different development goals.

It should be noted that not all agricultural and forestry development projects need necessarily result in a positive carbon-balance. It would be a misapplication of EX-ACT and related tools if the project proposal manipulated arbitrarily to transform it from a carbon source to a carbon.

The use of EX-ACT should instead be integrated with the use of other performance indicators. The tool aims to identify mitigation potential where it is most cost-effective and co-beneficial to a wide range of project outcomes. Even for situations in which project emissions are similar to the business-as-usual scenario, EX-ACT helps to identify the practices that would reduce emission intensity while respecting the needs of other development goals.

Such advantages may include:

1. Allowing project designers to make informed decisions of their project options to better target their mitigation objectives.
2. Providing the ability to prove to third party stakeholders that mitigation objectives have been targeted (in the design stage) and achieved (in the monitoring stage).
3. Allowing the allocation of additional funds for climate change mitigation.

Building on this, the following lists the main reasons why EX-ACT is an instrumental and effective tool for conducting a carbon-balance appraisal.

<u>Comprehensive appraisal</u>: EX-ACT offers the advantage of an integrated analysis of GHGs, through the inclusion of a wide range of activities from the AFOLU and fishery sectors. It can account for the carbon-balance of activities of deforestation, afforestation and reforestation, land use change and conservation, land degradation, annual crop production, agroforestry, production of perennial crops, irrigated rice, livestock and aquaculture production, management activities within coastal wetlands and fish capture at sea.

The tool also comprehensively covers all five carbon pools: above-ground biomass, below-ground biomass, dead wood, litter, and soil carbon. It considers CO_2, CH_4 and N_2O as sources and associated greenhouse gases from (1) biomass growth and removal, (2) site preparation (tillage, burning), (3) use of mechanization and agro-chemicals (fuel, fertilization, liming and irrigation), (4) exported harvested wood products, (5) for peatlands drainage, extraction of peat, rewetting and fires of organic soils, (6) extraction, drainage and rewetting of coastal wetlands, (7) fuel consumption and energy inputs in the fishery sector . It also considers CH_4 from rice and CH_4 and N_2O from livestock and aquaculture production and management.

<u>Landscape and scaling up</u>: EX-ACT is well-suited to assessing project activities at a range of scales. While the tool works best at project level, given that only one dominant soil and climate type can be considered at a time, it can nonetheless be easily up-scaled to regional and national scales. In such cases, sensitivity analyses of soil and climate conditions or separate EX-ACT analyses conducted by region may be undertaken to supplement the usual appraisal process and ensure precise results. The tool has already been used in this way to analyze national agricultural programs and policies in Nigeria and Morocco, product carbon footprint studies in Madagascar as well as various ARD projects.

<u>Data Flexibility</u>: EX-ACT offers a high level of data flexibility. It allows users to choose between site-specific data and default values from the IPCC that are furnished by EX-ACT, based on data availability and the desired level of precision. The tool also provides a wide range of resources (such as tables, maps and FAOSTAT) which can direct the user to the required information. Default values can be chosen from drop-down menus if no project-specific data is available.

<u>Long-term projection</u>: When compared with similar tools EX-ACT can handle greater timescale projections and takes into account the saturation effects concerning soil carbon content and vegetation growth in forests.

<u>Cost-efficient planning tool</u>: EX-ACT is a tool that can be used quickly and at low cost. To facilitate cost effective data collection, the project appraisal team should be coordinated with the teams in the target country, or to other country stakeholders. Specifically, a workshop between the EX-ACT team and the national project team in charge of the appraisal, introducing the technical aspects of the tool and covering project-specific data assessment and the scenario building process, will equip the appraisal team with sufficient data to carry out the full appraisal process.

<u>Interactive and participatory</u>: The EX-ACT appraisal process is interactive and participatory, capable of strengthening the overall project design process, especially when training and workshops (for project teams, government counterparts, and other stakeholders) are included in the process. This has already proven useful during EX-ACT appraisals in Russia, India, and Niger. The tool also allows factors that hinder the adoption of more carbon-neutral activities (or adjustments to proposed activities) to be identified. This may aid the discussion on how to create incentives and institutional conditions to promote their uptake (such as payments for environmental services).

