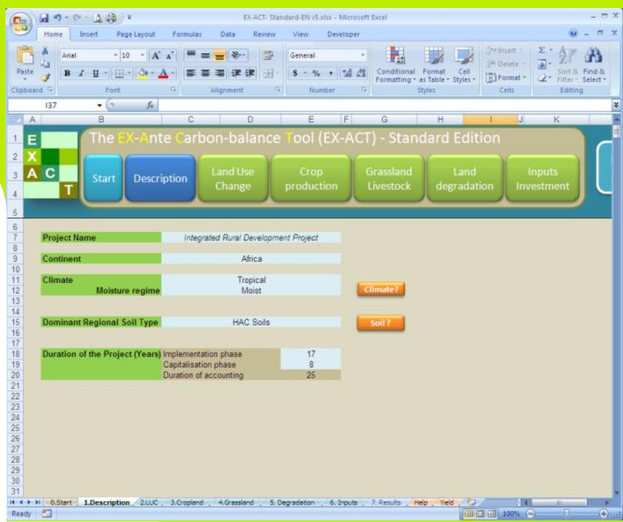
EX-ACT Quick Guidance



Estimating and Targeting Greenhouse Gas Mitigation in Agriculture

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The World Bank

FAO FIAT PANIS

Abstract:

This *Quick Guidance* material provides a well-founded overview and understanding of methodology, data needs, application and final use of the Ex-Ante Carbon-balance Tool (EX-ACT). It complements the more comprehensive EX-ACT *User Manual* that is targeted at leading users to proficiency in the independent use of the tool. The *Quick Guidance* is thereby structured into two parts: The here first presented *Guide for decision makers* (10 pp.) discusses main logic and utilization of the tool and its results, the then following *Guide for tool users* (8 pp.) introduces more technical aspects concerning data collection and entry as well as methodology.

The Ex-Ante Carbon-balance Tool is an appraisal system developed by FAO providing ex-ante estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. The carbon-balance is defined as the net balance from all GHGs expressed in 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 C 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 high benefits in economic and climate change mitigation terms. The amount of GHG mitigation may also be used as part of economic analyses as well as for the application for additional project funds.

The tool can be applied on a wide range of development projects from all AFOLU sub-sectors, including besides others projects on climate change mitigation, watershed development, production intensification, food security, livestock, forest management or land use change. Further, it is cost effective, requires a compared small amount of data, and is equipped with resources (tables, maps, FAOSTAT data) that help to populate the tool. While EX-ACT is mostly used at project level it may easily be up-scaled to the programme/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

Acknowledgement:

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Part A: Quick Guidance for Decision Makers

1) Overview[1]

This quick guidance material is structured into two parts: The here first presented *Guide for decision makers* (10pp.) discusses main logic and utilization of the tool and its results, the then following *Guide for tool users* (8pp.) introduces more technical aspects around methodology as well as data collection and entry.

Guide for decision makers

More specifically *chapter 2* provides the background on why it is important to target climate change mitigation as part of agricultural investment planning. It states central facts showing the importance of agriculture as emission source and its potential for climate change mitigation. Subsequently *chapter 3* briefly presents the Ex-Ante Carbon-balance Tool in its most essential characteristics. *Chapter 4* provides the main results of EX-ACT, shows how to utilize them as part of the project design process and to prioritize selected investments. *Chapter 5* gives a concise overview of the advantages for engaging in a carbon-balance appraisal and for using EX-ACT as a tool.

Guide for tool users

In the following *chapter 6* then shortly depicts the methodological background of EX-ACT, followed by the description of main data needs (chapter 7) and the steps needed in the scenario building process for the baseline scenario (chapter 8). As a last part, users are provided with a short guide to data entry (chapter 9).

2) Climate change mitigation and agriculture

A. Why targeting GHG mitigation as part of agricultural investment planning

Agriculture is a major source of greenhouse gases. In 2010 it contributed directly to between 10 and 12 per cent, or between 5.2 and 5.8 billion tons (gigatons) of CO_2 equivalents annually ($GtCO_2$-e/yr) of total global anthropogenic emissions (Smith, et al., 2014). When combined with related changes in land use, including deforestation (of which agriculture is a major driver), it accounts for a quarter of total GHG emissions. Globally, the agricultural sector is the largest contributor to anthropogenic non-CO_2 emissions, notably methane from cattle, rice plantations, and wetlands and nitrous oxide from the application of fertilizer. The scale of global emissions from agriculture and land use change is increasing as a result of population growth, growing consumption of meat and dairy products, and the rising use of nitrogen fertilizers.

The potential for mitigation in agriculture is high and 74 percent of this potential can be found in developing countries. The IPCC estimates the global technical mitigation potential of agriculture and forestry to be 7.18 to 10.60 $GtCO_2$-e/yr at carbon prices up to 100 USD per tonne of CO_2-e, about a third of which can be achieved at prices up to 20 USD. This makes mitigation in agriculture and forestry a cost effective mitigation strategy when compared with non-agriculture sectors such as

[1] For more detailed information, a glossary of terms and the complete bibliography, please refer to the EX-ACT *User Manual*.

energy. Within agriculture, abatement options in the crop and livestock subsectors were identified as the most cost effective areas (Smith, et al., 2014).

There is much evidence that climate change is likely to lead to decreases in global efficiency and resilience of agriculture production[2], while at the same time being confronted with increasing demand from a growing population as well as from other possible sources. Agriculture is thus not only a cause of climate change, but also strongly impacted by it. Complementing its overall economic importance, agricultural systems are thereby more than any other sector directly linked to the livelihood of vulnerable people and their food security situation.

Measures that promote climate change mitigation thereby contain the potential to strongly co-benefit adaptation and food security, if targeted in an adequate way. The comprehensive consideration of all three elements constitutes the paradigm of Climate Smart Agriculture (CSA) (FAO, 2013).

In combination, these various reasons underpin the importance of targeting climate change mitigation in agriculture. Structural planning decisions as part of agricultural project, programme and policy design are thus central processes in which it is important that climate change mitigation objectives complement other development goals.

B. GHG accounting tools in agriculture

In order to facilitate the different activities of targeting climate change mitigation in agriculture, decision makers can today choose from a wider range of available GHG tools. These tools follow different main objectives (awareness raising, national reporting, (ex-ante) project evaluation, etc.), cover to a different extent all relevant GHGs as well as agricultural activities and are adapted to different geographical scales (farm, landscape, project, national scale).

