Food and Agriculture Organization
of the United Nations

# Ex-Ante Carbon-balance Tool for Value Chains | EX-ACT VC

GUIDELINES

Third edition

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## Acronyms and abbreviations

| | |
|---|---|
| **ADEME** | *Agence de la transition écolgique* |
| **AFOLU** | agriculture, forestry and other land use |
| **BAU** | business as usual |
| **CFC** | chloro-fluorocarbons |
| **COD** | Chemical Oxygen Demand |
| **DFID** | UK Department for International Development |
| **EF** | emission factor |
| **EX-ACT** | Ex-Ante Carbon-balance Tool |
| **EX-ACT VC** | Ex-Ante Carbon-balance Tool for Value Chains |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **FTE** | full-time equivalent |
| **GHG** | greenhouse gas |
| **GPV** | gross production value |
| **GRI** | Global Reporting Initiative |
| **GVA** | gross value added |
| **GWP** | global warming potential |
| **HFC** | hydro-fluorocarbons |
| **HH** | household |
| **IAMs** | Integrated Assessment Models |
| **IEA** | International Energy Agency |
| **IFI** | International Financial Institutions |
| **II** | intermediate input |
| **ILO** | International Labour Organization |
| **IMF** | International Monetary Fund |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **ISCO** | International Standard Classification of Occupations |
| **ISIC** | International Standard Industrial Classification of All Economic Activities |
| **LCU** | local currency unit |
| **MIMEC** | mining, industry, manufacturing, electricity and constructions |
| **NVA** | net value added |
| **OECD** | Organization for Economic Co-operation and Development |
| **PV** | production value |

| | |
|---|---|
| **SCC** | social cost of carbon |
| **SDGs** | Sustainable Development Goals |
| **SMEs** | small and medium enterprises |
| **SNA** | System of National Accounts |
| **USD** | United States dollar |
| **VA** | value added |
| **VC** | value chain |
| **WBCSD** | World Business Council for Sustainable Development |
| **WRI** | World Resources Institute |

# Introduction

### Objectives of the guidelines

The guidelines aim at:

- providing a comprehensive overview of the EX-ACT VC tool and helping users assess the sustainability of agrifood value chains across environmental, economic, and social dimensions using the EX-ACT VC tool (FAO, 2022);
- describing the various methodological concepts underlying the tool to perform a value chain assessment and calculating several indicators of sustainability;
- illustrating the structural layout of the tool, explaining data requirements, and providing step-by-step data entry guidance to perform a value chain assessment using the EX-ACT VC tool;
- discussing the different indicators the tool calculates and how they can be used for project and policy evaluation and design.

### Target readership

The EX-ACT VC methodological guidelines are intended to assist potential users of the EX-ACT VC tool including policy makers, project managers, analysts and researchers, among others.

### Structure of the document

The present guidelines are organized into four parts. Part 1 introduces and provides a brief overview of the EX-ACT VC tool, describing its objectives, its intended uses, and main outputs, followed by summarizing the scope of the tool and its limitations. Part 2 explains in detail the methodology underlying the tool in a systematic and transparent framework, discussing the different indicators used by the tool to assess the sustainability of agrifood value chain interventions and introducing the technical equations used to calculate these indicators. Part 3 explains how the tool is structured and organized and provides step-by-step data entry guidelines while discussing the data requirements to complete an assessment using the EX-ACT VC tool. Part 4 presents the various results and outputs that EX-ACT VC generates and discusses how users can interpret them.

# PART 1. FAO's EX-ACT for Value Chains (EX-ACT VC) tool

The Ex-Ante Carbon-balance Tool for Value Chains (EX-ACT VC), developed by FAO is a multi-appraisal system that evaluates the environmental and socio-economic performance of agrifood value chains (agrifood VC). This section begins with a summary of the tool objectives, its intended uses, followed by introducing the main outputs, describing the scope, and limitations of the tool. **Annex 1** reviews the historical development of the tool.

## 1.1 Objectives

The EX-ACT VC, an excel-based tool is developed to evaluate the sustainability of agrifood VC simultaneously along the environmental, economic, and social dimensions. The primary objective of the EX-ACT VC tool is to provide decision support to design (*ex ante*) and evaluate (*ex post*) agrifood VC projects and policies by comparing a "current" scenario with baseline information and a "planned" scenario involving a future vision or goal (or implemented activities scenario in case of *ex post* evaluations). Guided by the sustainable food framework (FAO, 2014a), the tool provides a standardized approach for users to measure, analyse, and improve the sustainability of agrifood VCs.

The tool was developed with the following specific objectives:

- to help users "quantify" sustainability performance of agrifood VCs by assessing the environmental, economic, and social dimensions in a consistent and transparent framework;
- to help users "identify" drivers of sustainability across agrifood VCs through comparing a "current" and "planned" scenario of a project or policy;
- to help users "determine" entry points for investments and interventions;
- to help users "evaluate" whether their planned projects and policies meet their objectives; and
- to support users "design" and develop effective projects and policies to improve sustainability in agrifood VCs.

Ultimately, the EX-ACT VC tool is intended to provide an accessible operational resource that can be tailored to address sustainability in agrifood value chains in different contexts and at multiple levels to help achieve environmental, economic, and social objectives.

## 1.2 Uses

EX-ACT VC tool is intended for any user who is interested in assessing the sustainability of agrifood value chains. The tool does not require specific scientific knowledge. It provides stakeholders operating at multiple levels a cost-effective, consistent, and transparent framework to evaluate the sustainability of agrifood VCs regardless of their context, size, and geographic location. EX-ACT VC tool serves as an effective means for the development community, international financial institutions, public and private investors, policy makers, and governments at local, regional, and national levels to:

- pre-assess the potential impacts of a project or policy in a given time frame at the value chain level (*ex ante* appraisal);
- identify hot-spots for performance improvement by contrasting multiple indicators in a "current" and "planned" scenario;
- determine synergies and trade-offs between the three dimensions of sustainability occurring along each stage of the value chain;
- enable intervention design and investment prioritization to support climate-smart agrifood value chain;
- evaluate the extent to which a project or policy has been successful in achieving its stated objectives at the value chain level (*ex post* appraisal); and
- facilitate informed decision making by providing clear, well-structured, quantified analysis of the effects and consequences of proposed actions.

## 1.3 Outputs

The EX-ACT VC tool calculates several quantitative indicators and measures which are listed below. Part 2 introduces these indicators in detail, defines them, and describes the methodology and the underlying technical equations and parameters used to compute them. All the indicators across the environmental, economic, and social dimensions together provide a comprehensive picture of the sustainability of agrifood VCs. It is worthwhile to note here that the indicators below are inter-dependent and mutually reinforcing, sometimes overlapping across several dimensions. For example, food loss is not only an environmental cost but entails economic costs and subsequently societal food-(in)security costs. The tool, however, delineates any overlapping indicators for ease of use.

The environmental indicators estimated by the tool are (i) greenhouse gas (GHG) emissions which measure total GHG emissions, net carbon balance, and carbon footprint; (ii) water usage; (iii) food loss; and (iv) monetary value of GHG's emitted in the value chain.

The economic indicators calculated by the tool are (i) value-added, which measures gross production value (GPV) and gross and net value added (GVA); and (ii) distribution of value-added among production factors, which measures net income and average daily wage.

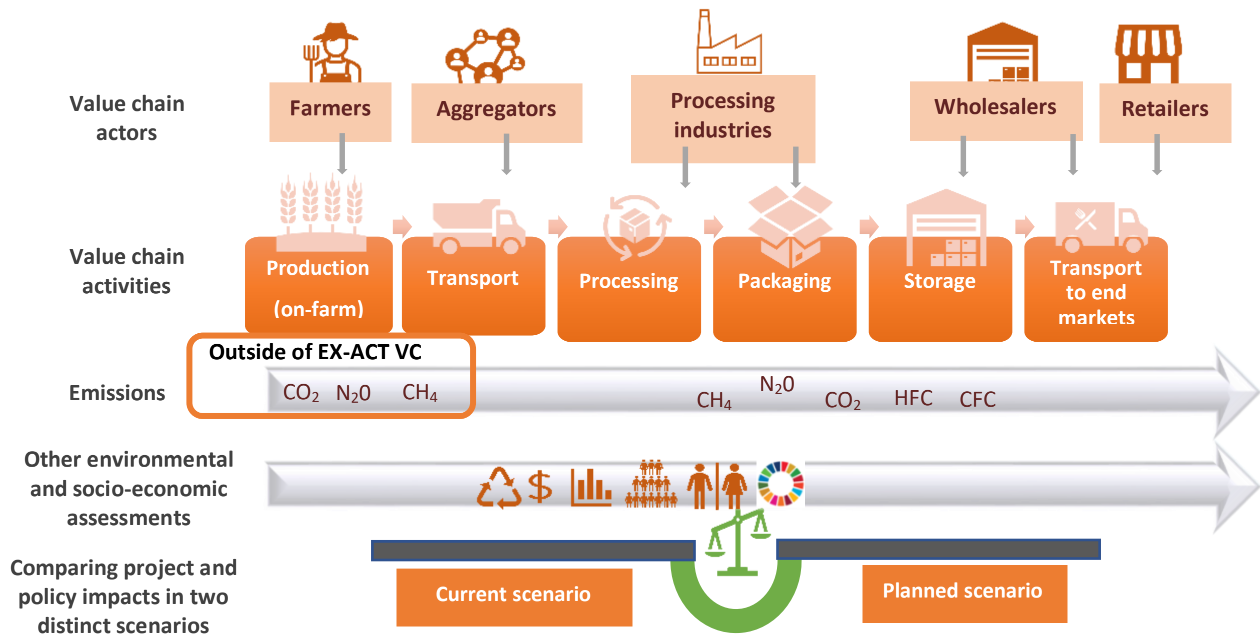
The social indicators computed by the tool are (i) employment which calculates the total number of jobs created along the value chain and disaggregates the number of jobs created across different actors and activities; (ii) women representation which reflects the number of women owning a business, the number of women in managerial positions, and the number of women employed (hired and as family labour); and (iii) Youth participation which indicates the number of jobs disaggregated by age group.

Apart from the above indicators, the tool also tracks a set of Sustainable Development Goals to evaluate the project or policy alignment to reach relevant SDG targets. The main SDGs tracked are zero hunger (2); gender and equality (5); clean water and sanitation (6); industry innovation and infrastructure (9) and responsible consumption (12).

## 1.4 Scope

The scope of the EX-ACT VC tool is defined by its methodological framework that relates to mapping the value chain, defining actors, describing activities, and quantifying outcomes in a given period. **Figure 1** illustrates the current framework of the tool. Annex 1 reviews the historical development of the tool. The tool framework is straightforward (DFID, 2008), micro-economic theory, and macro-economic accounting frameworks (System of National Accounts (SNA) 2008) to quantify socioeconomic indicators; Intergovernmental Panel on Climate Change (IPCC) guidelines (IPCC, 2006, 2019c), and FAO's Global Food Loss Index (2018) and several others to quantify environmental outcomes (see Part 2).

**Figure 1. EX-ACT VC framework**




Source: Authors' own elaboration.

The tool allows assessment of:

- five categories of commodities including annuals, perennials, dairy, meat and fish;
- up to nine unique categories of actors, whereby a "category of actors" refers to "a type of individuals, households, farms, firms, etc., who share similar activities performed and scale (e.g. small, medium, large)";
- up to five possible activities, in which each category of actor can carry out up to five different activities (e.g. primary production, processing, storage [pre/post storage], transportation, and distribution);
- annual time-period of accounting or an annual "snapshot". All data (e.g. GHG emissions, costs, revenues, jobs, etc.) are for a specific year;
- current vs planned scenario as the tool calculates and compares the environmental and socioeconomic outcomes for two distinct scenarios (e.g. "current" and "planned" scenarios) (see Section 1.6).

## 1.5 Limitations

The EX-ACT VC tool assessments are limited to:

- **Single commodity or product**: the tool allows the assessment of a single commodity at a time and does not account for any resulting by-product(s). Assessing by-products would require a parallel analysis (carried out in a second excel file).
- **Minimal level of food processing**: the tool allows assessment of minimal level of food processing, thus products that entail a combination of different commodities, cannot be considered.
- **Micro-meso level of analysis**: the EX-ACT VC tool was initially designed for performing project level value chain analysis at the micro (individual actor) and meso (category of actors) level. Currently, the tool is not best suited to perform macro-level analysis at a national or international level.
- **Static model**: the tool performs a static computation that covers the value chain assessment over an annual time period under two different scenarios. It has, therefore, limited capability in capturing the dynamic interactions between actors and feedback-loops over time that affect the sustainability of value chain.
- **No uncertainty assessments**: the tool does not capture any uncertainty related to the calculated outcome indicators.

## 1.6 Outlining the scenarios

Estimating environmental and socioeconomic costs and benefits associated with a proposed agrifood value chain project or policy requires establishing a comparable context to track changes in the value chain at two points in time (e.g. a current or pre-intervention phase with a planned or post-intervention phase). The EX-ACT VC allows users to construct two scenarios to compare and contrast the impact of a project or policy. The impact is then defined as the difference between what the situation is "without the project or policy" and what would be "with the project or policy". Within EX-ACT VC, the "current" scenario corresponds to the "without project or policy" scenario, and the "planned" scenario corresponds to the "with project or policy" scenario. When performing an *ex ante* analysis, the planned scenario would incorporate the foreseen activities outlined in a Project Design Report, or similar, and it would answer the question "what would happen with the implementation of the project?" In the case of a monitoring or *ex post* analysis, it would correspond to the advances or actual activities implemented as a result of the project. Thus, in the environmental assessment, the final balance is the comparison between the GHG emissions associated with the project implementation and the baseline following a business as usual (BAU) model. Similarly, in the socioeconomic assessment, the final balance is the difference between selected economic indicators in the planned and current scenarios.

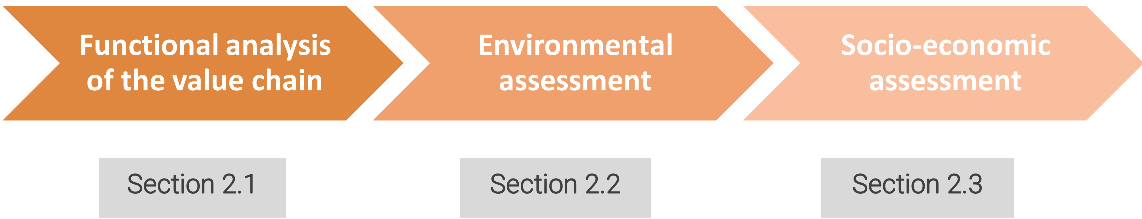
# PART 2. Methodology



This section describes in detail the methodology behind the tool to assess the sustainability of value chains across environmental, economic and social dimensions. This section is organized according to the methodological steps that users should follow to complete an assessment using the EX-ACT VC tool. **Figure 2** provides an overview of the main steps and lists the corresponding sections in which they are explained in detail.

The functional analysis of the value chain draws on common approaches in the literature. The environmental assessment derives methodology from IPCC guidelines (IPCC, 2006, 2019c), GHG protocol (Bhatia *et al.*, 2011, WRI, and WBCSD, 2013), Global Logistics Emissions Council Framework (Greene and Lewis, 2019) and Smart Freight Centre (2019), Institute for Global Environmental Strategies (2020), *Agence de la transition écologique* (ADEME, 2020) and Breisinger (2012) FAO's Global Food Loss Index (2018). The socioeconomic assessment borrows from different strands of economic analysis including micro-economic accounting (crop and enterprise budgets), macro-economic frameworks on national accounts (SNA, 2008), FAO (FAO, 2017, 2019c, 2019d), International Standard Classification of Occupations (ISCO-88) of the International Labour Organization (ILO) (ILO, 2012) and International Energy Agency (IEA, 2020).

**Figure 2. Methodological steps**

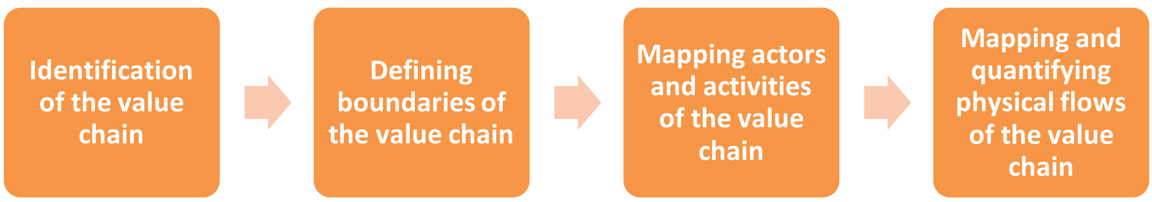



Source: Authors' own elaboration.