<u>Simulation and scenario building tool</u>: EX-ACT encourages stakeholders to actively engage in scenario building exercises that compare different project and development options over time. These could, for instance, involve simulation and modelling. These exercises allow reflection on the long-term goals of the project and help to adjust initial assumptions to suit their feasibility.

Section B: Quick guidance for tool users

5. Methodology

EX-ACT is a land-based accounting system that relates activity data from the (AFOLU and the fishery sectors to:

- Estimated values of the five carbon pools: above ground biomass, below ground biomass, dead wood, litter and soil organic carbon;
- Estimated coefficients of CH_4, N_2O and selected other CO_2 emissions.

It is through this that EX-ACT derives values of carbon stocks, stock changes as well as CH_4, N_2O and CO_2 emissions, which are the basis of the overall carbon-balance.

EX-ACT was developed using the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and augmented with the wetlands supplement (IPCC-WS, 2014). These equip EX-ACT with recognized default values for emission factors and carbon values – the so-called Tier 1 level of precision. EX-ACT is also based on Chapter 8 of the Fourth Assessment Report from Working Group III of the IPCC (Smith *et al.*, 2007) to account for more specific mitigation options not covered in IPCC 2006. Other required coefficients are taken from published reviews or international databases. For instance, GHG emission values for farm operations, transportation of inputs, and irrigation systems implementation are derived from Lal (2004). Electricity emission factors are based on data from the International Energy Agency (2013). In the fishery sector, fuel use intensity (FUI) data from the capture phase of target species at sea are taken from Parker & Tyedmers (2014).

Each tier of analysis represents a level of methodological complexity that is used to estimate GHG emissions, according to the definitions in IPCC 2006. Tier 1 methods rely on default values and entail less complexity. Tier 2 methods require region-specific carbon stock values and emission coefficients, demanding higher data requirements but offering higher precision.

Whilst users may use the Tier 1 default values provided, EX-ACT encourages users to substitute these values for more location-specific Tier 2 data to improve the accuracy of the analysis. The process for procuring and entering Tier 2 data is discussed briefly in this *Quick Guidance* and in more detail in the *User Manual*.

6. EX-ACT data requirements

a) Identifying the relevant EX-ACT modules for your project

In this section we summarise the types of data required by EX-ACT. As discussed previously, users need only to collect data from those topic modules that are altered in some fashion by their project. In any one module, Tier 1 data can be supplemented with Tier 2 data to increase the regional specificity and confidence level of the results.

EX-ACT does not require a full inventory of all land-use types and agricultural practices used within the project area, but is instead concerned with all land areas and management activities that would be altered by implementation of the project. Therefore **data is required for all areas in which change is observed between initiation of the project and the end of the capitalization phase**, as well as for all areas in which **such alterations are actively prevented** by the project (e.g. reduced deforestation). Table 4 below provides a check-list to help users determine which modules are relevant to their project.