EX-ACT is targeted at providing (ex-ante) project evaluations, characterized by relatively low data and cost requirements in order to fit with the requirements of a cost-effective investment project design process, as common in agricultural planning. The tool is able to accommodate certain location specificity (Tier 2) and thus exceeds pure Tier 1 functionality. Furthermore EX-ACT can accommodate all agricultural sub-sectors, a wide range of agricultural management practices and all types of GHGs and emission processes in the AFOLU sector.

Each GHG tool is nevertheless characterized by certain competitive advantages. In case you are looking for a GHG tool with other functionalities as described here, please consult the online available multi-criteria selector for GHG tools in agriculture (available at: 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 agriculture, forestry and other land use sector on GHG emissions and carbon stock changes, 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 C-balance per unit of produce (carbon footprint) is also available.

B. Targeted 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

[2] C.f. Gornall (2010), IPCC (2007a), Beddington,et al. (2012b), HLPE (2012a), Thornton et al. (2012).

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 greenhouse gas 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 agriculture, forestry and land use sector. 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.

C. Basic structure of EX-ACT

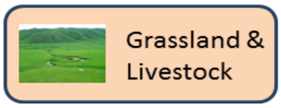
EX-ACT is an accounting tool consisting of a set of six linked Microsoft Excel sheets, covering different activity areas of the AFOLU sector. They allow users to specify information concerning few geographical, climatic and agro-ecological variables and a wider set of information regarding land-use change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

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

The wide coverage of these six topic modules allows that EX-ACT is able to analyse a wide range of agricultural and forestry development projects, such as besides others projects with a main focus on:

- Livestock development
- Crop production intensification
- Food security
- Forest protection and management
- Watershed development
- Land rehabilitation
- Climate change mitigation (forestry, etc.)

Depending on the specific project, data collection and model completion is nevertheless only necessary in the limited number of modules relevantly altered by the project. The main data needs occur thereby only in the focal areas of the project. Indeed, rather than using modules according to project type, they are thereby chosen in regards to project impacts i.e. what is affected by the project.

This flexibility also allows for the adequate consideration of multi-segment projects and leads the project designer to think of possible indirect impacts on not directly targeted area, as 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. It is thus in the basic logic of EX-ACT that for the limited set of as relevant identified variables, data is required for three points in time:

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

The data needs in EX-ACT are thus very similar to the usual data required for ex-ante economic analyses of projects. The figure here below illustrates this essential differentiation which is crucial to the correct understanding and application of EX-ACT:

Thus $\mathbf{x_0}$ gives the **initial situation** of land use and management practices in the project area, e.g. the amount of cropland managed under improved nutrient management. The consecutively starting project intervention (**With-Project scenario**) will lead to an increase in the improved managed area to $\mathbf{x_2}$. In absence of the project intervention (**Without-Project scenario**) it is instead expected that this increase is smaller and only $\mathbf{x_1}$ hectares are managed in an improved way (cf. baseline scenario building).

Thereby EX-ACT differentiates between two time periods: The **implementation phase** defines the time period in which active project activities are carried out and lasts from $\mathbf{t_0}$ until $\mathbf{t_1}$. Thereby the period covered by the analysis does not necessarily end with the termination of the active project intervention. Even after that a new equilibrium in land use and practices is reached in t_1, further changes may occur e.g. in soil carbon content or in biomass, that are caused by the prior intervention. This period defines the **capitalization phase** which lasts from $\mathbf{t_1}$ until $\mathbf{t_2}$.

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

Figure 1: Building of development scenarios for the use in EX-ACT

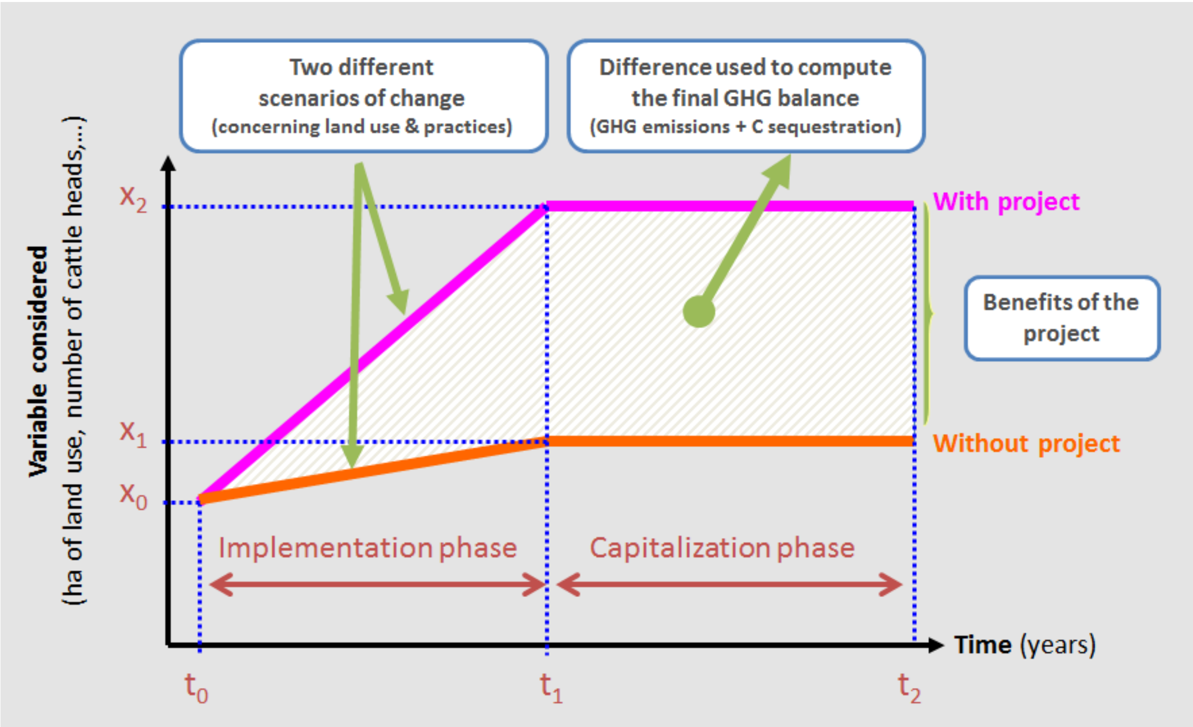


Figure 2: Some practical principles for the easy use of EX-ACT

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

4) EX-ACT results

A. Results interpretation

The specified agro-ecological conditions and activity data throughout all considered EX-ACT modules lead to the calculation of GHG emissions and carbon stock changes.