## 2.1 Functional analysis of the value chain

The functional analysis of the value chain examines the production activities in the value chain, different actors contributing to such production activities and physical flows of the commodity across different actors and activities of the value chain. The main steps of a functional analysis are summarized in **Figure 3.**

**Figure 3. Main steps of a value chain functional analysis**




Source: Authors' own elaboration.

### 2.1.1 Identification of the value chain

The EX-ACT VC tool currently allows the assessment of a single commodity or product. Therefore identifying a value chain to assess in EX-ACT VC tool will be straightforward for projects and policies dealing only with a single commodity or product. However, agrifood value chains are complex, with often a single commodity being transformed into multiple products. For projects and policies dealing with either multiple commodities or multiple products, it is necessary to identify and prioritize which commodity or product is to be analysed. Several approaches and tools of priority setting exist to help users. The most common approach is to determine criteria based on the goals of the project/policy (e.g. jobs created, market growth potential and subsidies), develop weighted scores and prioritize highest ranked value chain. It is also important to also note that the EX-ACT VC tool does not account for any resulting by-products of the agrifood VC. However, a user can run multiple parallel analyses of different commodities, products and by-products within the scope of a particular project or policy and aggregate them manually.

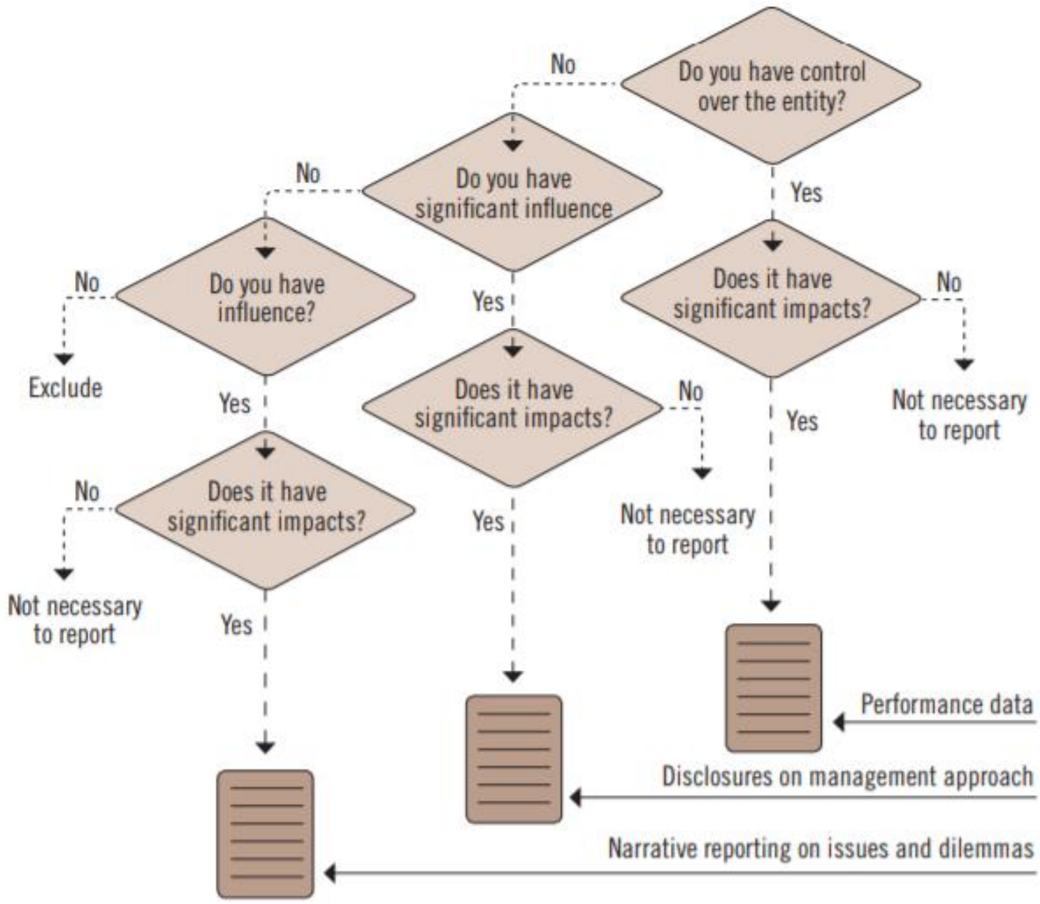
### 2.1.2 Defining boundaries of the value chain

After identifying the value chain to be assessed, it is important to define the boundaries of the value chain e.g. to define the portion of the value chain the user wants to analyse and map the main actors and activities in the value chain. These two steps are simultaneous, evolving and co-dependent. The needs, objectives and scope of the value chain project or policy define the boundaries of the value chain. Therefore, there is no one-size-fits-all template to perform this exercise,

Defining the boundaries of a value chain assessment is one of the most difficult steps. In reality, almost every actor and every activity is connected with everything else. **Figure 4** provides some guidance on how the user can define the boundaries to evaluate their project or policy.

As elaborated in the Sustainability Assessment of Food and Agricultural Systems guidelines (FAO, 2014b), the decision tree of the Global Reporting Initiative (GRI) G3.1 Guidelines is a broadly tested tool which can be used as a template to guide decisions on defining the boundaries, e.g. to decide what and who is included in the scope of a value chain assessment (GRI, 2011).

**Figure 4. Decision tree for boundary setting**




Source: GRI. 2011. *Sustainability Reporting Guidelines. Version 3.1*. Amsterdam. www.globalreporting.org/resourcelibrary/G3.1-Guidelines-Incl-TechnicalProtocol.pdf

Once the boundaries are clearly defined, the next step is to map the main actors and activities within the value chain and quantify the physical flows of the commodity across actors and activities. Drawing from common approaches and guidelines (Bellù, 2013; DFID, 2008; Collins *et al.*, 2016), the next two sections provide some guidance on mapping actors, activities and quantifying physical flows in the value chain.

### 2.1.3 Mapping actors and activities

Mapping the value chain is a central component of the EX-ACT VC assessment. It helps identify the various activities, actors in the value chain and the interdependencies among them. The mapping will provide the foundation upon which subsequent environmental and socioeconomic assessments are performed.

EX-ACT VC tool simplifies the mapping exercise by providing the initial structure of activities necessary to bring a product from production to consumption. These activities in the tool are:

1. primary production
2. processing
3. packaging
4. storage (pre/post processing)
5. distribution or transportation.

Often, value chain assessments follow a linear sequence of activities and actors. However, the real world is highly complex, with some actors performing more than one activity. The tool accounts for this complexity by introducing a flexible approach that will allow users to map the actors to multiple activities. The tool is designed to identify up to nine categories of actors, of which up to three categories can be specified as performing primary production activities, and map each of the nine actors to the five activities listed above.

Distinguishing between actors depends on the level of detail the user requires and, on the needs, and objectives of the agrifood VC project or policy to be assessed. A simple way to distinguish an actor is to identify their main activity or occupation (Bellù, 2013; DFID, 2008). For example, aggregators are involved in collection of primary harvest, rice producers are the ones who produce rice. However, rice producers may display heterogeneous characteristics, which can allow further classification based on farm size (small, medium, large, etc.), production system (rain-fed, irrigated intensive, etc.) and many other specificities.

Once the actors have been classified, the actual number of actors within each category of actors is important to provide an overview of the scope and size of different actors within the value chain.

Additional resources that can help users perform this part of the analysis are listed in Annex 2.

### 2.1.4 Mapping and quantifying physical flows in the value chain

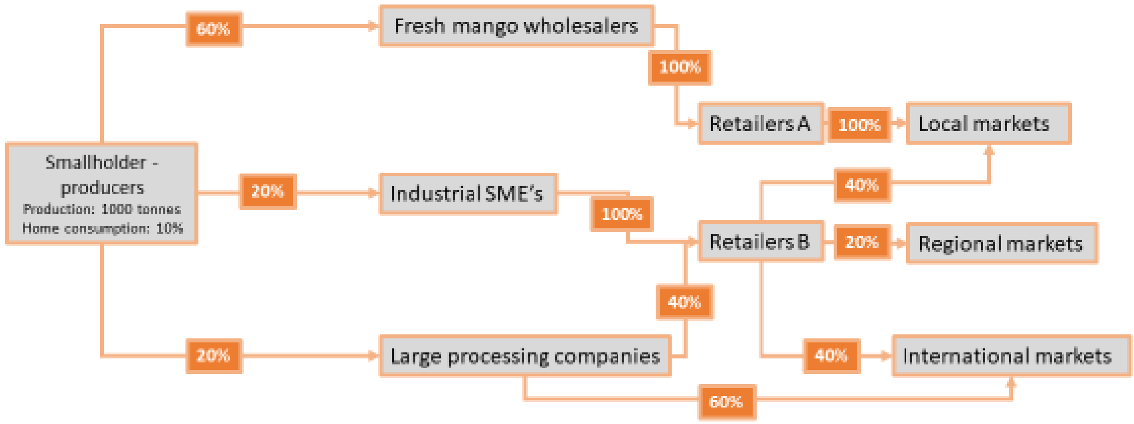
The actors in an agrifood value chain are linked together through many different flows. These flows can be both tangible (material/products and financial) and intangible (information). The EX-ACT VC tool provides a framework to map only the physical flows. In simple terms, mapping physical flows will allow the user to understand who is buying and who is selling; and quantifying physical flows will allow the user to understand how much is sold and how much is purchased by different actors. Physical flows include the transformation, storage, and transportation of products. A typical physical product flow begins with the raw materials supplied to processors and the processed product transferred to storage and distribution to the final consumer. The physical flows are quantified in terms of volume to provide an overview of the size of the different actors and channels within the value chain.

The user is first required to enter data on the total volume of raw material produced or harvested by each category of actors identified as performing primary production activities. The subsequent physical flows are then entered in the EX-ACT VC tool as a proportion of the total volume of raw material that flows through each actor and at each activity. The user is responsible for collecting data on the volume of products sold and purchased by each identified actor in the value chain.

**Figure 5** gives an overview of the mapping of volumes of product flows through a value chain. In this example, there are several actors who are selling and purchasing mangoes. The value chain begins with smallholder producers harvesting 1 000 tonnes of mangoes of which 100 tonnes are consumed by the households. The remaining 900 tonnes of mangoes are sold to three different actors. Fresh mango wholesalers purchase 540 tonnes, industrial small and medium-sized enterprises (SMEs) and large processing companies purchase 180 tonnes each from the smallholder producers.

The user must convert data collected on volumes purchased by each actor as a proportion of the total volume sold by the previous actor in the value chain. In this example, therefore, the fresh mango wholesalers purchase 60 percent of the total mangoes sold by the smallholder producers. Similarly, industrial SMEs and large processing companies purchase 20 percent each of the total mangoes sold by the smallholder producers.

**Figure 5. An example of mapping volumes and physical flows in the value chain**




Source: Authors' own elaboration.

Collecting all data needed to quantify flows for a value chain analysis usually requires drawing information from different data sources. Annex 2 provides more information on this and guides the user in mapping and quantifying the physical flows.

## 2.2 Environmental assessment

The environmental assessment builds essentially on the functional analysis of the value chain described in Section 2.1, because it requires that users identify the building blocks of the value chain e.g. the actors and activities performed by each of the actors as well as quantification of the physical flows of the production among different actors and activities.

The EX-ACT VC tool calculates a set of indicators that represent the environmental performance of the value chain. Multiple measures are computed for some indicators. These indicators are listed in Table 1Table 1 and described below.

**Table 1. List of environmental indicators**

| | |
|---|---|
| **Environmental indicators** | GHG emissions ($tCO_2$-e) and carbon footprint ($tCO_2$-e/tonne of final product) |
| | Water usage (litres) |
| | Food loss (tonnes of product) |
| | Monetary value of GHGs estimated in the value chain |

Source: Authors' own elaboration.

### 2.2.1 Indicator: GHG emissions

This indicator is intended to assess the potential of the value chain to contribute towards achieving climate mitigation goals by estimating GHG emissions from different types of activities across the value chain. GHG emissions are generated by activities in all stages of an agrifood value chain. The tool first distinguishes between "on-farm" and "off-farm" activities, and their related emissions as described in **Box 1**.

**Box 1. On-farm vs off-farm GHG emissions**

On-farm and off-farm GHG emissions are defined within EX-ACT VC as follows:

- **On-farm GHG emissions** are those strictly related to primary food/agriculture production. They include emissions originating from most of the activities arising from land use, primary production, up to harvesting, namely land use change, crop (annuals, perennials) and livestock management, use of inputs and infrastructure related to primary production.
- **Off-farm GHG emissions** are those originating from post-primary production activities e.g. related to processing, packaging, storage, and distribution up to the retailer.

Source: Authors' own elaboration.

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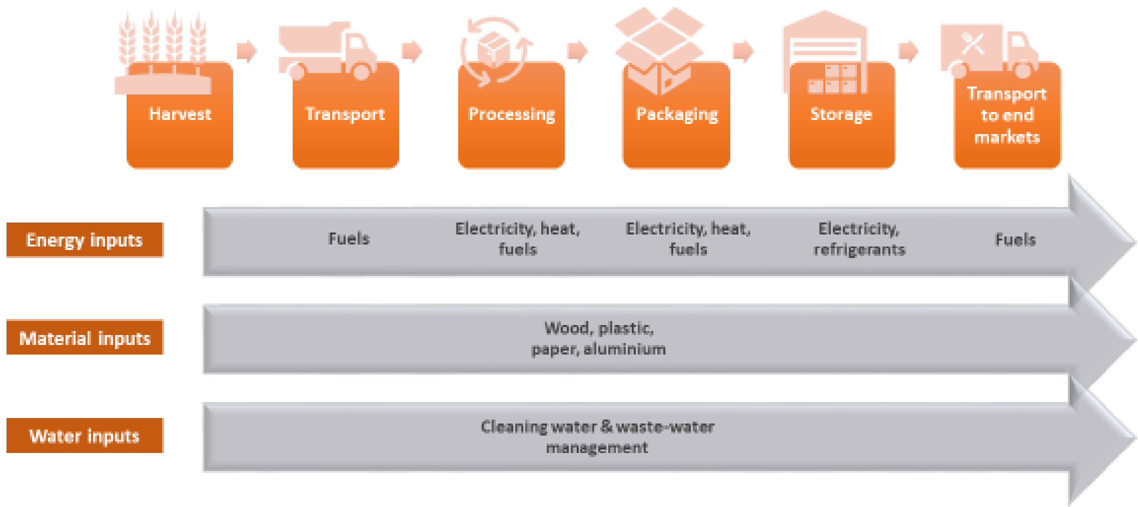
When any post-harvest activities are performed on the farm, e.g. if some farmers (primary producers) begin any part of the product transformation within their farms, the related GHG emissions are not accounted as on-farm emissions, even though they occur on the farm; rather, they constitute off-farm emissions, as originating from post-harvest activities.

GHG emissions from on-farm activities are not calculated within the tool, however, the tool can account for the on-farm emissions when provided as an input by the user expressed in tonnes of carbon oxide equivalent ($tCO_2$-e). These on-farm emissions can be either externally calculated using on-farm GHG accounting tools such as EX-ACT (FAO, forthcoming) or derived from literature.

GHG emissions from off-farm activities are calculated within the tool. The EX-ACT VC tool calculates the total off-farm GHG emissions from energy (e.g. diesel, fuel, etc.), material use (packaging) and water inputs utilized across each activity and stage of the value chain in a current and planned scenario. The EX-ACT VC tool in its current version does not account for emissions originating from food losses across the value chain. **Figure 6** provides a visual overview of energy, water, and material inputs at different activities and stages of a typical value chain that lead to GHG emissions which are accounted in the EX-ACT VC tool.

**Figure 6. Overview of emission sources across a typical value chain**




Source: Authors' own elaboration.

The following two measures are calculated by the EX-ACT VC tool for the GHG emission indicator:

1. total amount of GHG emissions and net carbon balance in $tCO_2$-e per year;
2. carbon footprint in $tCO_2$-e/ tonne of product.

GHG emissions are generally calculated following the methodology established by the IPCC with using the following formula:

$$GHG\ emissions = Activity\ Data\ \times\ Emission\ Facor$$

In the above formula, activity data refers to a quantitative measure of a specific activity that results in GHG emissions or sequestration during a given period of time. Emission factors, expressed per unit of an individual activity, allow estimating GHG emissions from the activity. For example, processing a tonne of mangoes requires a certain amount of energy, reported in kilowatt hour (kWh) as activity data, which multiplied by a corresponding emission factor (GHG emissions per kWh) calculates the quantity of GHG emissions resulting from the usage of electricity to process the one tonne of mangoes.

The IPCC guidelines specify a "tier" to represent the reliability and methodological complexity of emission factors and activity data. Tier 1 are simple methods that provide default emission factors, Tier 2 are similar to Tier 1, but provide country specific emission factors, Tier 3 are the most complex approaches requiring specific data that provide more accurate emission factors.

EX-ACT VC tool embeds default Tier 1 emission factors from literature. However, the tool is flexible and allows the user to specify Tier 2 emission factors for activities if available.