Table 4: Checklist for identifying project relevant EX-ACT modules

	Carbon-Balance Impact Main Impact area		EX-ACT modules to fill	Project Intervention Yes	No
Positive (sink)	A	**Reduced CO_2 emissions**			
	A1	Reduction in rate of deforestation	Land Use Change		
	A2	Reduction in forest degradation	Management		
	A3	Adoption of improved cropland management	Cropland		
	A4	Introduction of renewable energy and energy saving technologies	Inputs & Investments		
	A5	Improved management at sea decreasing the FUI	Fishery		
	B	**Reduced emissions of non CO_2 gas and off site CO_2**			
	B1	Improved animal production	Livestock		
	B2	Improved management of livestock waste	Livestock		
	B3	More efficient management of irrigation water in rice	Cropland		
	B4	Improved management of peatland	Management (Peatland)		
	B5	Improved nutrient management	Crop, Livestock		
	C	**Carbon sequestration**			
	C1	Conservation farming practices	Cropland		
	C2	Improved forest management practices	Land Use Change		
	C3	Afforestation and reforestation	Land Use Change		
	C4	Adoption of agroforestry	Cropland		
	C5	Improved grassland and peatland management	Grassland, Peatland		
	C6	Restoration of degraded land	Management		
	C7	Rewetting of coastal wetlands	Coastal Wetlands		
Negative (source)	D	**Increased emissions of CO_2, non-CO_2 and offsite**			
	D1	Increased livestock and aquaculture production	Livestock, aquaculture		
	D2	Drainage, extraction, rewetting and fire in peatlands	Peatland		
	D3	Increased irrigated rice production	Cropland		
	D4	Increased fertilizer use and over-fertilization	Inputs & Investments		
	D5	Production, transportation, storage and transfer of agricultural chemicals	Inputs & Investments		
	D6	Increased electricity and fuel consumptions	Inputs & Investments		
	D7	Installation of irrigation systems	Inputs & Investments		
	D8	Building and infrastructures	Inputs & Investments		
	E	**Decreased carbon stock**			
	E1	Increased deforestation & timber logging	Land Use Change		
	E2	Increased land degradation (forest, croplands, grassland, peatland, coastal wetlands)	Land Use Change, peatland, coastal wetland		
	E3	Cropland expansion	Land use change		
	E4	Residue burning and deep tillage	Cropland		
	E5	Extraction and drainage in wetlands (peatlands and coastal)	Coastal Wetlands		

b) Overview of data requirements

Once the relevant modules have been identified, users may proceed with data collection. Tier 1 data are often easy to procure for project managers and are part of the standard information available in project appraisal documents. They concern a wide range of land-use change activities and agricultural management practices, but comparatively few geographical, climatic and agro-ecological variables. A comprehensive list of all Tier 1 data requirements is given in Table 5 below.

Tier 2 data consists of location-specific variables that provide specific carbon content and stock changes for all five carbon pools, as well as the emission factors for selected practices. All Tier 2 data requirements that can be used in EX-ACT are listed in full in the annex of the *User Manual*. Below are a few key examples:

- Above and below ground biomass levels and changes for forestland.
- Soil carbon content.
- Rates of soil carbon sequestration on various land uses.
- Amount of biomass burnt during land conversion and crop residue management.
- N_2O and CH_4 emissions from manure management.
- N_2O, CH_4, CO and off-site CO_2 emissions from drainage, rewetting, peat extraction and fire in peatlands.
- CO_2 and CH_4 emissions from coastal wetlands.
- Emissions from livestock and fish-fed farming systems (enteric fermentation, excretion of ammonia from fish).
- Emissions associated to the construction of agricultural, fishery, and road and building infrastructure.

Collection of Tier 2 data is often difficult and expensive so can never be achieved for all project variables. However collection of Tier 2 data is strongly advised for those core project components that are predicted to be stronger sources or sinks of GHGs. This practice invariably leads to a more harmonious integration of Tier 1 and Tier 2 data.

Table 5: Overview of Tier 1 activity data that can be accommodated in EX-ACT (next page)