The comparison of the net emissions from With- and Without-Project scenario thereby constitute the marginal difference due to project implementation which defines the overall carbon-balance (c.f. figure 3).

These main EX-ACT results are shown in the screenshot below (figure 4). The exemplary project is implemented in an area that experiences strong deforestation and land degradation. The proposed project is foreseen to lower the pace of deforestation and other land use change, while establishing agroforestry and increasing productivity by stronger use of fertilizers. The EX-ACT results section may be interpreted in the following way:

1. ***Overall gross results***: Users may first of all see the overall gross emissions and sequestration results of the without-project scenario (left column) and with-project scenario (right column). The indications are made in tonnes of CO_2 equivalents as total over the entire period of analysis, but also per hectare and per hectare and year.
In the here chosen example the without-project scenario leads to combined effects from GHG emissions and carbon sequestration that add up to 4.9 mio tCO_2-e. This translates into 246 tCO_2-e per hectare over the full analysis duration or into 12.3 tCO_2-e per hectare and year. The hypothetical project scenario has a considerably more favourable impact on GHG emissions and carbon sequestration leading only to a total impact of 718,860 tCO_2-e. Both scenarios are thus overall sources of GHG emissions.

Figure 3: The final carbon-balance

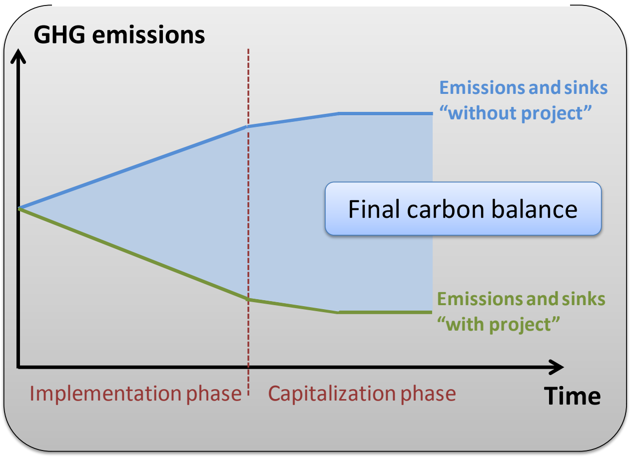


Figure 4: Main EX-ACT results

Component of the project	Gross fluxes Without	With	Balance
	All GHG in tCO2eq		
	Positive = source / negative = sink		
Land Use Changes			
Deforestation	3,740,693	481,117	-3,259,576
Afforestation	-61,922	-59,994	1,928
Other	398,762	-51,877	-450,640
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
Livestock	12,563	9,699	-2,864
Degradation	499,722	103,011	-396,711
Inputs & Investments	162,352	664,934	502,581
Total	4,967,178	718,860	**-4,248,318**
Per hectare	246	36	-210
Per hectare per year	12.3	1.8	-10.5

2 ***Overall carbon-balance***: Comparing the gross results between the without- and with-project scenario gives the difference achieved through project implementation, which is also called the project's carbon-balance. It accounts for a total of -4,248,318 tCO_2-e of avoided emissions or increased carbon sequestration over the full analysis duration of 20 years. This is equivalent to reduced emissions of -210 tCO_2-e per hectare over the full duration or -10.5 tCO_2-e per hectare annually.

3 ***Gross results and carbon-balance by module***: The three columns in the middle of the table allow the sub-differentiating of gross results and carbon-balance by module. This is an essential functionality to identify those practices and activities that are the strongest sources of emissions or most important sinks leading to carbon sequestration.

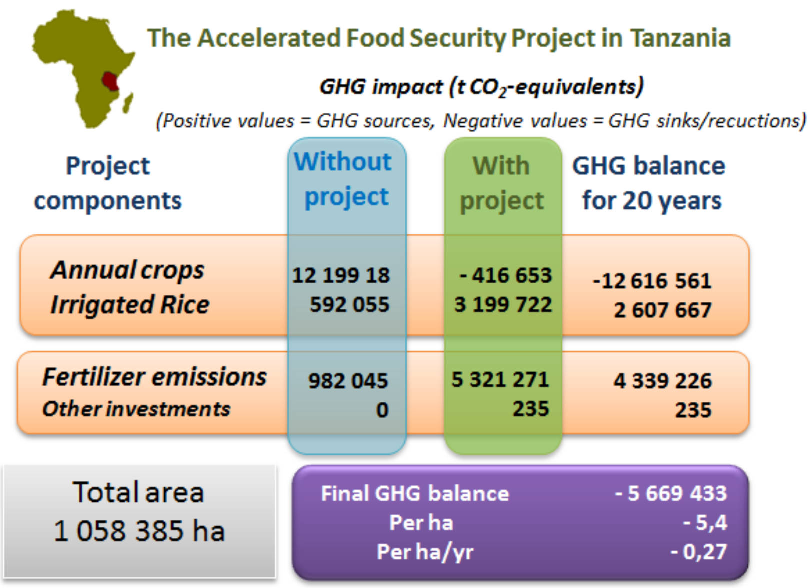
Regarding the gross emissions of the with-project scenario, the central components leading to carbon sequestrations are the establishment of perennial crop land (-304,467 tCO_2-e) and the rehabilitation of degraded grassland (-113,685 tCO_2-e). The leading causes of carbon losses and GHG emissions are instead the use of fertilizers and other inputs (664,934 tCO_2-e) as well as the still ongoing deforestation (481,117 tCO_2-e).
The components strongest contributing to gross emissions of a project thereby do not necessarily need to be the strongest determinants of the carbon-balance: The strongest element contributing to the positive carbon-balance of the with-project scenario is thus in the presented example the reduction in pace of deforestation (-3,259,576 tCO_2-e), which is alone responsible for more than 75% of the project's carbon-balance. The following most important activities contributing to a positive carbon-balance of the project are the non-forest land use change activities (-450,640 tCO_2-e), and the rehabilitation of degraded land (-396,711 tCO_2-e).

B. A real case example from Tanzania

Project analysis with the Ex-Ante Carbon-balance Tool (EX-ACT) shall serve to privilege project components that are characterized by higher mitigation benefits, while delivering the same development goals.