A few examples of the type of activities and emission factors needed at each stage of the value chain is provided in **Table 2**.

**Table 2. Examples of off-farm activity data and emission factors**

| Off-farm activity in agrifood VC | Source of emissions | Example of activity data | Example of emission factor |
|---|---|---|---|
| **Processing (energy and wastewater)** | Consists of carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$) gases associated with direct liquid/gas fossil fuel or dry matter burned or energy consumed for food processing. | Amount of energy (kilowatt hour (kWh), fuel or gas (m³), tonnes of dry matter (tdm) consumed, expressed per tonne of processed product. | Based on IPCC (2006) Volume 2, Energy. Energy emission factor (EF) expressed in $tCO_2$-e/m³.<br>Based on International Finance Institutions (IFI, 2022) country specific emission factor of the energy grid of the selected country, in $tCO_2$-e/MWh (MegaWatt per hour). |
| | Consists of both, methane ($CH_4$) – when treated or disposed of anaerobically, and nitrous oxide ($N_2O$) emissions. | Total amount of water used in the processing activity in m³ per tonne of product. | Based on IPCC (2019) Volume 5, Waste. EF expressed in kg $CH_4$/kg Chemical Oxygen Demand (COD) for treatment/ discharge pathway or system(s) used. |
| **Storage (with refrigerant)** | Consists of the energy use for the operation of the facility. | Amount of energy consumed in the facility during the time of the product is stored (kWh/day).<br>The allocation of the emissions is based on the total amount of stored product and the total volume of storage facility. | Based on IFI (2022). Country specific emission factor of the energy grid of the selected country, express in $tCO_2$-e/MWh. |

| Off-farm activity in agrifood VC | Source of emissions | Example of activity data | Example of emission factor |
|---|---|---|---|
| | Refrigerated storage can release potent GHG: hydro-fluorocarbons (HFCs) and chloro-fluorocarbons (CFCs) from leakage throughout the life operation of refrigerants or chillers. | The total refrigerant leakage over the year, expressed as kg per year. | Global Warming Potential (GWP) based on the fifth IPCC 2014 Assessment Report. |
| **Packaging** | Consists of the emissions of the energy on mass of packaging raw material from which the package is made. | The weight (kg) of material package per tonne of product. | The emissions factors for packaging are derived from Berneers-Lee and Hoolohan (2012), expressed in $tCO_2$-e per tonne of packaging. |
| **Transport** | Consists of the fuel combusted to power the transport (tank-to-wheel) during a distance (km) and weight (tonnes). | Number of tonne/kilometres (weight and distance), in km and tonnes of product. | Emission intensity factor derived from the fuel and vehicle type, expressed in $tCO_2$-e/tkm based on Smart Freight Center (2019). Refrigerated transport consumes 20 percent additional energy than ambient distribution (Tassou *et al*., 2009). |

Source: Authors' own elaboration.

### Calculation of total off-farm GHG emissions in EX-ACT VC tool

This section introduces and describes the technical equations used to calculate the GHG emissions from different activities at different stages of the value chain. Emissions calculated across all the activities and actors are aggregated to quantify total off-farm GHG emissions. In the following sections, the methodology used to calculate emissions from each of the activity is described.

**Processing:** the main activities in processing such as cooking, drying, shredding, grinding etc. involve utilization of heat, fuels, or electricity. GHG emissions from this activity are calculated following the guidelines published by GHG protocol (WRI, and WBCSD, 2013) using the equation below:

$$kg\ CO_2e\ emissions = \sum (Qe\ (m^3 or\ kWh) \times EF(kgCO_2e/m^3\ or\ kWh))$$

where:

- Qe = quantity of energy, in $m^3$ or kWh/year
- EF = emission factor corresponding to the fuel or energy used, in $kgCO_2$-e/$m^3$ or $kgCO_2$-e/kWh.

Associated emission factors for the heat and energy derived from different stationary and mobile combustion fuels, are provided in **Table 3**. Annex 3 provides country level grid emission factors, in $tCO_2$-e/MWh.

**Table 3. Default net calorific values, in TJ/Gg, emission factors for stationary and mobile combustion, in $tCO_2$-e/m³ and kg GHG/TJ, and fuel density, in kg/m³**

| Fuel and solid biofuels type | $EF_{fuel}$ | Net calorific values | EF $CO_2$ | EF $CH_4$ | EF $N_2O$ | Density |
|---|---|---|---|---|---|---|
| Stationary – motor gasoline | 2.292 | 44.3 | 69 300 | 10 | 0.6 | 741 |
| Stationary – gasoil /diesel oil | 2.686 | 43.0 | 74 100 | 10 | 0.6 | 837 |
| Stationary – waste oil/ lubricants | 2.819 | 40.2 | 73 300 | 10 | 0.6 | 950 |
| Stationary LPG | 1.596 | 47.3 | 63 100 | 5 | 0.1 | 533 |
| Stationary – natural gas | 0.002 | 48.0 | 56 100 | 5 | 0.1 | 0.768 |
| Mobile – motor gasoline | 2.343 | 44.3 | 69 300 | 33 | 3.2 | 741 |
| Mobile – gasoil /diesel oil | 2.714 | 43.0 | 74 100 | 3.9 | 3.9 | 837 |
| Mobile – natural gas | 0.002 | 48.0 | 56 100 | 92 | 3 | 0.768 |
| Mobile – LPG | 1.645 | 47.3 | 63 100 | 62 | 0.2 | 533 |
| Mobile – ethanol (cars) | 0.045 | 27.0 | 1 508 | 18 | N/A | 788 |
| Mobile – ethanol (trucks) | 0.480 | 27.0 | 1 508 | 260 | 41 | 788 |
| Off-road diesel | 2.979 | 43.0 | 74 100 | 4.15 | 28.6 | 837 |
| Off-road gasoline (2-stroke) | 2.435 | 44.3 | 69 300 | 140 | 0.4 | 741 |
| Off-road gasoline (4-stroke) | 2.384 | 44.3 | 69 300 | 80 | 2 | 741 |
| Wood | 1.925 [0.178] | 15.6 | 112 000 | 300 | 4 | |
| Peat | 1.138 [0.104] | 9.8 | 106 000 | 300 | 1.4 | |
| Charcoal | 3.513 [0.209] | 29.5 | 112 000 | 200 | 1 | |

Notes: Numbers in bracket are the default emission factor for solid biofuels excluding $CO_2$ emissions.

Source: Authors' elaboration based on IPCC. 2006. *IPCC Guidelines for National Greenhouse Gas Inventories*. Volume 2, Chapter 2. Geneva, Switzerland. www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html

**Packaging:** GHG emissions from packaging reflect the embedded energy based on the material used and the mass of such material used for packaging. The following equation calculates the GHG emissions from packaging based on the type of material used and the weight of the material:

$$kg\ CO_2e\ emissions = W(kg/tonne) \times EF(kgCO_2e/kg)$$

where:

- W = weight of type of packaging, in kg/tonne of product
- EF = emission factor associated with the type of packaging, in $kgCO_2$-e/kg of packaging material.

**Table 4. Emission factors for type of packaging**

| Type of packaging | Emission factors ($tCO_2$-e/tonne of packaging) |
|---|---|
| Wood | 0.4 |
| Paper | 2.1 |
| Aluminium | 8.5 |
| Plastic (mixed) | 3.6 |

Source: Berneers-Lee, M. & Hoolohan, C. 2012. *The Greenhouse Gas Footprint of Booths*. Booths GHG report final, Small World Consulting Ltd. Lancaster, UK, Lancaster University.

**Storage:** storage consumes electricity. The electricity requirement will be dependent on a variety of factors including whether the goods are stored in ambient, cold, or freezing temperatures. In cases of temperature-controlled storage, GHG emissions are also calculated from the leakage throughout the operational life of the refrigerants. Users must specify the type of refrigerant used and its GWP value in the EX-ACT VC tool. Default refrigerants and their respective GWP values are not embedded within the tool and users are responsible to specify them. Most commonly used refrigerants, their main applications and their GWP values are provided in Annex 4 to guide the users to perform an EX-ACT VC assessment (refer to Table A3, Annex 4).

Based on the GHG protocol (WRI and WBCSD, 2013), the GHG emissions from storage are calculated using the following set of equations:

$$SEC = Ec\ (kWh/year)\ /\ 365\ \times N(days\ in\ storage)$$

$$kg\ CO2e\ emissions = SEC(kWh) \times EF(kgCO2e/kWh) \times\ [(Qs(tonnes)\ /\ D)\ /\ V(m3)]$$

With refrigerant:

$$kg\ CO2e\ emissions = [SEC(kWh) \times EF(kgCO2e/kWh) + Qr(kg) \times GWP(kgCO2e/kg)]\ \times\ [(Qs(tonnes)\ /\ D)\ /\ V(m3)]$$

where:

- SEC = specific energy consumption, in kWh
- Ec = electricity consumption, in kWh/year
- N = number of days stored, days
- EF = emission factor corresponding to the electricity used, in $kgCO_2$-e/kWh
- Qr = leakage, in kg
- GWP = global warming potential, in $kgCO_2$-e/kg.

The second part of the above equations aims at allocating emissions only to the part of storage occupied by the commodity analysed. As the storage facility can be used for multiple commodities at the same time, this calculation is applied to avoid overestimating emissions. It entails dividing the amount stored, in tonnes – which is first divided by the density of the commodity, by the volume of the storage facility, in $m^3$. For this calculation, the tool assumes 1 MT = 1 $m^3$. The density of the commodity is by default equal to 1 and modifiable manually in the Tier 2 section for specific commodities with density significantly different from 1. As for the volume of the storage facility, the tool accounts for the usable volume and uses default values (see **Table 5**) from FSN Network – Commodity Management Toolkit (2017) and CARE Food Manual (1998). It also allows for the possibility of manually inputting precise volume data in the Tier 2 section.

**Table 5. Storage volume: default values**

| | Area ($m^2$) | Height (m) | Gross volume ($m^3$) | Usable volume ($m^3$) | Capacity (MT) |
|---|---|---|---|---|---|
| **Small (one stack)** | 50 | 3 | 150 | 48 | 24 |
| **Small (two stacks)** | 50 | 3 | 150 | 42 | 21 |
| **Average small** | 50 | 3 | 150 | 45 | 23 |
| **Medium (one stack)** | 200 | 4 | 800 | 432 | 216 |
| **Medium (two stacks)** | 200 | 4 | 800 | 408 | 204 |
| **Average medium** | 200 | 4 | 800 | 420 | 210 |
| **Large (one stack)** | 600 | 5 | 3 000 | 1 976 | 988 |
| **Large (two stacks)** | 600 | 5 | 3 000 | 1 768 | 884 |
| **Average large** | 600 | 5 | 3 000 | 1 872 | 936 |
| **Very Large** | 1 624 | 6 | 9 744 | 4 230 | 2 160 |

Sources: FSN Network. 2017. *Commodity Management Toolkit*. Washington, DC, USAID (United States Agency for International Development). www.fsnnetwork.org/sites/default/files/CM_Toolkit_v2.2%20for%20online.pdf; CARE. 1998. CARE Food Manual. Atlanta, Georgia.

**Transportation:** GHG emissions from transportation primarily come from burning fossil fuel for cars, trucks, ships, trains, and planes to travel from one-point to another. Based on the Smart Freight Centre's Global Logistics Emissions Council Frame (2019), the GHG emissions from transportation are calculated using the following equation:

$$kg\ CO_2e\ emissions = \sum_{1}^{n}(total\ tkm\ \times\ iEF\ (kgCO_2e/tkm))$$

where:

- tkm = tonnes per kilometre
- iEF = intensity factor, in $kgCO_2/tkm$
- n = transports involved.

**Table 6. Emission factors for transportation, in $tCO_2$-e/tkm**

| Type of transport | Type of fuel | Intensity factor | Refrigerant |
|---|---|---|---|
| | | TTW – $tCO_2$-e/tkm | TTW – $kgCO_2$-e/tkm |
| **Animals** | None | 0.000 | 0.000 |
| **Aviation – air freight** | Kerosene | 0.00026 | 0.008560 |
| **Inland water (>1 000 tonnes)** | Diesel | 0.00002 | 0.008340 |
| **Inland water (1 000–2 000 tonnes)** | Diesel | 0.00002 | 0.008340 |
| **Inland water (container 110 metres)** | Diesel | 0.00002 | 0.008340 |
| **Inland water (container 135 metres)** | Diesel | 0.00002 | 0.008340 |
| **Rail (container)** | Diesel | 0.00002 | 0.008560 |
| **Rail (cereals)** | Diesel | 0.00002 | 0.008560 |
| **Rail (container)** | Electric | 0.00001 | 0.008560 |
| **Rail (cereals)** | Electric | 0.00001 | 0.008560 |
| **Van (>3.5 tonnes)** | Diesel | 0.000550 | 0.000660 |
| **Van (>3.5 tonnes)** | Gasoline | 0.000850 | 0.001020 |
| **Van (>3.5 tonnes)** | Compressed Natural Gas (CNG) | 0.000540 | 0.000648 |
| **Van (>3.5 tonnes)** | Liquefied petroleum gas (LPG) | 0.000590 | 0.000708 |
| **Light-duty-truck (3.5–7.5 tonnes)** | Diesel | 0.000300 | 0.000360 |
| **Light-duty-truck (3.5–7.5 tonnes)** | CNG | 0.000310 | 0.000372 |
| **Medium-duty-truck (7.5–12 tonnes)** | Diesel | 0.000190 | 0.000228 |
| **Medium-duty-truck (7.5–12 tonnes)** | CNG | 0.000190 | 0.000228 |
| **Medium-duty-truck (12–20 tonnes)** | Diesel | 0.000120 | 0.000144 |
| **Medium-duty-truck (12–20 tonnes)** | CNG | 0.000130 | 0.000156 |
| **Medium-duty-truck (12–20 tonnes)** | Liquefied natural gas (LNG) | 0.000130 | 0.000156 |
| **Medium-duty-truck (20–26 tonnes)** | Diesel | 0.000099 | 0.000119 |
| **Medium-duty-truck (20–26 tonnes)** | CNG | 0.000100 | 0.000120 |
| **Medium-duty-truck (20–26 tonnes)** | LNG | 0.000100 | 0.000120 |
| **Heavy-duty-truck (26–32 tonnes)** | Diesel | 0.000078 | 0.000094 |
| **Heavy-duty-truck container (26–32 tonnes)** | Diesel | 0.000069 | 0.000083 |
| **Heavy-duty-truck (up 34 tonnes)** | Diesel | 0.000074 | 0.000089 |
| **Heavy-duty-truck container (up 34 tonnes)** | Diesel | 0.000083 | 0.000100 |
| **Heavy-duty-truck (up to 40 tonne)** | CNG | 0.000066 | 0.111000 |
| **Heavy-duty-truck container (up to 40 tonnes)** | CNG | 0.000065 | 0.111000 |

| Type of transport | Type of fuel | Intensity factor | Refrigerant |
|---|---|---|---|
| | | TTW – $tCO_2$-e/tkm | TTW – $kgCO_2$-e/tkm |
| **Heavy-duty-truck (up to 40 tonnes)** | LNG | 0.000065 | 0.111000 |
| **Heavy-duty-truck container (up to 40 tonnes)** | LNG | 0.000064 | 0.111000 |
| **Heavy-duty-truck (up to 40 tonnes)** | Diesel | 0.000064 | 0.111000 |
| **Heavy-duty-truck container (up to 40 tonnes)** | Diesel | 0.000060 | 0.111000 |

Note: For refrigerated transportation: vans to heavy-duty-truck up 34 tonnes, it is assumed a 20 percent of intensity increased (Tassou *et al.*, 2009).

Source: Smart Freight Centre. 2019. Global Logistics Emissions Council Framework for Logistics Emissions Accounting and Reporting.

**Wastewater management:** activities in the processing stage of the value chain might require water as a material input to transform the commodity and thereby sometimes resulting in wastewater. Such wastewater is a source of both, methane ($CH_4$) – when treated or disposed of anaerobically (McIlvaine, 2015) – and nitrous oxide ($N_2O$) emissions. GHG emissions from wastewater management are calculated in the tool using IPCC methodology (IPCC, 2006, 2019c) as follows:

$$CH_4 \ emissions = \sum_i [(TOWi - Si)EFi - Ri]$$

where:

- $CH_4$ emissions = $CH_4$ emissions in $kgCH_4$/year
- $TOW_i$ = total organically degradable material in wastewater from industry i, in kgCOD/year
- i = industrial sector
- $S_i$ = organic component removed as sludge, in kgCOD/year
- $EF_i$ = emission factor for industry i, in $kgCH_4$/kgCOD
- Ri = amount of $CH_4$ recovered, in $kgCH_4$/year.

$$N_2O \ emissions = \left[\sum (T \cdot EF \cdot TN)\right] \times \frac{44}{28}$$

where:

- $N_2O$ = $N_2O$ emissions from industrial wastewater treatment plants in inventory year in $kgN_2O$/year
- T = degree of utilization of treatment/discharge pathway or system
- EF = emission factor for treatment/discharge pathway or system, in $kgN_2O–N$/kg N
- TN = total nitrogen in wastewater from industry, in kgN/year.