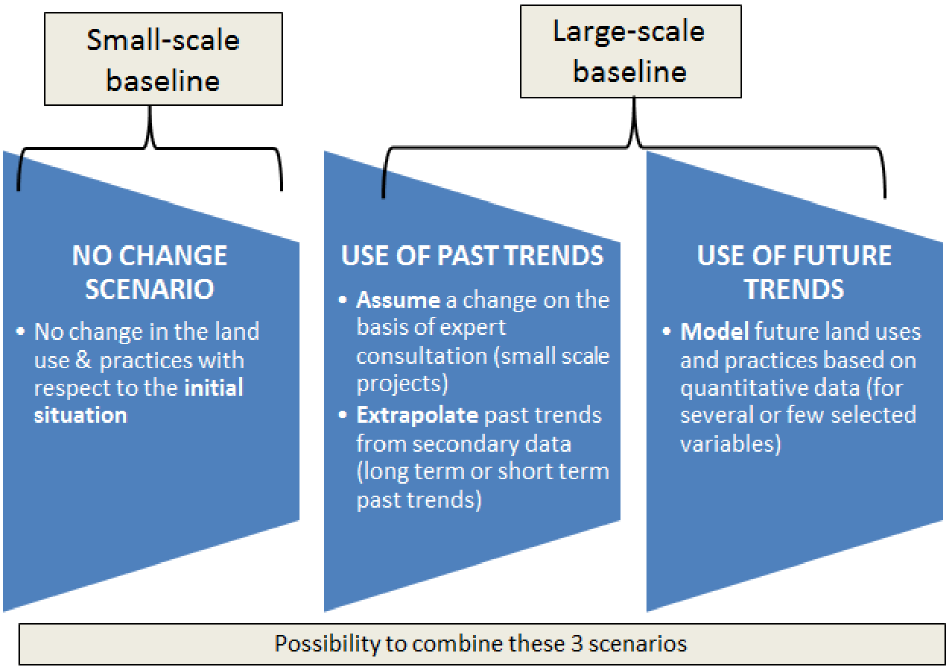
obligatory	Description module	
	• Sub-continent	• Dominant regional soil type
	• Type of climate	• Project duration
	• Moisture regime	
Only if project rela+A5:A44ted	**Land Use Change Module**	
	I. Deforestation	
	• Forest type and size	• Final land use after conversion
	• Area deforested	• Burning during conversion?
	II. Afforestation & reforestation	
	• Type of current land use	• Burning during conversion?
	• Type of future forest	
	III. Other land use change	
	• Type of current land use	• Burning during conversion?
	• Type of future land use	
	Crop Production Module	
	I. Annual systems	
	• Current and future planted crop area (by type of crop)	• Practices of residue burning?
	• Crop management practices	
	II. Perennial systems	
	• Current and future planted crop area (by type of crop)	• Practices of residue burning?
	III. Irrigated rice	
	• Specifications of water management practices	• Type of organic amendment
	Grassland and Livestock Module	
	I. Grassland	
	• Current and future grassland area by state of degradation	• Practices of grassland burning?
	II. Livestock	
	• Type and number of livestock	• Feeding and breeding practices
	Management and degradation Module	
	I. Forest degradation & management	
	• Dynamic of forest degradation/rehabilitation by forest type and size	• Occurrence of forest fires?
	II. Degradation & management of organic soils (peatland)	
	• Vegetation type and size concerned by drainage of organic soils, % of ditches relative to the surface area	• Area affected by peat extraction, height of the extraction
	• Area affected by rewetting	• Area affected by fire, occurrence & intensity of fire
	Coastal wetlands Module	
	I. Extraction/excavation & drainage	
	• Vegetation type and % of the start surface area affected by extraction	• % of the start surface area affected by drainage
	II. Rewetting	
	• Vegetation type and area affected by rewetting	• % of nominal biomass restored
	Inputs & Investments module	
	I. Agricultural inputs	**II. Energy consumption**
	• Quantity of agricultural inputs by type	Quantity of electricity, liquid and gaseous fuel, and wood consumed
	III. Irrigation & infrastructures	
	• Size of area with newly established irrigation (by type)	• Size of area with infrastructures and buildings (by type)
	Fishery & Aquaculture module	
	I. Fishery	
	• Species categories and associated fishing gear	• Annual Total catch
	• % of the catch preserved with on board refrigerant	• % of the catch preserved on ice produced ashore
	• Management practices that will affect the FUI	
	II. Aquaculture	
	• Annual production	• Quantity of feed use

7. Building the baseline scenario

The term 'baseline scenario' refers to the counterfactual outcome, in terms of input variables and the resulting GHG-balance that would most likely have occurred in the absence of project intervention. EX-ACT determines the carbon-balance of a project by comparing the outcomes of the project with the baseline scenario. Therefore the baseline scenario is as integral to the final results of the EX-ACT analysis as the project itself.

To produce a baseline scenario, EX-ACT allows users to choose between three approaches, as depicted in Figure 5 below:

Figure 5: Three baseline methodologies for creating a baseline scenario



Each method will produce baseline scenarios that differ greatly in complexity. For example, assuming that no changes to the initial situation will occur will produce a simpler baseline scenario than engaging expert opinion, extrapolating past trends based on secondary data or modelling future trends with the help of, say, computable general equilibrium models.