The *Accelerated Food Security Project* (FAO/World Bank) consists of different components having opposite impacts on GHGs: On the one hand the project introduces higher fertilizer use that contributes to emissions, on the other hand it encourages and incentivises sustainable land management practices – such as the incorporation of crop residues. The EX-ACT analysis was carried out to clarify the overall dimension of the opposite emission impacts and in order to specify whether the project is an overall GHG sink or emission source.

Figure 5: Exemplary results of an EX-ACT appraisal



The figure above shows that the increase in fertilizer utilization as well as the expansion of flooded rice systems (“Irrigated rice”), which are essential parts of the food security objectives of the project, both lead to substantial increases in GHG emissions. The emissions and sinks of the With-Project scenario (above in the green frame) thus show that also with project implementation, the area stays an overall emission source, with the irrigated rice systems emitting 3.2 Mt of CO_2-e and the agricultural inputs causing 5.3 Mt of CO_2-e. The enhanced land and crop management practices that are not expected to compromise on yields and were identified as adequate technological choices within more intensified systems are instead carbon sinks of -0.4 Mt of CO_2-e. The activities leading to GHG emissions are thus considerably greater than those causing carbon sinks.

Although the through productivity gains legitimized project components lead to significant GHG emissions, the project is nevertheless also compared to the baseline scenario – here given by the continuation of prior prevailing agricultural practices (such as crop residue burning; in the blue frame).

Comparing the With- and Without-Project scenario shows in this case that the project leads to a reduction in emissions as compared to the business-as-usual scenario. Over the full period of analysis of 20 years, the project thus leads to a carbon-balance of -5.6 Mt of CO_2-e that are less emitted due to project implementation. This is equal to a carbon-balance of -0.27 MtCO_2-e per hectare and year. This project analysis made use of the EX-ACT modules: *Description, Crop Production and Inputs*.

C. Results utilization

Besides such an analysis of a finished project proposal, EX-ACT is also often used at a stage when still several different project options are considered for implementation.

The *Irrigation and Watershed Development Project* in Madagascar was appraised comparing different designs of tis watershed component: One smaller watershed component with other project components focussing comparably stronger on the diffusion of irrigation infrastructure, and one bigger watershed component with a stronger focus on natural conservation aspects.

More specifically, the smaller watershed option is implemented on 8,250 ha. The up-scaled project would instead cover 65,000 ha and strengthen the project components on afforestation, reduced deforestation and agroforestry.

Table 1: Differential project activities as part of a smaller and up-scaled watershed component

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

The incremental improved areas under the up-scaled scenario will require additional funding, whereby the differential costs of the measures are estimated at: US$ 1500 per ha reforested area, US$ 300 per ha of avoided deforestation, US$ 400 per ha of improved pasture, US$ 1000 per ha of agroforestry. The additional watershed components are thus estimated to require funding of US$ 47.9 million. The total project budget would increase in such a way to US$ 83 million (+103%). By doubling the budget of the project in this scenario, and by allocating the incremental funds to watershed management components, the accumulated benefits in terms of GHG mitigation are not doubling but multiplied by six from 2.4 million tonnes of CO_2-e to 12.4 million tonnes over the full 20 years of the analysis (c.f. table below).

Table 2: Budget and carbon-balance of the two scenarios

	Small watershed component (ha)	**Up-scaled watershed component (ha)**
Budget (million USD)	40.5	83
Carbon-balance (mio t CO_2)	2.4	12.4
Carbon-balance per ha (t CO_2, 20 years)	21	93
Carbon-balance per ha/yr (t CO_2)	1.05	4.6

In such a way EX-ACT can be used to compare different project scenarios for their mitigation benefits. This mitigation analysis should thereby always only complement other performance indicators as e.g. most centrally socio-economic analyses. Investment decisions should then be taken in joint consultation of the different development goals.

It is important to notice that not all agricultural and forestry development projects need to have a positive carbon-balance and it is a misapplication of EX-ACT and similar tools if a project proposal is on an arbitrary basis so long manipulated as to transform it from being a source towards a sink of GHGs.

EX-ACT instead is intended to be used in an integrated manner together with other performance indicators. It aims at the identification of mitigation potential where they are cost-effective and co-beneficial with a wide range of project outcomes. Even where projects lead to emissions as compared to a business-as-usual scenario, EX-ACT helps to identify the available practices that reduce emission intensity under respect of the limits introduced through other development goals.

5) The added-value of carbon-balance appraisals & EX-ACT

The introduction of this user guide stated why climate change mitigation in agriculture is an important target to be included in investment project design. Besides this need of a well established overall rationale and justification, the engagement in a carbon-balance appraisal also should provide direct instrumental advantages that support the work of investment and policy planners in international financial institutions as well as of national stakeholders from ministries.

Such instrumental advantages of engaging in a carbon balance appraisal can be mainly identified by:

1. Allowing to better target mitigation objectives by choosing in an informed manner between alternative project options.
2. Providing the functionality to proof to third party stakeholders that mitigation objectives are targeted (design stage) and achieved (monitoring stage).
3. Allowing to target supplementary finance for climate change mitigation.

Complementing the question of the value-added from engaging in a carbon-balance appraisal, the following list still provides a concise overview of the main reasons why EX-ACT is an instrumental and effective tool for preparing a carbon-balance appraisal.

Comprehensive appraisal: EX-ACT offers the advantage of an integrated analysis of greenhouse gases, through its inclusion of a wide spectrum of activities from the agriculture, forestry and other land use sector. It is able to account for the carbon-balance concerning the activities of deforestation, afforestation and reforestation, land use change and conservation, land degradation, annual crop production, agroforestry and production of perennial crops, irrigated rice as well as livestock production.

Besides being thus widely inclusive in terms of activity areas, it is also fully comprehensive in covering all five carbon pools of above-ground biomass, below-ground biomass, dead wood, litter, and soil carbon. The tool considers CO_2, CH_4 and N_2O as sources and associated greenhouse gases, from biomass growth and removal, site preparation (tillage, burning), use of mechanization and agro-chemicals (fuel, fertilization, liming and irrigation) and exported harvested wood products. It also considers CH_4 from rice and CH_4 and N_2O from livestock production and management.

Landscape and scaling up: EX-ACT is well-suited for the assessment of projects activities on various 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 levels. In such cases sensitivity analyses concerning soil and climate conditions or separate EX-ACT analyses by region may complement the usual appraisal process and ensure precise results. In such a way it has already been used to analyze national agricultural programs and policies in Nigeria and Morocco, product carbon footprint studies in Madagascar as well as various ARD projects.