### Table 7. Emission factors for wastewater

| IPCC (2019) Chapter 6 and associated tables | Table 6.8 | Table 6.8a | Table 6.10c |
|---|---|---|---|
| | $CH_4$ correction factor MCF | kg $N_2O$–N/kg N EF | Nrem Default |
| Untreated (discharge to aquatic environments) | 0.11 | 0.005 | 0 |
| Untreated (discharge to aquatic environments other than reservoirs, lakes and estuaries) | 0.035 | 0.005 | 0 |
| Untreated (discharge to reservoirs, lakes and estuaries) | 0.19 | 0.005 | 0 |
| Centralised aerobic treatment plant | 0 | 0.016 | 0.4 |
| Anaerobic reactor | 0.8 | 0 | 0.4 |
| Anaerobic shallow lagoon, <2m depth | 0.2 | 0 | 0.4 |
| Anaerobic deep lagoon, >2m depth | 0.8 | 0 | 0.4 |

Source: IPCC. 2019. *IPCC Guidelines for National Greenhouse Gas Inventories*. Volume 5. Cambridge, UK, Cambridge University Press and New York, USA. www.ipcc-nggip.iges.or.jp/public/2019rf/vol5.html

### Table 8. Emission factors for wastewater management

| IPCC (2019) Chapter 6 and associated tables | Table 6.9 | | Table 6.12 |
|---|---|---|---|
| Industry type | Wastewater generation ($m^3$/t) | COD (kg/$m^3$) | Total nitrogen kg/$m^3$ |
| Alcohol refining | 24 | 11 | 2.4 |
| Beer and malt | 6.3 | 2.9 | 0.055 |
| Coffee | 15 | 9 | – |
| Pulp and paper combined | 162 | 9 | – |
| Starch production | 9 | 10 | 0.9 |
| Sugar refining | 11 | 3.2 | – |
| Vegetable oils | 3.1 | 0.85 | – |
| Vegetable, fruits and juices | 20 | 5 | – |
| Wine and vinegar | 23 | 1.5 | – |
| Dairy products | 7 | 2.7 | – |
| Fish processing | 13 | 2.5 | 0.6 |
| Meat and poultry | 13 | 4.1 | 0.19 |

Sources: IPCC. 2006. *IPCC Guidelines for National Greenhouse Gas Inventories*. Volume 2, Chapter 2. Geneva, Switzerland. www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html; Basnet, R. 2014. *Sustainable utilization of coffee processing wastes through biogas technology*. Cited 3 February 2022. https://energypedia.info/wiki/Sustainable_Utilization_of_Coffee_Processing_Wastes_through_Biogas_Technology (for values in red).

**New infrastructure:** construction of new infrastructure such as buildings, warehouses and roads lead to GHG emissions from the use of material inputs, fuel, and energy inputs throughout the construction phase. GHG emissions from construction of new infrastructure is calculated in the tool as follows:

$$kg\ CO_2e\ emissions = Builtup\ area\ (m^2) \times EF(kgCO_2e/m^2)$$

where:

- Builtup area = area covered by the new infrastructure, in $m^2$
- EF = emission factor associated with building new infrastructure, in $kgCO_2$-e/$m^2$.

**Table 9. Emission factors for construction of buildings and roads, in $tCO_2$-e/m²**

| Type | Emission factor |
|---|---|
| Housing (concrete) | 436 |
| Agricultural buildings (concrete) | 656 |
| Agricultural buildings (metal) | 220 |
| Industrial buildings (concrete) | 825 |
| Industrial buildings (metal) | 275 |
| Garage (concrete) | 656 |
| Garage (metal) | 220 |
| Offices (concrete) | 469 |
| Offices (metal) | 158 |
| Other (concrete) | 550 |
| Other (metal) | 220 |
| Road (bitumen) | 18 |
| Road (asphalt) | 73 |
| Road (reinforced concrete) | 86 |
| Road rehabilitated (pavement) | 9 |
| Food sales (retail or wholesale) | 515.9 |
| Food service (restaurants) | 517.4 |
| Warehouse and storage | 1 568.3 |
| Education | 440 |
| Health care (metal) | 440 |

Source: Authors' own elaboration based on ADEME. 2020. *Resource centre for greenhouse gas accounting*. Angers, France. Cited 26 June 2020. www.bilans-ges.ademe.fr; Breisinger, M. 2012. *Greenhouse Gas Assessment Emissions Methodology*. Technical Note IDB–TN–455. Washington, DC, Inter–American Development Bank (for values in red).

After estimating emissions from each of the activity, the EX-ACT VC tool calculates:

## Total GHG emissions

Emissions across all the activities and actors are aggregated to quantify total GHG emissions in both current and planned scenarios as expressed below:

$$Total\ GHG\ emissions = on\ farm\ emissions + off\ farm\ emissions$$

where:

- on-farm emissions = emissions from primary production (calculated in EX-ACT and inputed in the EX-ACT VC);
- off-farm emissions = emissions from processing, storage, packaging, transport, wastewater management and new infrastructure.

## Net carbon balance

The GHG emissions in current and planned scenario are compared using the following equation to estimate GHG emissions emitted or sequestered due to a specific project or policy implementation within a value chain:

$$Net\ carbon\ balance\ (Net(+/-)\ tCO2e\ per\ year) =$$

$$Total\ on\ farm\ emissions + (-)\ reductions + (total\ emissions\ off\ farm\ planned - total\ emissions\ off\ farm\ current)$$

### GHG emission intensity by activity

The emission intensity for *primary production* is the amount of GHG emissions originating from primary production expressed in tonnes of $CO_2$-e per tonne of (initial) product. It is estimated using the below equation:

$$Emission\ intensity\ for\ primary\ production\ (tCO2e/tonne\ of\ (initial)\ product) = Total\ GHG\ emissions\ from\ primary\ production\ /\ Total\ amount\ produced$$

The emission intensity for *processing* is the amount of GHG emissions originating from processing expressed in tonnes of $CO_2$-e per tonne of (final) product. It is estimated using the below equation:

$$Emission\ intensity\ for\ primary\ production\ (tCO2e/tonne\ of\ (final)\ product) = Total\ GHG\ emissions\ from\ processing\ /\ Total\ amount\ after\ processing$$

The above equations sum up activity emissions and amounts of product for all the actors engaged in that activity.

## 2.2.2 Indicator: food loss

This indicator estimates the food losses along the value chain to assess the efficiency and functioning of the value chain. Food losses across the value chain impact environmental, economic, and social dimensions. Food loss is a reduction of food "quantity" – physical losses of food that were destined for human consumption – or food "quality" – decrease in food attributes that reduce its value in terms of intended use – resulting from decisions and actions by food suppliers in the chain up to the retailer's door[1] (FAO, 2019a).

Food loss occurs at every stage of the value chain. The EX-ACT VC tool only calculates the food losses in terms of "quantity" reduced expressed in tonnes of the commodity. The computed food loss includes the commodity as a whole with its any non-edible parts.

EX-ACT VC tool follows the methodological approach in line with the FAO's Global Food Loss Index (2018). It standardizes food losses at each activity of the value chain and aggregates them to obtain the overall production that does not reach the retail stage. The EX-ACT VC tool computes food loss across the value chain as follows:

1. It requires users to provide an average percentage of food lost at each actor and activity in the value chain.
2. The EX-ACT VC tool then compiles the amount lost at each stage by multiplying the average losses (in percent) of that stage to a reference quantity. At the primary production stage, this reference quantity is the total amount harvested, and for the subsequent stages the reference quantity is the amount remaining from the previous stage.
3. The tool computes the amount remaining at each stage by subtracting the amount lost from the amount remaining in the previous stage.

Figure 7 provides an example of aggregating food losses along the value chain.

[1] It excludes retailing, food service providers, and consumers. At this stage the food that does not get consumed is known as "food waste".

**Figure 7. Example of aggregating food losses along the value chain**

| | Total harvest | On-farm post-harvest | Transport | Processing | Packaging | Storage |
|---|---|---|---|---|---|---|
| Starting amount – (Total agricultural production/Raw material) | 1 000 tonnes | | | | | |
| Average losses (%) | | 7.3% | 1.5% | 3.5% | 0% | 5.6% |
| Amount lost | | 73 | 13.9 | 31.9 | 0 | 49.3 |
| Amount remaining | | 927 | 913 | 881 | 881 | 831 |

Source: Authors' own elaboration.

The tool computes the food loss for the current and planned scenarios and compares the change between the two scenarios.

### 2.2.3 Indicator: water usage

This indicator enables users to capture the water used during all processing activities in the entire value chain to assess the water use efficiency and sustainability of the value chain. EX-ACT VC tool calculates the total water usage in litres during the processing stage of the value chain and per tonne of final product and disaggregates the water usage across each actor involved in processing activities in the current and planned scenario and the change in amount of water used between the two.

The tool follows a simple water end-use approach and does not differentiate between the different water sources such as rainfall, surface/groundwater, or freshwater (Mekonnen and Hoekstra, 2011).

### 2.2.4 Indicator: monetary value of GHGs estimated in the value chain

This indicator represents the scale of expected economic costs or benefits resulting from GHG emissions or reductions across the value chain. This indicator uses the social cost of carbon (SCC) to quantify climate damages, representing the net economic cost of GHG emissions. In simple terms SCC "tries to add up all the quantifiable costs and benefits of emitting one additional tonne of $CO_2$, in monetary terms" (Carbon Brief, 2021). By assigning a monetary value to the emissions, the harmful externalities of climate change are converted into economic terms.

SCC links emissions from a value chain to climate change damages complementing traditional GHG calculations and allows to assess whether and to what extent the value chain project or policy contributes to climate change impact or climate change action. The EX-ACT VC tool quantifies the expected economic value per GHG emitted, reduced, or avoided across both current and planned value chain activities and helps evaluate whether the costs and benefits of a proposed agrifood VC project or policy to curb climate change are justified. It estimates the economic value of damages from the total GHG emissions in the value chain and from per tonne of the final product.

To estimate the net economic costs to climate change attributable to the value chain project or policy in a current and planned scenario, the total GHG emissions determined from the environmental assessment is multiplied by a selected SCC estimate. This is expressed as:

$$\begin{aligned}&Monetary\ value\ of\ GHGs\ estimated\ in\ the\ value\ chain\\&\qquad = total\ GHG\ emissions\ (tCO2e) \times social\ cost\ of\ carbon\ (USD/tCO2e)\end{aligned}$$

The default social cost of carbon (lower and upper bound) is taken from Nordhaus (2017).

The default lower bound for the SCC is USD 44.15[2] and upper bound for the SCC is USD 165.72 (as of 2021 US dollars). These values are calculated by the DICE–2016R model, using the model's baseline assumptions, and using a 2.5 percent discount rate.

[2] The tool is showing one value only (the lower bound), which can be overwritten by the user with the upper bound or any other ad hoc values.

### 2.2.5 Indicator: monetary value of food loss

The tool calculates the monetary value of the food losses along the value chain multiplying the amount of food lost for each category of actors by the corresponding actor's average selling price. It is estimated using the below equation:

$$Monetary\ value\ of\ food\ loss\ (LCU/year) = Total\ food\ losses\ (tonnes/year) \times Selling\ price\ (LCU/tonne)$$

The above formula is calculated at the category level, then results are aggregated to measure the total monetary value at the value chain level.

Total food losses can include – based on user's data entry, losses before harvest and during harvest (for primary producers only), losses during storage (pre- and post-processing), losses during processing, losses during packaging, and losses during transport (pick-up and/or delivery).

## 2.3 Socioeconomic assessment

The socioeconomic assessment builds on both the functional analysis of the value chain described in Section 2.1 and on the environmental assessments described in Section 2.2.

The EX-ACT VC tool calculates a set of indicators that represent socioeconomic performance of the value chain. These are listed in **Table 10.**

**Table 10. List of socioeconomic indicators**

| | |
|---|---|
| Economic indicators | Gross production value |
| | Gross and net value added |
| | Net Income |
| | Average daily wage |
| Employment indicator | No. of jobs created along the entire VC |
| | No. of jobs created by category of actor/activity/sector |
| Gender and youth analysis | No. of women owning a business |
| | No. of women in managerial position |
| | No. of women employed (hired and as family workers) |
| | No. of jobs disaggregated by gender and age group |

Source: Authors' own elaboration.

### 2.3.1 Economic indicators

#### Indicator: value-added

This indicator represents a set of economic productivity measures that reflects the contribution of the value chain to the economy. The EX-ACT VC tool calculates "value-added" across every stage of the value chain in a current and planned scenario. The tool defines value-added as an indicator of the agrifood VCs economic performance based on wealth created or accumulated along the different value chain activities and actors, net of the resources consumed by the activities and actors. The EX-ACT tool measures three types of value added (Bellù *et al.,* 2013):

1. Value-added by each actor and activity at each stage of the value chain;
2. Aggregate value-added by the value chain;
3. Distribution of value added among production factors (land, labour, capital, etc.) through their respective distributive variables (rent, wages, taxes and profits).

The following measures in monetary terms are computed as part of the value-added indicator:

1. Gross production value
2. Gross value added
3. Net value added
4. Net income
5. Average daily wage.

The methodological framework to calculate value-added measures throughout the value chain is based on macroeconomic framework provided by the System of National Accounts (SNA, 2008), and theory of firm, crop, and farm microeconomic budgets. An example of how value-added measures are calculated is reported in **Table 11**. This set of measures is calculated for each category of actors along the value chain, both at the aggregate level (e.g. entire category of actors) and at the individual level (e.g. for each actor in the category).

**Table 11. Methodology to calculate different economic measures of value-added indicator**

| Equation | Economic measures of value added | Example | |
|---|---|---|---|
| **C** = A + B | **Gross production value** | | **USD 1 000** |
| A | Sales revenue | USD 900 | |
| B | Final own consumption | USD 100 | |
| **D** | **Intermediate inputs** | | **USD 500** |
| **E** = C – D | **Gross value added** | | **USD 500** |
| F | Fixed capital consumption | USD 100 | |
| **G** = E – F | **Net value added** | | **USD 400** |
| H | Wages | USD 100 | |
| I | Interests | USD 50 | |
| J | Rents | USD 0 | |
| K | Taxes | USD 25 | |
| L | Subsidies | USD 20 | |
| **M** = H + I + J + K – L | **Production factors** | | **USD 155** |
| **N** = G – M | **Net income** | | **USD 245** |

Source: Authors' own elaboration.

Following the SNA guidelines, the tool first distinguishes between the production account and the income account in simple terms as follows:

- The production account determines the value added (VA) of the production process;
- The income account determines how this value added is distributed among the actors participating in the production process through the supply of production factors such as land, labour, capital etc.

The following section introduces and describes the steps to calculate the various items in **Table 11** within the tool.

## Production account items

### C: gross production value (GPV)

GPV is calculated for every category of actors within the value chain and represents an intermediary step in the calculation of value added. It is calculated by summing sales revenues and the value of own consumption, if any. The former is obtained by multiplying the price per unit of product sold (denominated as "selling price") by the quantity of product sold.[3] The latter is estimated by multiplying the amount of product that was self-consumed by the selling price.

### D: intermediate inputs (II)

Any goods entering the production process and totally consumed during a production period are recorded as intermediate inputs (only referred to as "inputs" in the tool). The cost of intermediate inputs

[3] The product sold differs for every category of actors and corresponds to the output of each actor (e.g. the tomatoes for the producer, but the tomato paste for the processor).

is obtained by multiplying their purchase price e.g. their price when they enter the process of production, by the amount of the corresponding inputs used.[4]

#### E and G: gross and net value added (VA)

Value added measures the accumulation of wealth and the contribution of the production process to economic growth. In other words, the value added is the value that each actor, at each stage of the value chain, adds to the value of inputs during the accounting period of the food production process. Value added can be calculated by taking the GPV of each actor's output and subtracting the value of intermediate inputs used to create the output. Gross value added (GVA) does not consider the cost of consuming or using fixed capital. Net value added (NVA) also subtracts fixed capital consumption from GPV. If fixed capital consumption is unknown, then gross value added will equal net value added.