Modelling approaches are highly advisable when the project addresses a situation in dynamic change. However, the simpler methodological approaches also have strong advantages due to their low data and resource needs. They may be a viable alternative in cases where land use change and agricultural practices have stagnated or where there are no clear incentives for change.

It is important to note that setting a baseline can have political implications as well as technical; the emission levels that a country or project might claim as correct, is not necessarily the most likely emissions growth scenario without the project. This is a highly contentious issue in the UNFCCC and as yet there is no internationally agreed standard for setting agricultural mitigation baselines.

8. Brief guide to entering data

a) Where to download and how to start

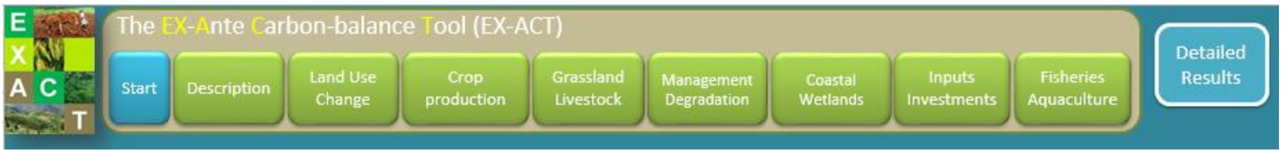
Users can download the Excel file containing EX-ACT for free at www.fao.org/tc/exact/carbon-balance-tool-ex-act.

b) Navigation bar

The navigation bar at the top of the Excel spreadsheet allows users to easily navigate between the eight different topic modules. Each Excel worksheet provides an overview of the topic and activity areas of relevance to EX-ACT.

By clicking on the EX-ACT logo at the top left, users navigate directly to the EX-ACT homepage where they can find additional information. The navigation bar is shown in Figure 6.

Figure 6: EX-ACT navigation bar with the eight modules (green boxes)

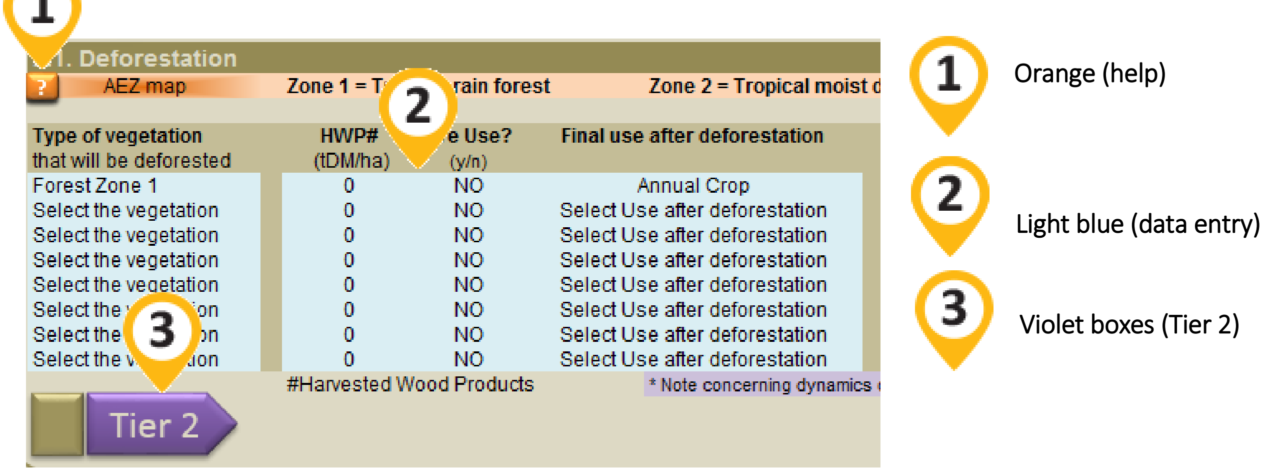


c) EX-ACT colour codes

Every EX-ACT module is subdivided into its different components using boxes. EX-ACT thereby uses a repeating colour code throughout all modules (see Figure 7 below). Cells in "light blue" indicate where users must specify information, while the background colour, shown here in brown, specifies the variables and units that must be provided as well as resulting changes in GHG emissions and carbon stock changes.