Data Flexibility: EX-ACT offers a high data flexibility, allowing the user to choose between site-specific data and default values from the IPCC that are furnished by EX-ACT, based on the targeted level of precision and based on data availability. The tool also provides a wide range of resources (tables, maps, FAOSTAT) which can direct the user to the required information in order to effectuate the estimation. Default values can be chosen from drop-down menus if no project-specific data is available.

Long-term projection: EX-ACT can handle projections for longer time horizons (in comparison to other tools) and takes into account the saturation effects concerning soil carbon content and vegetation growth in forests.

Cost-efficient planning tool: EX-ACT is a tool that can be applied with little cost and time intensity. For data collection purposes a link to project teams within the project country or to other country stakeholders can thereby strongly facilitate cost effective data collection. More precisely, a brief workshop of the project analyst that effectuates the EX-ACT appraisal with the national project team that allows to introduce the technical aspects of the tool and is followed by an in-depth, project-specific data assessment and scenario building process will equip the appraisal team with sufficient data to carry out the full carbon-balance appraisal.

Interactive and participatory: The EX-ACT appraisal process is interactive as well as participatory, and can strengthen the overall project design process, especially when a training and workshop element (for project teams, government counterparts, and other stakeholders) is integrated as part of the process. This happened exemplarily as part of EX-ACT appraisals in Russia, India, and Niger. It also enables the identification of the factors that hinder the adoption of more carbon-neutral activities (or adjustments to proposed activities) and may facilitate the discussion on ways to create incentives and institutional conditions that can promote their uptake (such as payments for environmental services).

Simulation and scenario building tool: EX-ACT stimulates stakeholders to actively engage in scenario building exercises that compare different project and development options over time, possibly involving simulation and modelling. This engagement may lead to a clearer identification and reflection on the long-term goals and helps to adjust initial assumptions for their reasonability.

Part B: Quick Guidance for Tool Users

6) Methodology

EX-ACT is a land-based accounting system that relates activity data from the Agriculture, Forestry and Other Land Use (AFOLU) 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.

In such a way 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 has been developed using mostly the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) that furnishes EX-ACT with recognized default values for emission factors and carbon values, the so called Tier 1 level of precision. Besides, EX-ACT is based upon chapter 8 of the Fourth Assessment Report from working group III of the IPCC (Smith, et al., 2007) for specific mitigation options not covered in NGGI-IPCC-2006. Other required coefficients are from published reviews or international databases. For instance embodied GHG emissions for farm operations, transportation of inputs, and irrigation systems implementation come from Lal (Lal, 2004) and electricity emission factors are based on data from the International Energy Agency (IEA, 2013).

A Tier level of analysis represents a level of methodological complexity to estimate greenhouse gas emissions following the definition in NGGI-IPCC-2006. Tier 1 methods rely on default values and entail a lower level of effort, whereas Tier 2 methods require regional specific carbon stock values and emission coefficients, implying higher precision and data needs.

Besides offering the option to use the here above identified default values (Tier 1), EX-ACT encourages users to substitute default values with more location specific Tier 2 data that lead to lower uncertainty levels of the estimation. How Tier 2 data can be procured and entered into the tool is presented shortly at a later point of this *Quick Guidance* and in detail in the *User Manual*.

7) EX-ACT data needs

A. Identifying the relevant EX-ACT modules

In the following we provide a concise overview of the specific data needs for EX-ACT. As stated and explained before, users only need to collect data concerning those of the six topic modules that are altered by their project. In case that a specific module is included in the analysis one can further divide between then largely obligatory data needs that follow the Tier 1 approach and complementary Tier 2 data that increases the regional specificity and confidence level of the results.

EX-ACT does not necessarily require a full inventory of all land-uses and agricultural practices in the project area, but is centrally concerned with all land areas which are altered due to the analyzed project process. Thereby data is needed concerning all those areas, **where change is observed between project start and end of the capitalization phase** due to project implementation as well as on those areas **where such alterations are actively prevented** through project implementation (e.g. deforestation). The table below offers a concise check-list for users to decide on which modules to use.

Table 3: Checklist for identifying project relevant EX-ACT modules

Carbon-balance Impact Main Impact Area				**EX-ACT** **Module(s) to fill**	**Project intervention** YES	**Project intervention** NO
POSITIVE (SINK)	**A**	**Reduced emissions of carbon dioxide**				
		A1	Reduction in rate of deforestation	Land use change		
		A2	Reduction in forest degradation	Land degradation		
		A3	Adoption of improved cropland management	Crop production		
		A4	Introduction of renewable energy and energy-saving technologies	Investments		
	B	**Reduced emissions of methane and nitrous oxide**				
		B1	Improved animal production	Livestock		
		B2	Improved management of livestock waste	Livestock		
		B3	More efficient management of irrigation water in rice	Crop production		
		B4	Improved nutrient management	Crop production, Livestock		
	C	**Carbon sequestration**				
		C1	Conservation farming practices	Crop production		
		C2	Improved forest management practices	Land use change		
		C3	Afforestation and reforestation	Land use change		
		C4	Adoption of agroforestry	Crop production		
		C5	Improved grassland management	Grassland		
		C6	Restoration of degraded land	Land use change		
NEGATIVE (SOURCE)	**D**	**Increased emissions of methane, nitrous oxide and carbon dioxide**				
		D1	Increased livestock production	Livestock		
		D2	Increased irrigated rice production	Crop production		
		D3	Increased fertilizer use and over-fertilization	Inputs		
		D4	Production, transportation, storage and transfer of agricultural chemicals	Inputs		
		D5	Increased electricity consumption	Investments		
		D6	Increased fuel consumption	Investments		
		D7	Installation of irrigation systems	Investments		
		D8	Building of infrastructure	Investments		
	E	**Decreased carbon stocks**				
		E1	Increased deforestation & timber logging	Land use change		
		E2	Increased land degradation (forests, croplands, grassland)	Land degradation, Grassland		
		E3	Cropland expansion	Land use change		
		E4	Residue burning, deep tillage, ...	Crop production		

B. Overview of data needs

After the identification of the relevant topic modules, users may proceed with data collection. Considering first the more elementary Tier 1 data needs, they are rather easy to procure for project managers and are part of the standard information available by project appraisal documents. They concern few geographical, climatic and agro-ecological variables and a wider set of information regarding land-use change activities and agricultural management practices. The entire tier 1 data needs are comprehensively depicted in the table below.