#### F: fixed capital consumption

While some inputs (e.g. intermediate inputs) are entirely consumed during one single production period, others, such as vehicles, machinery, and equipment, can be used over several production periods. These inputs are defined as fixed assets, and the stock of fixed assets is defined as fixed capital. Although fixed assets produce services for several periods, their value normally declines over time, due to physical deterioration (wear and tear), obsolescence (e.g. loss of value due to technical progress) or expected accidental damage. The decline in value in one accounting period is defined as the consumption of fixed capital in that period (SNA, 2008). To correctly consider all the resources consumed to produce a given output, the consumption of fixed capital for the given production period also needs to be accounted in the production process. EX-ACT VC uses the one-hoss shay depreciation model, which assumes that the asset provides the same quantity of services in all the periods of its economic life, until it completely wears out. This implies also that the gains from the use of the asset, as well as the loss of its value (the related cost), are equal and can be calculated by taking the asset's initial value divided by the number of periods of its economic life.

### Income account items:

#### M: production factor incomes

The NVA constitutes the net wealth available to remunerate the factors of production involved in the production process. There are several types of income deriving from the distribution of the NVA. These are termed as production factor incomes and are as follows:

1. **Wages** include payments in cash, or in-kind contributions to hired employees and the remuneration of family labour. They determine labour costs, calculated by multiplying the average wage by the number of hired workers (over the time period considered) across different categories and actors.
2. **Interests** include the financial charges on the purchase of fixed assets, and the charges generated in the short term to finance the working capital, for example the funds required to pay for input costs anticipated with respect to revenues (Bellù *et al.*,2013). Interests should not include the cost of financial services provided by banks, such as advice on funding opportunities and current account services (e.g. account keeping, check expenses, etc.) considered as services to be accounted for intermediate inputs. Interests belong to the category of "Other costs".
3. **Taxes** on production and imports accounted for the generation of the income account. **Subsidies** to production are recorded in this entry as negative. Taxes do not include social contributions and benefits paid to workers (comprised among the wages as components of the cost of hired labour), current taxes on income and wealth, or any other current transfer to the agent or referring to the household and not specifically to the production activity. Like interests, taxes belong to the category of "Other costs".

---

[4] Intermediate inputs, for instance, include fertilizers, pesticides, seeds, etc. and represent inputs originating from "outside" the value chain. Inputs understood as the "primary commodity" purchased from the previous actor in the value chain (e.g. whole tomatoes purchased by processors from producers to make tomato paste) do not belong to this category.

### 2.3.2 Social indicators

#### Indicator: employment

This indicator measures the employment opportunities generated along the value chain. Jobs are a key pathway, and labour is the most important asset to generate a steady income and enable a sustainable pathway out of poverty and towards shared prosperity. The EX-ACT VC tool calculates the number of jobs created along the value chain in both current and planned scenarios, and the number of jobs disaggregated for different actors. The EX-ACT VC tool distinguishes between remunerated and non-remunerated employment. **Box 2** explains the differences between these two in detail.

**Box 2. Remunerated vs. non-remunerated employment**

The tool classifies the employment opportunities generated across the value chain into four "sectors", defined as follows:

- **Remunerated** employment refers to workforce perceiving a wage remuneration. It corresponds to employees.
- **Non-remunerated (family) labour** refers to workforce not perceiving a wage remuneration, either because it perceives income from the operation, or because it is non-remunerated being at the family level.

Source: Authors' own elaboration.

EX-ACT VC derives the number of jobs by dividing the total person-days required per unit by one "full-time equivalent" (FTE) position, expressed in number of days, as follows:

$$No. of\ jobs = \frac{Total\ person\ days\ required}{one\ FTE\ position}$$

where:

- The number of person-days required per unit is measured according to the number of workers required per day to perform a task, e.g. 15 person-days for harvesting, (this includes both remunerated and non-remunerated labour);
- One "full-time equivalent" position refers to the number of working days over a year, on average. By default, the tool assumes that a full-time equivalent position is equivalent to working on average 250 days a year. This value (250 days) may be changed by the user if more precise information is available.

The tool adopts different data collection methods depending on the type of actor: for primary producers, the tool collects data in person-days directly. For non-producers, the tool collects data on the number of employees, and then converts them into person-days. In the case of part-time employees, the tool assumes one part-time job is half a full-time position. The number of person-days required are estimated using the following equations:

$$No. of\ person\ days = No. of\ full\ time\ employees\ \times one\ FTE\ position$$

$$No. of\ person\ days = No. of\ part\ time\ employees\ \times \frac{(one\ FTE\ position)}{2}$$

At the category of actors-level, the tool calculates the number of jobs created using the following equation:

$$No.of\ jobs, by\ category\ of\ actor = \frac{Total\ person\ days\ required, by\ category}{one\ FTE\ position}$$

where:

- Total person-days required by category of actor is the sum of person-days required for each activity performed by the category;

and then it aggregates results at the value chain level for all the existing categories of actors to estimate the total number of jobs created:

$$No.of\ jobs, value\ chain = \sum_{n=i}^{j} No.of\ jobs\ in\ category\ i$$

The tool also calculates the number of remunerated vs. non-remunerated jobs created across each category of actor, using the following equations:

$$No.of\ remunerated\ jobs = \frac{Total\ person\ days\ required}{one\ FTE\ position} \times percent\ of\ remunerated\ labour$$

$$No.of\ non\ remunerated\ jobs = \frac{Total\ person\ days\ required}{one\ FTE\ position} \times percent\ of\ non\ remunerated\ labour$$

And then it aggregates results for all the existing categories of actors to find the total number of remunerated/non-remunerated jobs at the value chain level.

### Indicator: women's representation

This indicator assesses the potential of the value chain to contribute to women's economic empowerment and advance gender equality. The EX-ACT VC tool focuses on three main aspects of women's participation in a value chain: i) ownership; ii) management; and iii) employment. See Box 3 on how the tool distinguishes between an owner and a manager. See **Box 3** on how the tool distinguishes between an owner and a manager.

The tool calculates, in both the current and planned scenario:

- the number of women *owners* – e.g. it corresponds to women owning farming operations (it may correspond to women as head of household), owning a processing enterprise, or a business engaged in trading activities, etc.;
- the number of women *in managerial positions* – it corresponds to women managing a business, and perceiving a salary;
- and the number of women *employed* – it corresponds to women part of the workforce i.e. not owning, nor managing the operations. They can either perceive or not a salary, e.g. in the case of family/non-remunerated labour.

The tool collects information on women participation in different sections of the tool.[5] Please refer to Part 3 of these guidelines for more details.

[5] For women owners, the tool collects data in Step 1.2 "Identifying value chain actors" of the functional analysis module, in terms of the share of women within each category of actors; for *women in managerial positions*, the tool collects data in (tool's) Section 3.2 "Labour costs and labour requirements" of the socioeconomic module, in terms of women employed as managers; for *women employed*, the tool collects data in (tool's) Section 3.2 "Labour costs and labour requirements" of the socioeconomic module, in terms of full-time and part-time employees – either remunerated or not-remunerated, that are women.

**Box 3. "Owner" and "manager" definitions**

According to the International Standard Classification of Occupation (ISCO–08) and other sources, owner and manager are classified and defined as follows:

- An **owner** is a physical person who owns the business and he/she may or may not work in the business. Profit and loss impact him/her directly. Ownership issues tend to be more strategic and might include dealing with the bank or finance, negotiating on suitable freehold or leasehold premises, maintaining relationships with other owners or investors in the business, deciding on future strategy and creating a compelling vision of the future.
- A **manager** is an employee of the business and he/she works for the owner in the business. The manager earns a salary and is not affected to the same extent as the power by fluctuating sales or profits. Management issues are the daily, weekly and monthly things that must be done to ensure the smooth running of the business.

Source: ILO. 2012. *International Standard Classification of Occupations. Structure, group definitions and correspondence tables*. Geneva, Switzerland. www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_172572.pdf

The tool calculates the *number of women owners* across each category of actor based on the number of women within each category of actors. Then it aggregates results for all the existing categories of actors to calculate the number of women employed at the value chain level. The equation used is the following:

$$No.of\ women\ owners = No.of\ actors\ within\ each\ category \times percent\ of\ women\ in\ each\ category$$

Then, the tool calculates the *number of women employed* across each category of actor, and it aggregates results for all the existing categories to calculate the number of women employed at the value chain level. Again, the tool has a different equation depending on the "type" of category of actors i.e. primary producers and non-producers: for the formers, data are collected in person-days, while for the latter, data are collected in number of employees. The calculation involves a multiplication of the total number of employees by the percentage of women employed, as follows:

$$No.of\ women\ employed\ (primary\ producers) = \frac{Total\ person\ days\ required}{one\ FTE\ position} \times percent\ of\ women\ employed$$

$$No.of\ women\ employed\ (non\ producers) = no.of\ employees \times percent\ of\ women\ employed$$

The tool eventually calculates the *number of women in managerial positions* across each category of actor, and it aggregates results for all the existing categories to calculate the number of women employed at the value chain level. The equation used is the following:

$$No.of\ women\ in\ managerial\ positions = no.of\ managers \times percent\ of\ women\ in\ managerial\ position$$

### Indicator: youth participation

This indicator explores the potential of the value chain to create opportunities for young people. Youth participation is a key pathway towards social change, economic growth, and innovation. EX-ACT VC extracts youth employment to estimate youth participation across the value chain in both a current and planned scenario.

EX-ACT VC adopts the United Nations categorization of age groups (United Nations, 1982), which defines "youth" as those persons "between the ages of 15 and 24 years inclusive".

The tool calculates, in both the current and planned scenario:

- the number of youth *owners* – e.g. it corresponds to youth owning farming operations, owning a processing enterprise, or a business engaged in trading activities, etc.;

- and the **number of youth *employed*** – it corresponds to youth part of the workforce i.e. not owning, nor managing the operations. They can either perceive or not a salary, e.g. in the case of family/non-remunerated labour.

As for women participation, the tool collects information on youth participation in different sections of the tool. Please refer to Part 4 of these guidelines for more details.

The tool calculates the *number of youth owners* across each category of actor based on the number of young people within each category of actors. Then it aggregates results for all the existing categories of actors to calculate the number of youth employed at the value chain level. The equation used is the following:

$$No.of\ youth\ owners = No.of\ actors\ within\ each\ category \times percent\ of\ youth\ in\ each\ category$$

The tool calculates the *number of youth employed* across each category of actor, and it aggregates results for all the existing categories of actors to calculate the number of young people employed at the value chain level. Again, the tool has a different equation depending on the "type" of category of actors i.e. primary producers and non-producers: for the formers, data are collected in person-days, while for the latter, data are collected in number of employees. The calculation involves a multiplication of the total number of employees by the percentage of the workforce in the 15-24 age group, as follows:

$$No.of\ youth\ employed\ (primary\ producers) = \frac{Total\ person\ days\ required}{one\ FTE\ position} \times percent\ of\ youth\ employed$$

$$No.of\ youth\ employed\ (non\ producers) = no.of\ employees\ \times percent\ of\ youth\ employed$$

The data required on the share of workforce belonging to the 15-24 age group must be collected by the users and entered into the EX-ACT VC tool.

### 2.3.3 SDG tracker – Links to United Nations Sustainable Developmental Goals

The EX-ACT VC tool recognizes that activities throughout the value chain can have a direct impact on achieving the SDG targets. The EX-ACT VC tool measures how agrifood VC project or policy contributes to the objectives of SDGs by tracking a set of SDG indicators. The tool estimates the indicators at the value chain level for both the current and planned scenario and expresses the change between the two scenarios in percentage terms to reflect how agrifood VC project or policy allows progress towards achieving the corresponding SDG target.

**Table 12** summarizes the specific SDG goals, targets and indicators that EX-ACT VC estimates.

**Table 12. United Nations Sustainable Development Goals (SDGs) targets and indicator assessed within EX-Ante Carbon-balance Tool for Value Chains**

| Target | | Indicator | |
|---|---|---|---|
| **SDG 2 – Zero hunger** | | | |
| 2.3 | By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, Indigenous Peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment. | 2.3.1 | Volume of production per labour unit by classes of arming/pastoral/forestry enterprise size. |
| | | 2.3.2 | Average income of small-scale food producers, by sex and indigenous status. |
| **SDG 5 – Gender equality** | | | |
| 5.5 | Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life. | 5.5.2 | Proportion of women in managerial positions. |
| **SDG 6 – Clean water and sanitation** | | | |
| 6.4 | By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity. | 6.4.1 | Change in water-use efficiency over time at the processing level (MIMEC). |
| **SDG 9 – Industry, innovation and infrastructure** | | | |
| 9.4 | By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities. | 9.4.1 | $CO_2$ emission per unit of value added. |
| **SDG 12 – Responsible consumption and production** | | | |
| 12.3 | By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses. | 12.3.1 | Adjusted global food loss index. |

Source: United Nations. 2016. *Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators*. Economic and Social Council (ECOSOC). Statistical Commission. Forty-seventh session. UN Doc. E/CN.3/2016/2/Rev.1, 19 February 2016. New York, USA. https://digitallibrary.un.org/record/821651

The following section introduces and describes the technical equations used within EX-ACT VC tool to calculate the indicators identified in **Table 12** for both the current and planned scenario.

### Indicator 2.3.1: production per labour unit of small-scale food producers

$$I_{2.3.1} = \frac{\sum_{j=1}^{n} \left( \frac{V_j \, p_j}{Ld_j} \right)}{n}$$

where:

- $V_j$ is the total physical volume of agricultural product sold by the $j^{th}$ category of small-scale food producers during the year assessed;
- $p_j$ is the constant sale price received by the $j^{th}$ category of small-scale food producer for the agricultural product during the year assessed;
- $Ld_j$ is the total number of labour days utilized by $j^{th}$ category of small-scale producers;
- $n$ is the total number of categories of small-scale producers.

**Note:**
This indicator is calculated for small-scale food producers within the value-chain, based on the user's self-identification of the category of actor as "small-scale" (FAO, 2017).

### Indicator 2.3.2: average income of small-scale food producers

$$I_{2.3.2} = \frac{\sum_{j=1}^{n}(V_j\, p_j - C_j)}{n}$$

where:

- $V_j$ is the total physical volume of agricultural product sold by the j[th] category of small-scale food producers during the year assessed;
- $p_j$ is the constant sale price received by the j[th] category of small-scale food producer for the agricultural product during the year assessed;
- $C_j$ is the total production cost of agricultural product produced by the j[th] category of small-scale food producers. Total production cost comprises all variable costs (e.g. payments in cash and kind of agricultural inputs as fertilizer, seeds, occasional labour, etc.) and fixed costs (e.g. hired labour, land rent and technical assistance costs);
- $n$ is the total number of categories of small-scale producers.

**Note:**
This indicator is calculated for small-scale food producers within the value-chain, based on the user's self-identification of the category of actor as "small-scale" (FAO, 2017).

### Indicator 5.5.2: proportion of women in managerial positions

$$I_{5.5.2} = P_W = \left(\frac{n_W}{n_t}\right) \times 100 percent$$

where:

- $P_W$ = proportion of women in managerial positions (within Value Chain);
- $N_w$ = total number of women employed in ISCO–88 category 1 (within Value Chain);
- Nt = total number of persons employed in ISCO–88 category1 (within Value Chain).

**Note:**
This indicator is calculated using ISCO–88 methodology. Since users are not asked to provide statistics at the sub-major group level (two-digit level of ISCO), the major group 1 of ISCO–88 and ISCO–08 can be used as a proxy and the indicator would then refer only to total management (including junior management) (ILO, 2020).

### Indicator 6.4.1: change in water-use efficiency over time (for mining, industry, manufacturing, electricity and constructions (MIMEC) sector only)

$$I_{6.4.1} = WUE = A_{we} \times P_A + M_{we} \times P_M + S_{we} \times P_S$$

where:

- WUE = water-use efficiency (USD/$m^3$)
- $A_{we}$ = irrigated agriculture water-use efficiency (USD/$m^3$)
- $M_{we}$ = MIMEC water-use efficiency (USD/$m^3$)
- $S_{we}$ = services water-use efficiency (USD/$m^3$)
- $P_A$ = proportion of water used by the agricultural sector over the total use
- $P_M$ = proportion of water used by the MIMEC sector over the total use
- $P_S$ = proportion of water used by the service sector over the total use.

**Note:**
Since EX-ACT VC currently does not account for water used by the agricultural or service sectors, the equations will not be expanded and are set to 0 and $P_m$ is equal to 1. The resulting estimated WUE of the current scenario is compared to the estimated WUE for the planned scenario.

### MIMEC water-use efficiency (including power production):

$$M_{we} = \frac{GVA_m}{V_m}$$

where:

- $M_{we}$ = MIMEC water-use efficiency (USD/m³)
- $GVA_m$ = gross value added by MIMEC (including energy) (USD)
- $V_m$ = volume of water used by MIMEC (including energy) (m³).

$V_m$ includes water from renewable freshwater resources, as well as over-abstraction of renewable groundwater or abstraction of fossil groundwater and use of desalinated water or direct use of (treated) wastewater. This definition refers to self-supplied industries not connected to the public water supply networks. If connected to such networks, water used for MIMEC sector may be included in the services water-use, unless disaggregated data are available. Water-use for this sector should include the losses for evaporation from artificial lakes used for hydropower production[6]. On the contrary, this sector does not include water used for powering the hydroelectric turbines, as such water is immediately returned to the riverbed (FAO, 2019c).