By clicking on the orange boxes used throughout EX-ACT, users may find additional information and help to assist in filling the relevant module components. The violet boxes indicating Tier 2 data allow users to specify location specific values for carbon pools (e.g. soil carbon content) and GHG emission factors.

Figure 7: EX-ACT colour codes

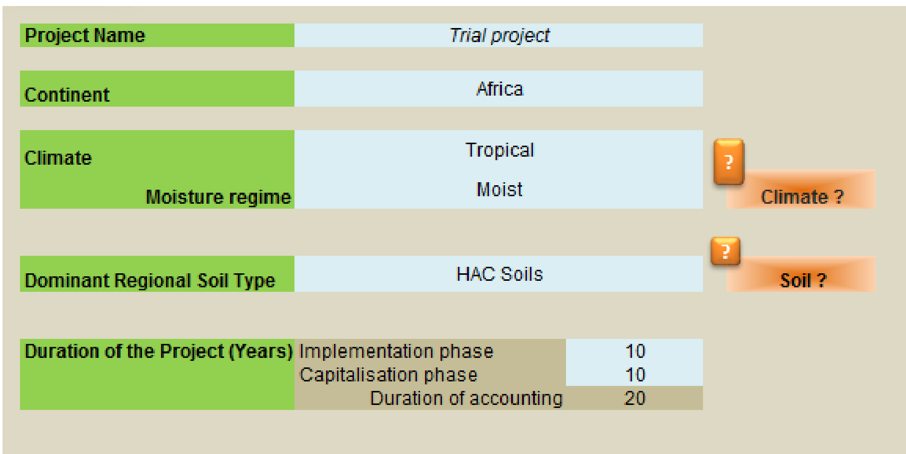


d) Description Module

After leaving the start screen, the first module users must complete is the *description module*. It should be filled with central descriptive information on regional agro-ecological conditions.

Figure 8: The Description Module

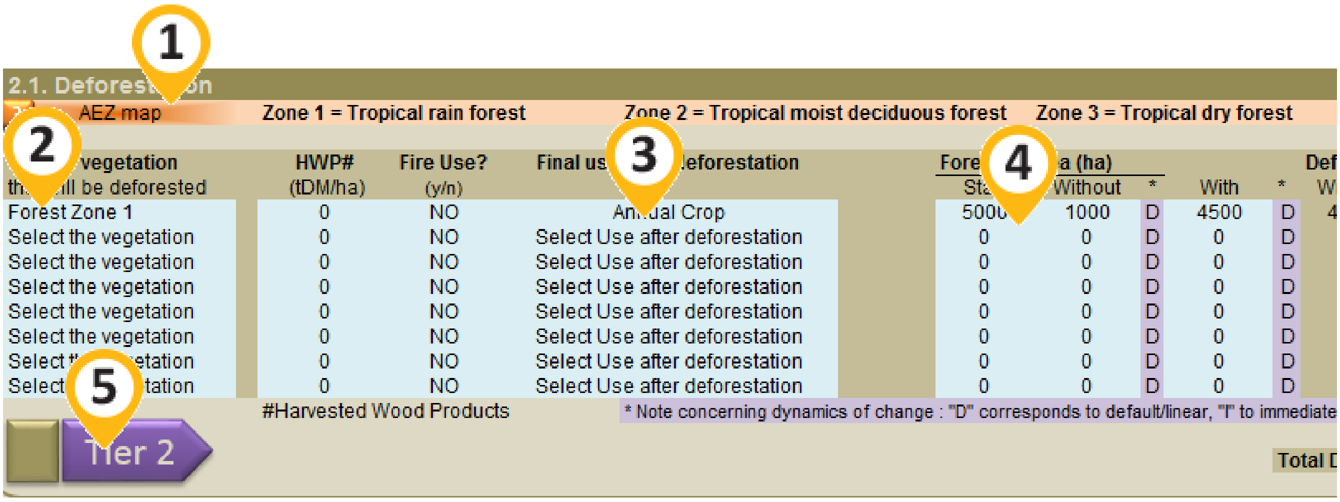
Every new user should always begin by filling in the description module. If this does not occur, the rest of EX-ACT would not contain the necessary input information to proceed. Specifically, users should fill in the information depicted in Figure 8, by selecting from the drop-down menus.



e) Data entry in the topic modules

A detailed step-by-step guide to data entry is provided in the *User Manual*. To illustrate data entry, we will describe here only the Deforestation sub-section of the Land Use Change Module.