Table 4: Overview of Tier 1 activity data that can be accommodated in EX-ACT

	Description Module	
Obligatory	- Sub-continent - Type of climate - Moisture regime	- Dominant regional soil type - Project duration
Only if project related	**Land Use Change Module**	
	• **Deforestation** - Forest type and size - Area deforested	- Final land use after conversion - Burning during conversion?
	• **Afforestation & reforestation** - Type of current land use - Type of future forest	- Burning during conversion?
	• **Other land use change** - Type of current land use - Type of future land use	- Burning during conversion?
	Crop Production Module	
	• **Annual systems** - Current and future planted crop area (by type of crop) - Crop management practices	- Practices of residue burning?
	• **Perennial systems** - Current and future planted crop area (by type of crop)	- Practices of residue burning?
	• **Irrigated rice** - Specifications of water management practices	
	Grassland and Livestock Module	
	• **Grassland** - Current and future grassland area by state of degradation	- Practices of grassland burning?
	• **Livestock** - Type and number of livestock	- Feeding and breeding practices
	Land Degradation Module	
	• **Forest degradation** - Dynamic of forest degradation/ rehabilitation by forest type and size	- Occurrence of forest fires?
	• **Degradation of organic soils (peatland)** - Vegetation type and size concerned by drainage of organic soils	- Area affected by peat extraction
	Input and Investment Module	
	• **Agricultural inputs** - Quantity of agricultural inputs by type	
	• **Energy consumption** - Quantity of electricity, liquid and gaseous fuel, and wood consumed	
	• **Building of infrastructure** - Size of area with newly established irrigation infrastructure or buildings (by type)	

Tier 2 data instead concerns location specific variables that offer specifications of the carbon content and stock changes in all five carbon pools as well as the emission factors for selected practices. While all tier 2 data needs that can be accommodated in EX-ACT are fully listed in the annex of the *User Manual*, central examples for Tier 2 data concern:

- 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
- Emissions from enteric fermentation
- Emissions associated to the construction of agricultural, road and building infrastructure

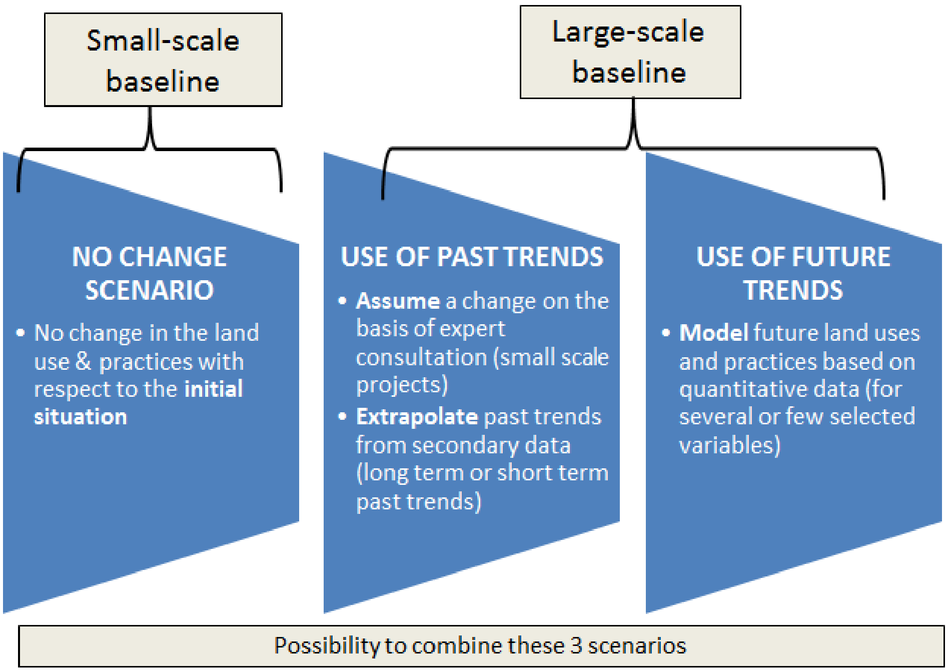
The collection of Tier 2 data is especially advised for core project components that are expected to be stronger sources or sinks of GHGs. This logic may be understood as a good practice leading to a reasonable combination of Tier 2 and Tier 1 data. Data collection of Tier 2 variables is thereby often difficult and it will for this reason never be possible to collect Tier 2 information for all considered variables as part of conventional project planning.

8) Building the baseline scenario

The baseline scenario depicts the counterfactual outcome in terms of input variables as well as the resulting GHG-balance that would have most likely occurred in absence of the project intervention. Since the EX-ACT carbon-balance of a project is given by the difference of the overall effects of project and baseline scenario, the final results of EX-ACT are determined as strongly by the project as the baseline scenario. This is why the baseline scenario is of central importance and one of the major steps of an EX-ACT analysis.

EX-ACT lets users thereby choose between three approaches to generate a baseline scenario depicted in the figure below:

Figure 6: Three main baseline methodologies



Thus one can attest a strong difference in complexity between baseline scenarios that largely assume that no changes to the initial situation will occur or rely on expert consultation and baseline scenarios that extrapolate past trends as based on secondary data or model future trends with the help of e.g. computable general equilibrium models.

Modelling approaches are thereby especially advisable when large project areas are appraised that are in a situation of dynamic change. The more simple methodological approaches to generate a baseline have instead strong advantages because of low data and resource needs. They may be a viable alternative in cases where land use change and agricultural practices have stagnated for a longer time period as well as where there are no or very clear directed incentives for a specific change in land use or management practices.

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

9) Brief guide to data entry

A. Where to download, 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

On the top of the Excel window the navigation bar is located, allowing users to easily navigate between the six different topic modules. Duplicating the Excel worksheets it provides the main overview about the topic and activity areas of relevance to EX-ACT. By clicking on the EX-ACT logo on the top left, users navigate directly to the EX-ACT homepage where they can find additional information.