### Indicator 9.4.1: $CO_2$ emission per unit of value added (manufacturing sector)

$$I_{9.4.1} = \frac{MCO_2}{MVA}$$

where:

- $MCO_2$ = total $CO_2$ emissions from manufacturing (in tonnes) activities within EX-ACT VC assessment
- MVA = total Value Added from manufacturing activities (in USD) within EX-ACT VC assessment.

**Note:**
$CO_2$ emissions resulting from energy used for transport by industry should not be included. The EX-ACT VC tool accounts only for the food and tobacco sector (ISIC Divisions 10 to 12).

### Indicator 12.3.1: adjusted global food loss index

EX-ACT VC is in line with the approach developed by FAO to calculate food loss. It is a simplified process to standardize losses and aggregate losses along the supply chain to obtain the overall percentage of production that does not reach the retail stage.

The methodology to track this indicator is the same that we discuss in Section 2.2.2. The EX-ACT VC uses the functional analysis module (see Section 3.1) as a reference of the quantity (tonnes) and the percentages of losses at different stages (e.g. transport, storage, etc.) and compares the food loss for the current and planned scenarios (FAO, 2019d; Fabi and English, 2018).

[6] More information can be found in Evaporation from artificial lakes and reservoirs (FAO, 2015; Lehner *et al.*, 2011).

# PART 3. Step-by-step instructions

This section provides a step-by-step overview of the tool, guiding the user through the structure of the
This section provides a step-by-step overview of the tool, guiding the user through the structure of the
tool, its different modules, the data requirements, and instructions for data entry to complete a value chain assessment using the tool.

The tool is organized into three different modules for data entry: 1) functional analysis; 2) GHG assessment; 3) socioeconomic assessment; and two modules for results visualization: 1) results – environmental and 2) results – socioeconomic. Additionally, the tool includes a "Help" tab that provides module-wise guidance and links to common data resources that the user can access. Throughout the tool layout, the user will find Help icons to click on ( Help ), indicating the availability of additional guidance on data entry.

The tool follows a sequential structure based on the general methodology described in Part 2. It begins with identifying and mapping actors and flows of the value chain and quantifying physical flows of the commodity in the "Functional analysis" module. Next, it collects data on activities that generate GHG emissions in the "GHG assessment" module. Finally it gathers data on costs, revenues, employment, and other socioeconomic variables in the "Socioeconomic assessment" module.

The tool also follows colour codes to guide the user in filling in the required cells, as follows:

- white cells indicate that data input is required from the user;
- light green cells highlight mandatory data requirements;
- light-grey cells do not require any action from the user;
- darker-grey cells indicate that data is automatically retrieved by the tool, hence no action is required.

## 3.1 Functional analysis module

The "Functional analysis" module is the backbone of the analysis, upon which subsequent modules will build to complete the assessment. Users must fill out this module before proceeding to compile the other two modules. In contrast, the GHG and socioeconomic assessment modules are independent of each other.

### Description of project

This table allows users to report key project information for their own personal records, specifically – username and date of analysis, project name, code, budget and status of the project, funding and implementing agencies (see **Figure 8**).

**Figure 8. Description of project**

| Description of Project | |
|---|---|
| **User Name** | Test User |
| **Date** | 2/2/2023 |
| **Project Name** | **Project Name** |
| **Project Code** | NA |
| **Project Budget** | NA |
| **Funding Agency** | NA |
| **Implementing Agency** | NA |
| **Project Status** | Design |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

### Step 1.1a – Description of value chain

Step 1.1a asks for key information about the value chain that will be analysed. Users must specify the general type of product at the origin of the value chain and have the option to define the specific *initial* and *end* products being studied. Users must also select whether the value chain has a domestic or international scope and define its geographic location (see **Figure 9**, panel a).

### Step 1.1b – Defining scenarios

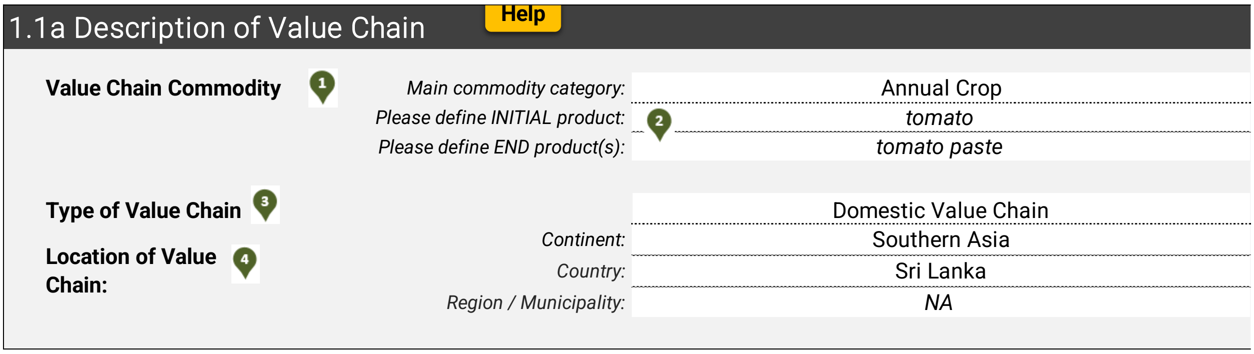
Users have the option to specify the reference years analysed for the current and planned scenarios (see **Figure 9**, panel a). **Note:** Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. EX-Ante *Carbon-balance Tool for Value Chains (EX-ACT VC). Version* 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

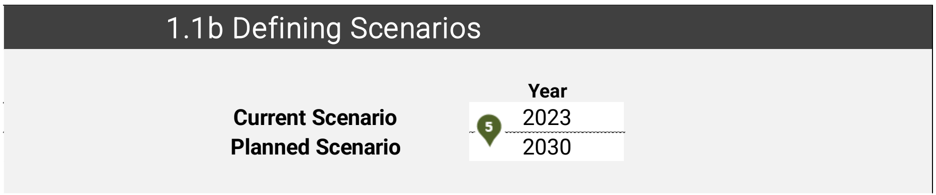
Table 13 provides detailed instructions on how to organize and enter information in Steps 1.1.a and 1.1.b.

**Figure 9. Step 1.1 – Description of value chain and defining scenarios**

a. Step 1.1a




b. Step 1.1b




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 13. Step 1.1 – Instructions**

| | | |
|---|---|---|
| 1 | **Value chain commodity**<br>**Main commodity category** | Users select from the drop-down list. The tool allows selection from annual crop, perennial crop, flooded rice, milk, meat and fish. This will automatically change the units in the tool to correspond to the commodity selected. |
| 2 | **Please define INITIAL/ END product** | (Optional) Users can also specify the initial and the end product analysed. Example: wheat (initial) and flour (end). |
| 3 | **Type of value chain** | Users select from the drop-down list whether the value chain analysed remains within country's boundaries (domestic) or involves import-export activities (international). This will prompt a block of cells to pop up in Step 1.2 in case "international" is selected, aimed at describing the location of value chain actors. |
| 4 | **Location (continent, country, region/municipality)** | This refers to the geographical area where the project is taking place. Users select continent and country from the drop-down list, while they may enter more specific geographic information in the corresponding cells of region/municipality. |

| | | |
|---|---|---|
| 5 | **Current scenario** | (Optional) Users may specify the year for current scenario. This is the reference/baseline situation; "without-project scenario"; "before". |
| | **Planned scenario** | (Optional) Users may specify the year for planned scenario. This is the situation with foreseen interventions; "with-project" scenario; "after". |

Source: Authors' own elaboration.

## Step 1.2 – Identifying value chain actors

Step 1.2 allows users to identify the different actors participating the value chain, within the boundaries of the analysis. This step is crucial as subsequent modules rely on it to complete the assessment. Users must identify and list the main categories of actors along the agrifood VC. The tool distinguishes between primary producers and non-primary producers (see Box 4). Users must then report the number of actors within each category of actor (see **Figure 10**).

If users wish to specify the share of women and youth in each category, they should select "Yes" in response to the related question. This action will reveal an additional table section, enabling the calculation of the number of women and youth *owners* (please read Part 2 for more details on indicators). Users are then required to put the corresponding percentage of women and youth, as applicable, for both scenarios.

In the case of international value chains, another block of cells will appear in this section, prompting users to specify the location (at country level) of each category of actor identified.

**Table 14** provides instructions for compiling Step 1.2. **Box 4** provides some guidelines on categorization of actors.

### Box 4. Step 1.2 – identifying and listing actors

- The categories of actors must be listed as per the sequential order of the commodity flow, beginning with the category(s) of actors involved in primary production.
- The first three categories of actors (A, B, C) in the tool are characterized as primary producers. This is to allow the users account for any heterogeneities associated with primary producers. Accordingly, the user should list in rows corresponding to actor A, B and C data related to primary producers only.
- If the users identify only one category of primary producers as actor A, they must list the next actors from categories D to I, leaving the rows corresponding to actor B and C empty.
- The actors from categories D to I do not perform any primary production activity.

Source: Authors' own elaboration.

**Figure 10. Step 1.2 – Identifying value chain actors**

**a. Naming categories of actors and quantifying actors within each category**

1.2 Identifying Value Chain Actors **Help**

**Please identify, define and quantify the categories of actors that will be analysed.**
*If you also want to specify the share (%) of women and youth (15-24 years) within each category, please select "Yes":*

| *Category of Actors:* | ❶ **Please Name Category** | ❷ **Number of Actors within Category** | |
|---|---|---|---|
| | | **Current** | **Planned** |
| **Primary Producers** | | | |
| Category A: | Small-Scale Tomato Farmers | 1,000 | 1,000 |
| Category B: | Medium-Scale Tomato Farmers | 200 | 200 |
| Category C: | | | |
| **Non-Primary Producers** | | | |
| Category D | Wholesalers | 50 | 50 |
| Category E: | Processors | 10 | 10 |
| Category F: | | | |
| Category G: | | | |
| Category H: | | | |
| Category I: | | | |

**b. Specifying the number of women and youth in each category, and location of category (in case of international value chain)**

❻ *What is a 'CATEGORY of ACTORS' in EX-ACT VC?*

Yes

| ❸ **% Women** | | ❹ **% Youth** | | ❺ **Location** |
|---|---|---|---|---|
| **Current** | **Planned** | **Current** | **Planned** | |
| 50% | 50% | 20% | 20% | Please select country |
| 30% | 30% | 0% | 0% | Please select country |
| 0% | 0% | 0% | 0% | Please select country |
| 60% | 60% | 30% | 30% | Please select country |
| 50% | 50% | 10% | 10% | Please select country |
| 0% | 0% | 0% | 0% | Please select country |
| 0% | 0% | 0% | 0% | Please select country |
| 0% | 0% | 0% | 0% | Please select country |
| 0% | 0% | 0% | 0% | Please select country |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 14. Step 2 – instructions**

| | | |
|---|---|---|
| 1 | **Please name category** | MANDATORY. Users must enter a name of the category of actors identified, as best fits the analysis. If the cell remains blank, the tool will assume that a category of actor does not exist and turns the row grey. Refer to Box 4 for additional instructions on arranging data in this section. Additionally, users must enter categories in sequential order of the commodity flow. Categories from A to C are involved in primary production. |
| | | "Category of actors" definition: a group of individuals (households/firms/etc.) that perform the same activities within the value chain and have consistent characteristics, such as scale of operation, gender, geographic location, program participation. |
| 2 | **Number of actors within category** | MANDATORY. Users must specify the number of individual actors who make up the category identified in the agrifood VC. For example, if there are 100 farmers who fit the description of "small-scale producer", then users would enter 100. The number of actors must be entered for both the current and planned scenario (even reporting zero e.g. in case a new category of actors emerges in planned scenario). |
| 3 | **% Women** | Users may also specify the share of women within each actor typology/category. |
| 4 | **% Youth** | Users may also specify the share of youth within each actor typology/category. Youth refer to people in the age range of 15-24 inclusive. |
| 5 | **Location** | Users may specify the location (country) of each category of actors, if the value chain analysed is international. |
| 6 | **What is a "CATEGORY OF ACTORS" in EX-ACT VC?** | By clicking on this banner, the tool directs you to the Help tab where a description of "category of actors" means in EX-ACT VC and provides some guidance on how to define it. |

Source: Authors' own elaboration.

## Step 1.3 – Quantifying primary production

Step 1.3 directs users to report data on primary production: production quantity and main input used for production. The tool will automatically calculate the yield (only for reporting purposes) (see **Figure 11**).

If no actors engaged in primary production activities are identified e.g. the analysis only concerns actors downstream, post-primary production, the initial quantity of commodity must still be reported in this section. In such cases, it will be regarded as the amount purchased rather than the amount produced. This may entail the creation of an ad hoc specific category of actors from whom the first analysed category of actor purchases.

Inputs in this step are crucial to quantify the amount of commodity at the origin of the agrifood VC and to track its physical flow across actors and activities in subsequent sections. **Table 15** shows Step 1.3 compilation instructions.

**Table 15. Step 1.3 – Instructions**

| | | |
|---|---|---|
| 1 | **Production quantity** | MANDATORY. Users must enter the total amount of primary agriculture product harvested/produced per year by the entire category of actors, within the value chain (e.g. multiply total production by two if there are two production cycles within a year). Values must be entered for both current and planned scenarios.<br>Depending on the type of commodity selected in Step 1.1a (e.g. annual crop, milk, etc.), the tool will adapt units of measure accordingly. |
| 2 | **Land/animals used for production** | OPTIONAL. Users may enter the total amount of land (in hectares), livestock (in heads), fish (in catch/tonnes landed) directly used to produce the total amount harvested/produced. The value must be per year and for the category of actors as a whole. |

| | | |
|---|---|---|
| 3 | **Yield** | *No action required*. The tool will automatically calculate the average yield given the total production and total amount of land/animals used for production. |
| 4 | ***Is this a small-scale actor?*** | Users may select yes or no from the drop-down list, to define if the corresponding category of actor is to be considered as a “small-scale” producer by the tool. If users are unsure about the definition of small-scale producers, they are encouraged to use the Help tab, or the Glossary provided in these guidelines. |

Source: Authors’ own elaboration.

## Step 1.4 – Value chain mapping

Step 1.4 allows the user to map the flows of the commodity throughout the value chain – defining whom each actor is *selling to*. Together with Step 1.2 – Identifying Value Chain Actors, and Step 1.3 – Quantifying Primary Production, it is a building block for the tool, upon which subsequent modules will build to complete the assessment.

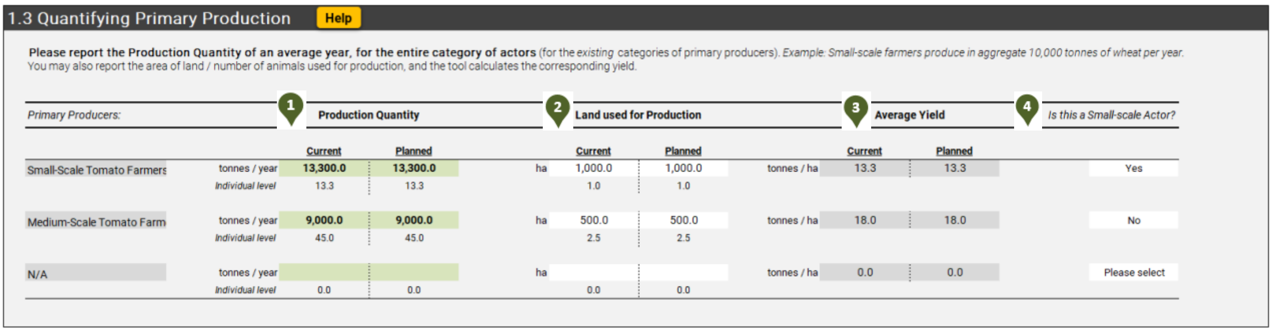
Value chain mapping is organized in a matrix, where the categories of actors “selling to” are displayed horizontally, and the categories of actors as “recipients” of the commodity vertically. The user defines the flows by directly entering the value (in percentage terms) of the commodity that is selling to actors downstream. There are two separate matrixes for the current and planned scenarios. The row total for each category must equal to 100 percent.

For primary producers, the percentage of production that goes for self-consumption can also be defined, and the row total must include that share as well. Moreover, primary producers are allowed to sell to non-producers directly (category D onwards) (no sale between primary producers can happen).

Users can also specify for each category the percentage of commodity that goes to “Other actors” – that is outside the scope of the value chain analysed, or to the End market.