Figure 9: Deforestation (Land Use Change Module)



When using the Deforestation Sub-Module, the following information will be required:

1. *__Identifying the current forest type__*:

   Based on the climatic information provided in the *Description Module*, users are provided with up to four different types of agro-ecological forest categories.

2. From the drop-down list users then choose which of the four forest types best describes the area under the project subject to potential deforestation. In the example above this is *Forest Zone 1* standing for *Tropical rainforest.*

3. *__Identifying the final land use after deforestation__*: In the next step, users select the subsequent land use after conversion from a drop down menu. In the above example the forest is converted into annual crop land.

4. *__Surface deforested__*: Next, users should specify the size of the area that remains forested for the three EX-ACT scenario points: In the example the initial forest size is 5 000 ha. Without project implementation it will diminish due to deforestation to a final size of 1 000 ha, while with project implementation 4 500 ha will remain.

5. *__Tier 2 specifications__*: While the previous information is sufficient for EX-ACT to calculate a Tier 1 based carbon-balance, further information can be specified by clicking on the Tier 2 button:

As shown in Figure 10 above, users can input Tier 2 specifications for forestland subject to deforestation, the carbon content of above and below-ground biomass, litter, dead wood and soil organic carbon.

In the below example, only the forest category "Forest – Zone 1/ Tropical rainforest" was used. This was automatically shaded in blue by EX-ACT. From the Tier 2 data collected by project staff, it is known that the forest subject to deforestation is, per hectare, characterized by 168 tonnes of carbon per hectare in above ground biomass, 65 tC per hectare in below ground biomass and 3.9 tC per hectare in litter, while the soil carbon content is 68.3 tC per hectare. More details on data collection and entry of such Tier 2 data can be found in the *User Manual*.[2]

[2] The full reference list of cited literature and further information can be found in the EX-ACT *User Manual*.

Figure 10: Tier 2 specifications for deforestation

2.1. Deforestation

? AEZ map | Zone 1 = Tropical rain forest | Zone 2 = Tropical moist deciduous forest | Zone 3 = Tropical dry forest | Zone 4 = Tropical shrubland

Back

You have indicated that you are using the following types of vegetation: Forest Zone 1

Use this part only if you want to refine the analysis with Tier 2 coefficients.
(default values are provided for your information only, while EX-ACT will use Tier 2 values automatically wherever specified) 0

All values are in t of carbon per ha (tC/ha)

Type of vegetation that will be deforested	**Above-ground** Default	Tier 2	**Below-ground** Default	Tier 2	**Litter** Default	Tier 2	**Dead wood** Default	Tier 2	**Soil carbon** Default	Tier 2
Forest Zone 1	145.7	168.0	53.9	65.0	3.7	3.9	0.0		65.0	68.3
Forest Zone 2	122.2		29.3		3.7		0.0		65.0	
Forest Zone 3	56.4		15.8		3.7		0.0		65.0	
Forest Zone 4	32.9		13.2		3.7		0.0		65.0	
Plantation Zone 1	70.5		26.1		3.7		0.0		65.0	
Plantation Zone 2	56.4		11.3		3.7		0.0		65.0	
Plantation Zone 3	28.2		7.9		3.7		0.0		65.0	
Plantation Zone 4	14.1		7.9		3.7		0.0		65.0	
Mangrove	86.6		42.4		0.7		10.7		68.0	

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EX-ANTE CARBON-BALANCE TOOL [EX-ACT]

The EX-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. The tool helps project designers estimate and prioritize project activities with high benefits in terms of economic and climate change mitigation, and it helps decision-makers to decide on the right course to mitigate climate change in agriculture and forestry and to enhance environmental services.

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