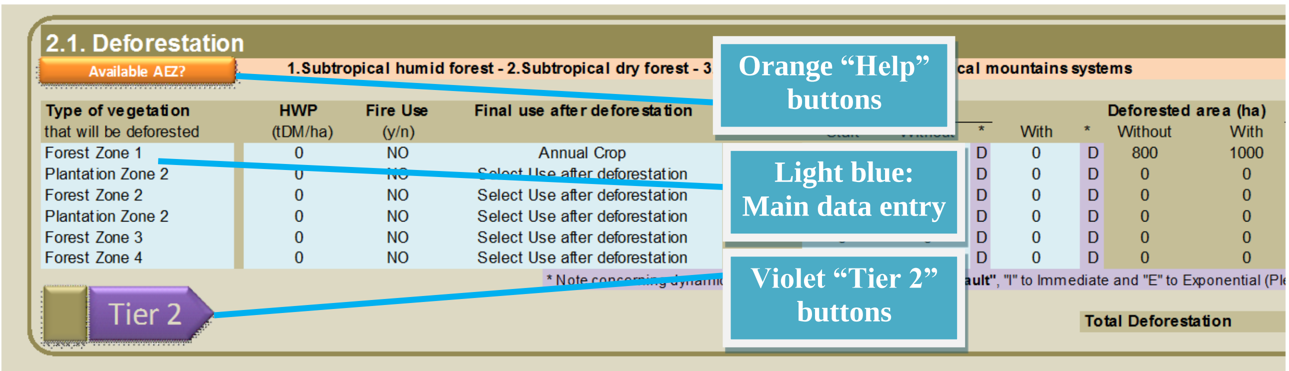
Figure 7: EX-ACT navigation bar

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 (c.f. figure 8 below). Thus cells in “light blue” indicate where users have to specify information, while the background colour, as here e.g. brown, specifies the variables and units that have to 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 that facilitates filling the relevant module components. The violet boxes indicating “Tier 2” instead allow users to specify location specific values for carbon pools (e.g. soil carbon content) and GHG emission factors.

Figure 8: EX-ACT colour codes

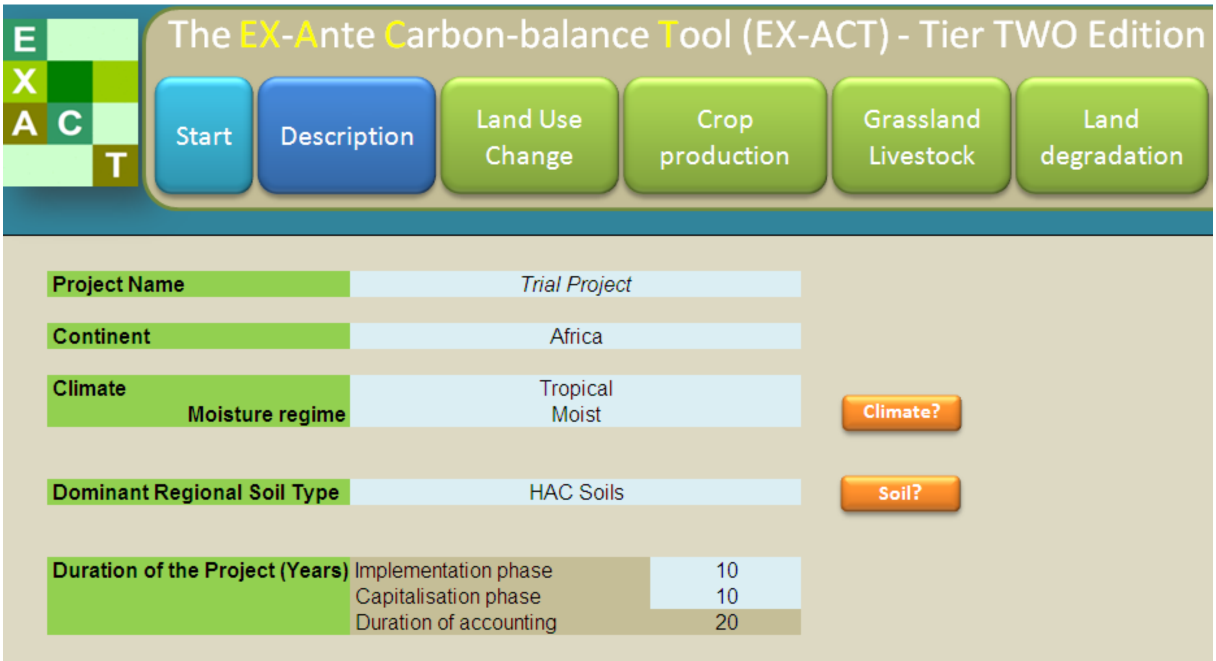


D. Description Module

After leaving the start screen, the first module users have to fill is the *description module*. It has to be filled with central descriptive information on regional agro-ecological conditions.

Every user should start always with filling the description module since the rest of EX-ACT otherwise does not contain the necessary input information to proceed. Precisely, users should fill in the following information depicted in figure 9, mainly by selecting from drop-down lists:

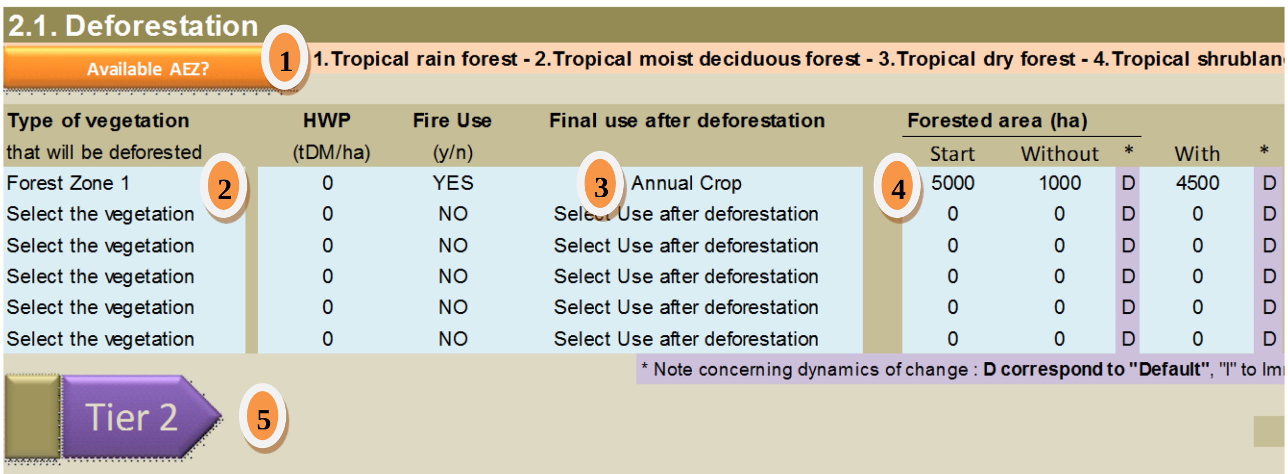
Figure 9: The Description Module



E. Data entry in the topic modules

A detailed step-by-step guide to data entry is a central part of the *User Manual*. To illustrate data entry, we will describe here only the deforestation sub-section which is part of the land use change module.