**Figure 12** presents how the matrix for value chain mapping appears, while **Table 16** describes how to report data.

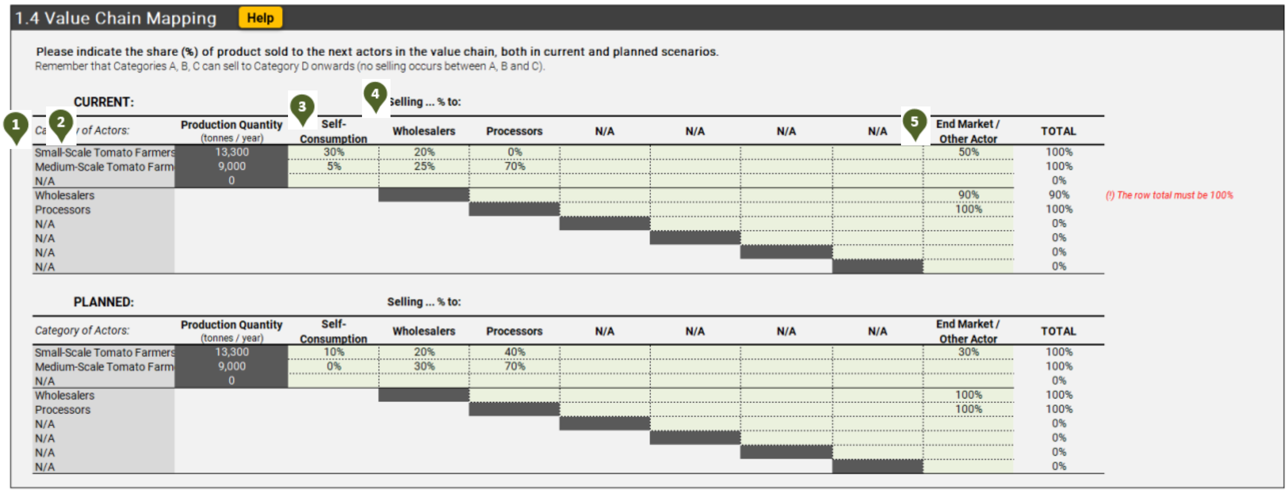
### Figure 11. Step 1.3 – Quantifying primary production




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

### Figure 12. Step 1.4 – Value chain mapping




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

### Table 16. Step 3 – instructions

| | | |
|---|---|---|
| 1 | **Category of actors:** | The names of the existing actors will appear in the first column of the matrix, as “origin” of the flow of commodity. The rows for non-existing actors will automatically display N/A. |
| 2 | **Production quantity** | The tool retrieves from data inputted in the previous step the amount of primary product harvested/produced, by categories (A, B, C) which correspond to primary producers. No action required. Only for easy reference. |
| 3 | **Self-consumption** | This block of cells appears only for categories (A, B, C) which correspond to primary producers. In case an actor self-consumes part of its production, the user should enter the percentage of the amount harvested which is not marketed, but kept for home-consumption. |
| 4 | **Selling … % to:** | MANDATORY. The names of the existing actors will appear in the top row of the matrix, as “destinations” of the flow of commodity. For each category identified, users have to report the share of the product sold that is sold to the next actor(s) in the chain. The row total must be 100 percent. An error message (see the figure) in red will pop up otherwise. |
| 5 | **End market/other actor** | Users may also indicate the share of product that goes to the end market, or to another actor outside the boundaries of the analysis. |

Source: Authors’ own elaboration.

## Step 1.5 – Quantifying food losses

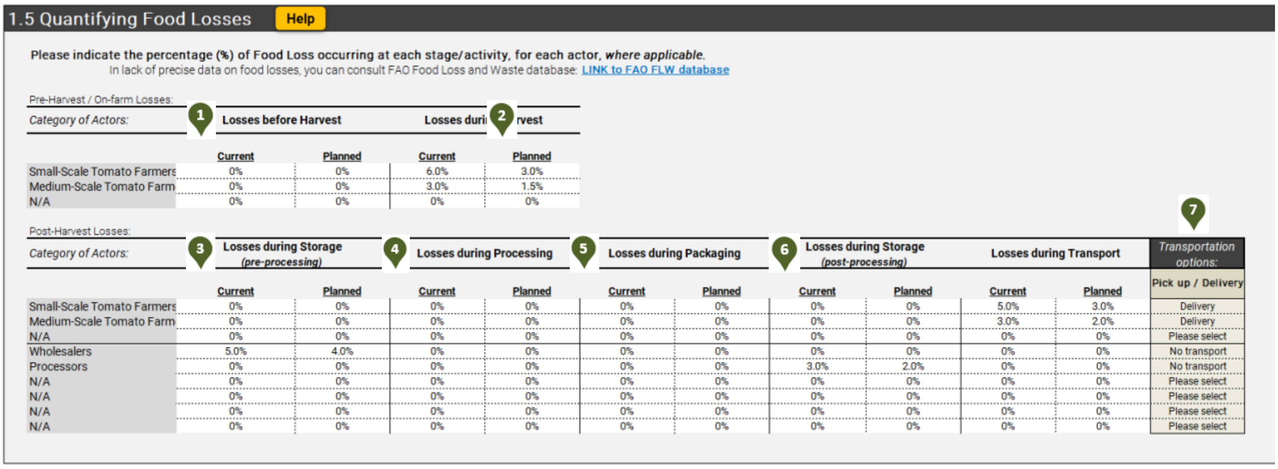
Step 1.5 aims at reporting the percentages of food loss along the value chain, for each category and activity, in order to properly define the quantities of the commodity flows along the chain.

It allows reporting pre-harvest and on-farm losses for primary producers only, and post-harvest losses for all categories: losses during storage (pre- and post-processing), losses during processing, losses during packaging, and losses during transport.

Next to the “Losses during transport” column, there is a section to define transport – to specify whether the actor is *picking up* the product from the previous actor(s) or *delivering* it to the next actor(s), or both, or is not engaged transportation activities. This allows to apply the percentage loss to the commodity amount at the correct stage of the chain (i.e. in case an actor is engaged in processing, there will likely be a weight change due to transformation, hence percentage losses applied to the amount picked up (not transformed) or to the amount delivered (transformed) would produce different results).

**Figure 13** presents how the section for reporting food loss percentages appears, while Table 18 describes how to report data.

**Figure 13. Step 1.5 – Quantifying food losses**



1.5 Quantifying Food Losses Help

Please indicate the percentage (%) of Food Loss occurring at each stage/activity, for each actor, *where applicable*.
In lack of precise data on food losses, you can consult FAO Food Loss and Waste database: LINK to FAO FLW database

Pre-Harvest / On-farm Losses:

| *Category of Actors:* | (1) Losses before Harvest | | (2) Losses during Harvest | |
|---|---|---|---|---|
| | Current | Planned | Current | Planned |
| Small-Scale Tomato Farmers | 0% | 0% | 6.0% | 3.0% |
| Medium-Scale Tomato Farm | 0% | 0% | 3.0% | 1.5% |
| N/A | 0% | 0% | 0% | 0% |

Post-Harvest Losses:

| *Category of Actors:* | (3) Losses during Storage *(pre-processing)* | | (4) Losses during Processing | | (5) Losses during Packaging | | (6) Losses during Storage *(post-processing)* | | Losses during Transport | | (7) *Transportation options:* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Current | Planned | Current | Planned | Current | Planned | Current | Planned | Current | Planned | Pick up / Delivery |
| Small-Scale Tomato Farmers | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 5.0% | 3.0% | Delivery |
| Medium-Scale Tomato Farm | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 3.0% | 2.0% | Delivery |
| N/A | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | Please select |
| Wholesalers | 5.0% | 4.0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | No transport |
| Processors | 0% | 0% | 0% | 0% | 0% | 0% | 3.0% | 2.0% | 0% | 0% | No transport |
| N/A | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | Please select |
| N/A | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | Please select |
| N/A | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | Please select |
| N/A | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | Please select |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 17. Step 1.5 – Definitions of food losses**

| | | |
|---|---|---|
| 1 | **Losses before harvest** | Losses from crops left unharvested – leaving crops that were ready for harvest in the field, or tilling them into the soil. |
| 2 | **Losses during harvest** | Losses during harvesting process which may be due to, for example, shattering and shedding of the grain from the ears to the ground (sorting, grading at the farm or its equivalent production site). |
| 3 | **Losses during storage** | Losses due to spoilage, pests, etc. due to, for example, inadequate storage techniques. |
| | **Pre-/post-processing** | Storage may occur both before and after the processing of the product analysed. As processing likely entails a change in the product quantity/weight, the distinction pre-/ post-processing is necessary for properly tracking the volumes of product losses. |
| 4 | **Losses during processing** | Losses that may occur during processing/product transformation. Due to machinery, techniques, etc. |
| 5 | **Losses during packaging** | Losses that may occur during packaging process. |
| 6 | **Losses during transport** | It refers to the amount lost from one actor to another during transport. |
| 7 | **Transport – Pick up vs. Delivery** | Users should select whether each actor either picks up the product from the previous actor in the chain, or delivers it to the next one, or both. This is necessary to properly track the volumes of product losses at each stage, accounting for potential product weight changes. In case the actor is not engaged in transport activities, users should select "No transport" from the dropdown list. |

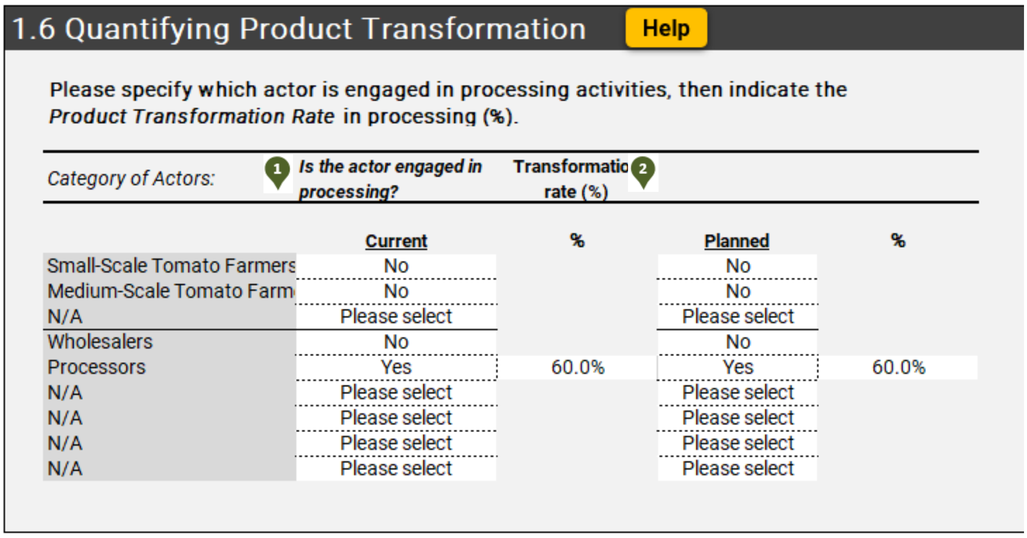
Source: Authors' own elaboration.

## Step 1.6 – Quantifying product transformation

Step 1.6 primarily aims to analyse product transformation along the chain. It requires specifying which actor is engaged in processing activities, and at indicating the product transformation rate. This allows to determine the changes in commodity weight due to transformation, and deal with proper amounts of product along the chain.

**Figure 14** presents how the section appears, while **Table 18** describes how to report data.

**Figure 14. Step 1.6 – Quantifying product transformation**



1.6 Quantifying Product Transformation **Help**

**Please specify which actor is engaged in processing activities, then indicate the *Product Transformation Rate* in processing (%).**

| *Category of Actors:* | ❶ ***Is the actor engaged in processing?*** | **Transformation rate (%)** ❷ | | |
|---|---|---|---|---|
| | **Current** | **%** | **Planned** | **%** |
| Small-Scale Tomato Farmers | No | | No | |
| Medium-Scale Tomato Farm | No | | No | |
| N/A | Please select | | Please select | |
| Wholesalers | No | | No | |
| Processors | Yes | 60.0% | Yes | 60.0% |
| N/A | Please select | | Please select | |
| N/A | Please select | | Please select | |
| N/A | Please select | | Please select | |
| N/A | Please select | | Please select | |

Note: Screenshot of the EX-ACT VC tool.

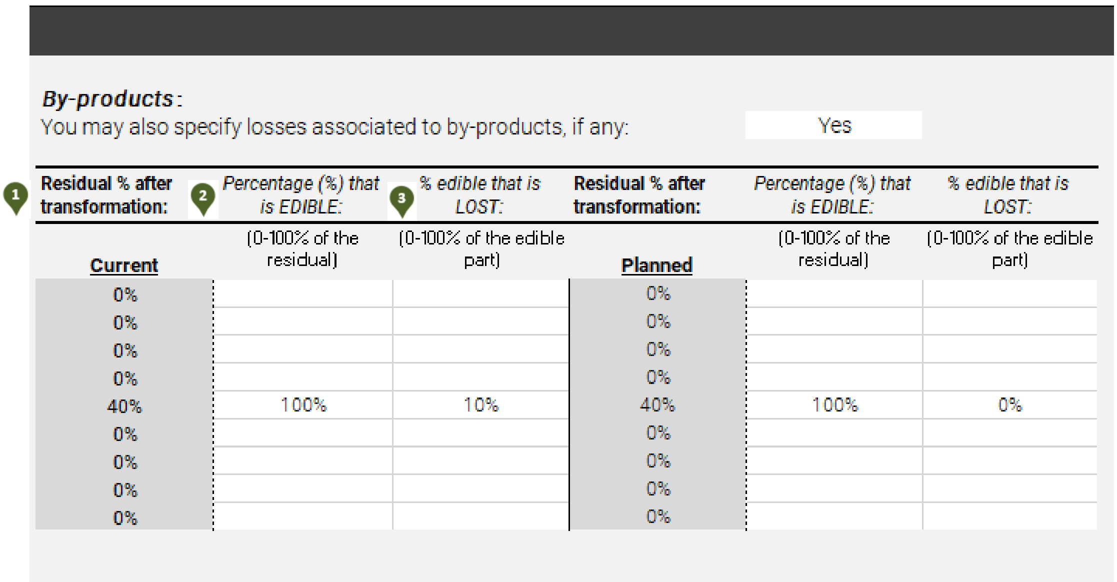
Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

| | | |
|---|---|---|
| ❶ | **Is the actor engaged in processing?** | Users are required to select "Yes/No" for both scenarios. Selecting "Yes", a cell will appear to report the corresponding transformation rate. |
| ❷ | **Transformation rate** | This refers to "how much output is obtained per unit of input". It must be reported in percentage terms. |

Source: Authors' own elaboration.

In the right-hand side of Step 1.6, users may also analyse by-product losses, which may occur during product transformation. This section is suggested only for users interested in performing complete calculations of food losses and who require this part of analysis. The tool allows to take into account the amount of edible by-product that is not used nor consumed in total food losses (**Figure 15**).

**Figure 15. Step 1.6 – By-product losses**



***By-products*:**
You may also specify losses associated to by-products, if any: Yes

| ❶ **Residual % after transformation:** | ❷ *Percentage (%) that is EDIBLE:* | ❸ *% edible that is LOST:* | **Residual % after transformation:** | *Percentage (%) that is EDIBLE:* | *% edible that is LOST:* |
|---|---|---|---|---|---|
| **Current** | (0-100% of the residual) | (0-100% of the edible part) | **Planned** | (0-100% of the residual) | (0-100% of the edible part) |
| 0% | | | 0% | | |
| 0% | | | 0% | | |
| 0% | | | 0% | | |
| 0% | | | 0% | | |
| 40% | 100% | 10% | 40% | 100% | 0% |
| 0% | | | 0% | | |
| 0% | | | 0% | | |
| 0% | | | 0% | | |
| 0% | | | 0% | | |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 18. By-product losses – Instructions**

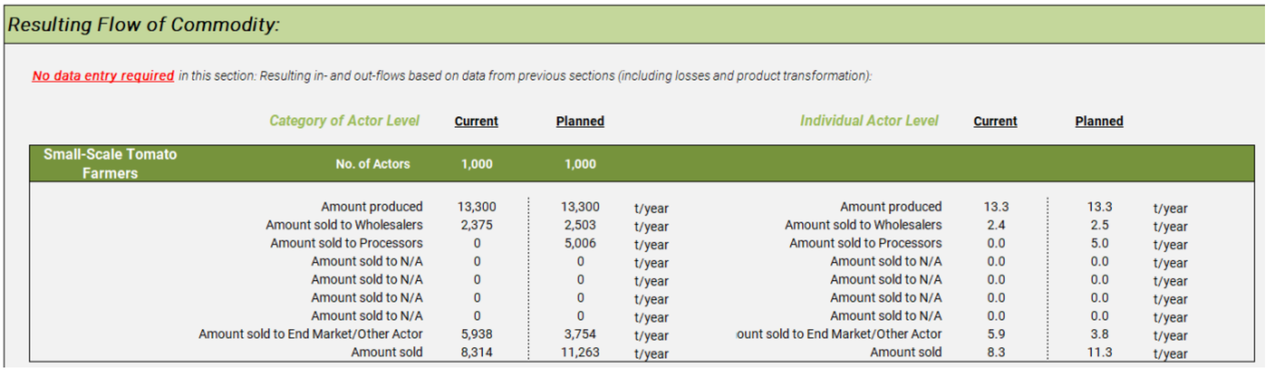
| | | |
|---|---|---|
| 1 | **Residual % after transformation** | This refers to the remaining percentage after transformation (if transformation rate is 75%, then this is equal to 25%). The tool automatically calculates it. |
| 2 | **Percentage (%) that is EDIBLE** | This refers to the share of the residual that is edible. It defines the amount of edible by-product from processing – that is the amount of secondary product derived from the production process that is edible or consumed.<br>It should be reported as a percentage in the range 0-100 of the residual. |
| 3 | **Percentage (%) edible that is LOST** | This refers to the share of the edible part that is lost. It defines the amount of edible by-product not used/consumed – that is the amount of secondary product derived from the production process that is edible yet not used or consumed and follows other destinations (e.g. landfill, discards, sewer, etc.<br>It should be reported as a percentage in the range 0-100 of the edible part. |

Source: Authors' own elaboration.