Figure 10: Deforestation (Land Use Change Module)



When using the Deforestation Sub-Module, the following types of information will be needed:

Identifying the current forest type:

1. 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. Users then choose from a drop-down list, which of these four forest categories describes best 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***: As the next step users chose the final land use after conversion from a drop down list. In the above example the forest is converted to annual crop land.

4. ***Surface deforested***: Subsequently users then specify the size of the area that remains forested for the three EX-ACT scenario points: In the example the initial forest size is 5000 ha. Without project implementation it will diminish due to deforestation to a final size of 1000 ha, while with project implementation still 4500 ha will remain forestland.

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 after clicking on the Tier 2 button:

Figure 11: Tier 2 specifications for deforestation

2.1. Deforestation

Available AEZ? **1.Tropical rain forest - 2.Tropical moist deciduous forest - 3.Tropical dry forest - 4.Tropical shrubland**

Back

You have indicated that your are using the following types of vegetation: Forest Zone 1
(here below highlighted in blue)

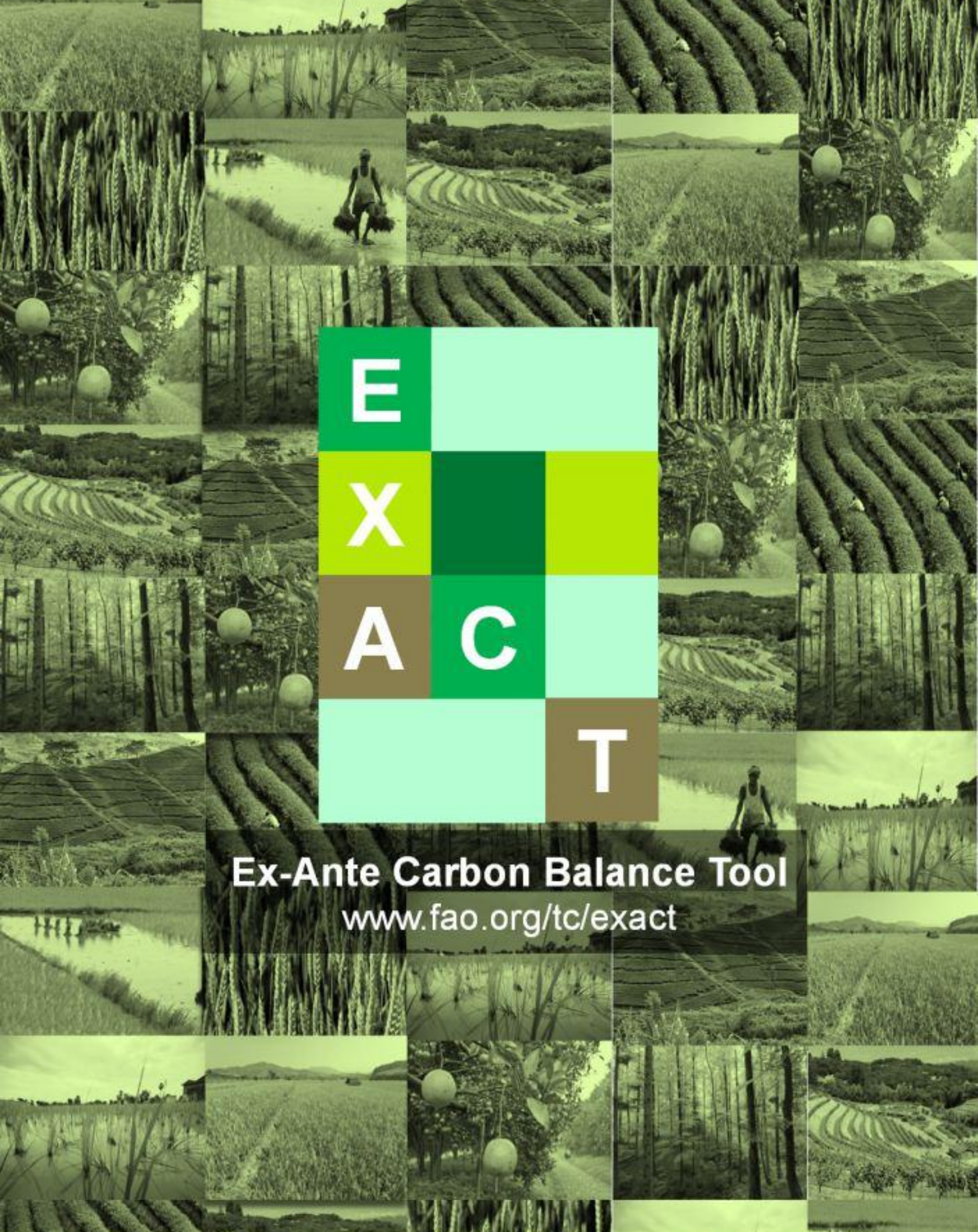
Use this part only if you want to refine analysis with Tier 2 coefficients **All values are in t of carbon per ha (tC/ha)**
(default values are provided for your information only, while EX-ACT will use Tier 2 values automatically wherever specified)

Type of vegetation (that will be deforested)	Above-ground		Below-ground		Litter		Dead wood		Soil C	
	Default	Tier 2	Default	Tier 2	Default	Tier 2	Default	Tier 2	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		5.6		3.7		0.0		65.0	

As shown in the screenshot above users can specify as part of the Tier 2 specifications for forest subject to deforestation the carbon content of above- and below-ground biomass, litter, dead wood and soil organic carbon.

In the example above we only made use of the forest category "Forest – Zone 1/ Tropical rainforest", which is why it is automatically shaded in blue by EX-ACT. Due to collected 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 in above ground biomass, 65 tC in below ground biomass and 3.9 tC 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*.[3]

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



EXACT

Ex-Ante Carbon Balance Tool

www.fao.org/tc/exact

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