### Resulting flow of commodity

This section does not require any data entry but provides a comprehensive overview of how the commodity flows throughout the chain (**Figure 16**). It shows for each category of actors the resulting in- and out-flows based on data from previous sections (including losses and product transformation), hence it summarizes the amount produced or purchased and sold (including to whom) by each category of actors analysed. It shows these data both at the aggregate level (for the entire category), and at the individual level (for the average actor within category).

**Figure 16. Resulting flow of commodity**



*Resulting Flow of Commodity:*

*No data entry required in this section: Resulting in- and out-flows based on data from previous sections (including losses and product transformation):*

| Category of Actor Level | Current | Planned | | Individual Actor Level | Current | Planned | |
|---|---|---|---|---|---|---|---|
| **Small-Scale Tomato Farmers** No. of Actors | 1,000 | 1,000 | | | | | |
| Amount produced | 13,300 | 13,300 | t/year | Amount produced | 13.3 | 13.3 | t/year |
| Amount sold to Wholesalers | 2,375 | 2,503 | t/year | Amount sold to Wholesalers | 2.4 | 2.5 | t/year |
| Amount sold to Processors | 0 | 5,006 | t/year | Amount sold to Processors | 0.0 | 5.0 | t/year |
| Amount sold to N/A | 0 | 0 | t/year | Amount sold to N/A | 0.0 | 0.0 | t/year |
| Amount sold to N/A | 0 | 0 | t/year | Amount sold to N/A | 0.0 | 0.0 | t/year |
| Amount sold to N/A | 0 | 0 | t/year | Amount sold to N/A | 0.0 | 0.0 | t/year |
| Amount sold to N/A | 0 | 0 | t/year | Amount sold to N/A | 0.0 | 0.0 | t/year |
| Amount sold to End Market/Other Actor | 5,938 | 3,754 | t/year | ount sold to End Market/Other Actor | 5.9 | 3.8 | t/year |
| Amount sold | 8,314 | 11,263 | t/year | Amount sold | 8.3 | 11.3 | t/year |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

## 3.2 GHG emission assessment module

The "GHG Assessment" module gathers the activity data required to calculate GHG emissions originating from off-farm (post-primary production) activities. It also allows to report on-farm GHG emissions (if the agrifood VC assessment requires them), but they must be calculated elsewhere.

The module structure differs from the "Functional analysis" module. It is organized with a vertical layout for up to nine categories of actors, while it displays activities horizontally. The tool collects information on the following off-farm activities: transport, processing, packaging, and storage. Information on water use in processing is also collected, as well as on new infrastructure (buildings and roads), if any.

Every "activity block" includes the activity data required. Data can be entered for both the current and planned scenarios.

The tool makes use of Excel's conditional formatting feature to hide the sections for the non-existing categories of actors, based on user inputs in the "Functional analysis" module, automatically turning the cells into grey.

For the existing categories of actors, users should input activity data where applicable – based on the activities performed by each category. Moreover, the tool automatically retrieves the amounts handled by each category during each activity (i.e. transported/processed/packaged/stored), as follows:

- **Transportation**: the tool reports the *amounts transported* based on data entry in Step 1.5 of "Functional analysis" module, in the section "Transport options" – either the amount transported during pick-up, or during delivery, or both, or zero if no transport occurs.
- **Processing**: the tool reports the *amounts to be processed* based on the selection made in Step 1.6 in the "Functional analysis" module – for the actors for which "es" has been selected, otherwise it reports zero.
- **Packaging** and **storage**: the tool always reports the *amounts packaged* and *amounts stored*. It is in users' hands to decide whether to analyse packaging and storage based on the actual performance of that activity, or depending on data availability.

**ATTENTION**

With the exception of primary production, data must be entered **for the average actor within each category** and **on an annual basis**.

### 3.2.1 Global warming potential

In this step, users can modify the global warming potential (GWP) on the basis of the IPCC's Second (1995), Fourth (2007) or Fifth (2007) Assessment Reports (see **Figure 17**).

**Figure 17. Global warming potential**

| Global Warming Potential 100-year | |
|---|---|
| Fifth Assessment Report (AR5) | |
| CO2 | 1 |
| CH4 | 34 |
| N2O | 298 |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

### 3.2.2 Tier 2 values

Users may always enter Tier 2 values in a dedicated section to overwrite default values for emission factors and other variables. Users should click on the box Tier 2 EF to move to the Tier 2 section.

### 3.2.3 Primary production

EX-ACT VC does not calculate on-farm GHG emissions but can account for them in the total GHG emissions when provided as an input in this section. On-farm GHG emissions can be calculated by using tools such as FAO's EX-ACT (see **Box 5**) or can be derived from literature.

Users can enter the total amount of GHG emissions ($tCO_2e$-year) that are generated **by the entire category of actor** (see **Figure 18**) while producing the total quantity of product entered in Step 1.3 of the "Functional analysis" module.

**Figure 18. Primary production – GHG emissions**

2.1 PRIMARY PRODUCTION — Help

**Please report GHG emissions originating from primary production, for the entire category of actors, for one average year** *(in tCO2-e / category / year)*

*! EX-ACT VC does NOT calculate GHG emissions associated with primary production (land-based emissions).*

*Users are encouraged to use the* ***EX-ACT tool*** *to calculate emissions, and report the results in this section.*

CLICK HERE for more information

| | Small-Scale Tomato Farmers | | Medium-Scale Tomato Farmers | |
|---|---|---|---|---|
| | Current | Planned | Current | Planned |
| **Total GHG Emissions Associated with Production** *(tCO2e / year)* | 500.0 | 500.0 | 350.0 | 350.0 |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Box 5. How to retrieve data from FAO's EX-ACT tool and feed into EX-ACT VC**

If calculating primary production emissions with FAO's Ex-Ante Carbon-balance Tool (EX-ACT), users should take the results from **"Results" Tab – cells N132 and O132**:

| | | GROSS FLUXES (In $tCO_2$-e over the whole period analysis) | | | SHARE PER GHG OF THE BALANCE (In $tCO_2$-e over the whole period analysis) | | | | | AVERAGE ANNUAL EMISSIONS (In $tCO_2$-e/yr) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROJECT COMPONENTS | | WITHOUT | WITH | BALANCE | $CO_2$ BIOMASS | $CO_2$ SOIL | $N_2O$ | $CH_4$ | ALL NON-AFOLU EMISSIONS* | WITHOUT | WITH | BALANCE |
| Land use changes | Deforestation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| | Afforestation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| | Other land-use | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| Cropland | Annual | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| | Perennial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| | Flooded rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| Grasslands & Livestock | Grasslands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| | Livestock | 0 | 0 | 0 | | | 0 | 0 | | 0 | 0 | 0 |
| Forest mngt. | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| Inland wetlands | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| Coastal wetlands | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Inputs & Invest. | | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 | 0 |
| **Total emissions, $tCO_2$-e** | | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Total emissions, $tCO_2$-e/ha** | | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | | | |
| **Total emissions, $tCO_2$-e/ha/yr** | | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | | | |

Source: Authors' own elaboration.

## 3.2.4 Transportation

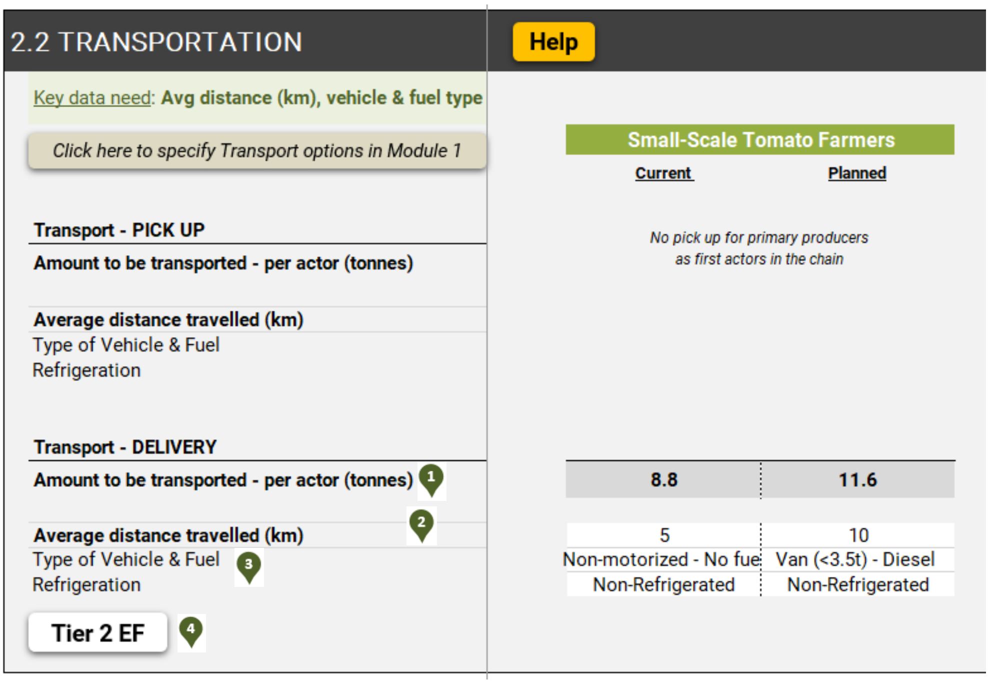
The Transportation section displays two separate parts for pick-up and delivery respectively. Based on the selection made in Step 1.5 in the "Functional analysis" module (select if transport is pick-up/delivery/both/no transport), the amount of the commodity transported will be automatically calculated, and users should fill in data only where data appear. The amount transported is reported at the individual level (for the average actor).

Users enter the distance as number of kilometres travelled between origin and destination. The number does not sum all the trips over a year. Users then must select from a drop-down list the type of fuel and vehicle used, and also choose the type of conditioning. If transport is analysed, all the data cells should be filled in.

In case the type of vehicle used is not in the list, or in case users have specific emission factors, they can fill in Tier 2 section with ad hoc data.

**Figure 19** shows how the Transportation section looks like in the tool, and **Table 19** describes how users should fill in the corresponding cells in the tool.

**Figure 19. Transportation – GHG emissions**




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 19. Transportation – Instructions**

| | | |
|---|---|---|
| 1 | **Amount to be transported** | *No action required.* The tool automatically calculates it and displays it either in the Pick-up or Delivery section, depending on the selection made in Section 1.5 in Module 1. The unit of measure is tonnes, and it is for the average actor within the category. |
| 2 | **Average distance travelled** | Users are required to input the number of kilometres (km) travelled (average distance between origin and destination, not the sum of all the trips). |
| 3 | **Type of vehicle and fuel** | Users select from a drop-down list the type of transport and fuel used. The tool allows to choose between vans/pick-ups, light-duty trucks, medium-duty trucks, heavy-duty trucks, rail, inland water, air-freight; and among fuels: gasoline, diesel, compressed natural gas (CNG), liquefied natural gas (LNG), liquefied petroleum gas (LPG), electric or kerosene. The options "Unknown" and "None" are also allowed. |
| | **Refrigeration** | Users choose from a drop-down list whether the type of conditioning is refrigerated or non-refrigerated. |
| 4 | **Tier 2 data** | User can also use the "Tier 2 EF" section (by clicking on the relative icon), to input more accurate data in relation to transportation. The user can report in the designated white cells the context-specific emission factor intensity in $tCO_2$-e/tkm. This can be specified for both the current and planned scenarios. |

Source: Authors' own elaboration.

### 3.2.5 Processing: energy use

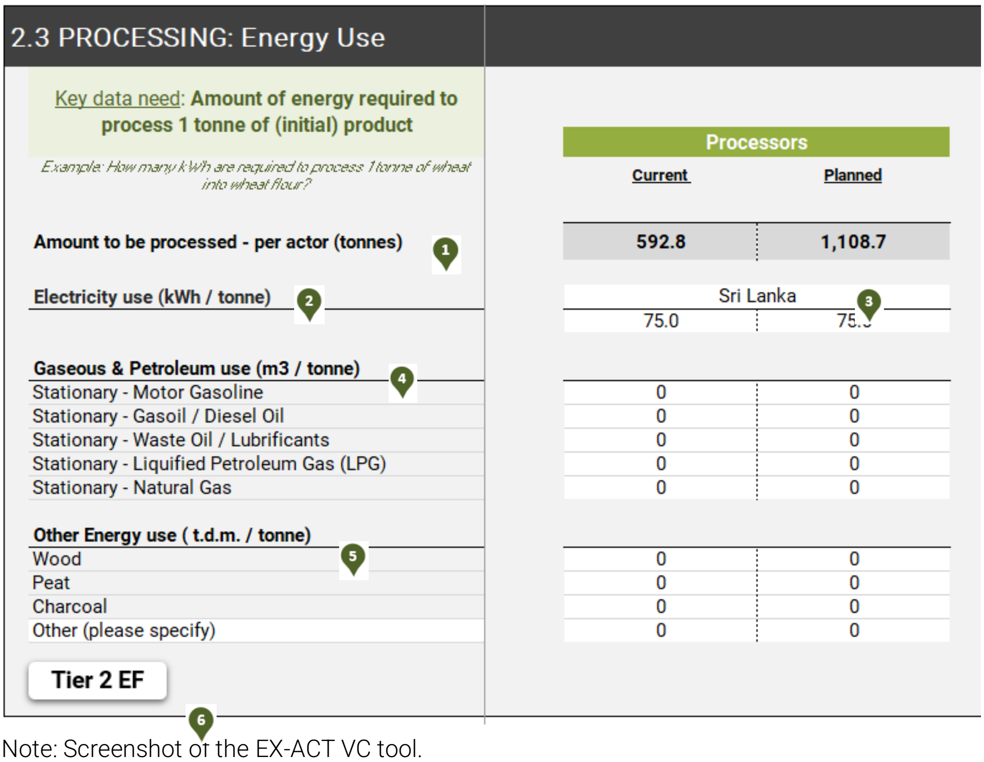
The processing section requires to enter data on the amount of energy used in processing activities. The tool automatically retrieves the amount of product to be processed, for the average individual actor within category, and on a yearly basis, based on data inputted in the "Functional analysis" module. Only for actors for which processing has been selected, this amount will appear.

The tool allows to enter data for electricity, gaseous and petroleum, other energy e.g. wood. It requires to input the amount of energy used to process one tonne of (initial) product. For electricity, the country grid must also be selected.

In case users know specific energy emission factors, they can fill in Tier 2 section with ad hoc data.

**Figure 20** shows how the Processing section looks like in the tool, while **Table 20** describes how users should fill in the corresponding cells in the tool.

**Figure 20. Processing – GHG emissions**




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 20. Processing – Instructions**

| | | |
|---|---|---|
| 1 | **Amount to be processed** | *No action required.* The tool automatically calculates it and displays it only if processing has been selected in Section 1.6 in Module 1. The unit of measure is tonnes, and it is for the average actor within the category. |
| 2 | **Electricity used** | How much electricity is required to process one tonne of initial product – in kWh per tonne |
| 3 | **Country of energy grid** | Selected from a drop-down list |
| 4 | **Fuel use – gaseous and petroleum** | How much fuel is required to process one tonne of initial product – in $m^3$/tonne of product |
| 5 | **Other energy use – solid biomass (wood, peat, charcoal)** | How much other energy is required to process one tonne of initial product – in tonnes of dry matter (tdm) |
| | **Other** | In case a power source not mentioned available above, the user can specify it with the EF |
| 6 | **Tier 2 data** | User can also use the "Tier 2 EF" section (by clicking on the relative icon), to input more accurate emission factors in relation to energy use. The user can report in the designated white cells the specific emission factors in $tCO_2$-e/MWh; $tCO_2$-e /$m^3$; $tCO_2$-e /t.d.m. This can be specified for both the current and planned scenarios. |

Source: Authors' own elaboration.

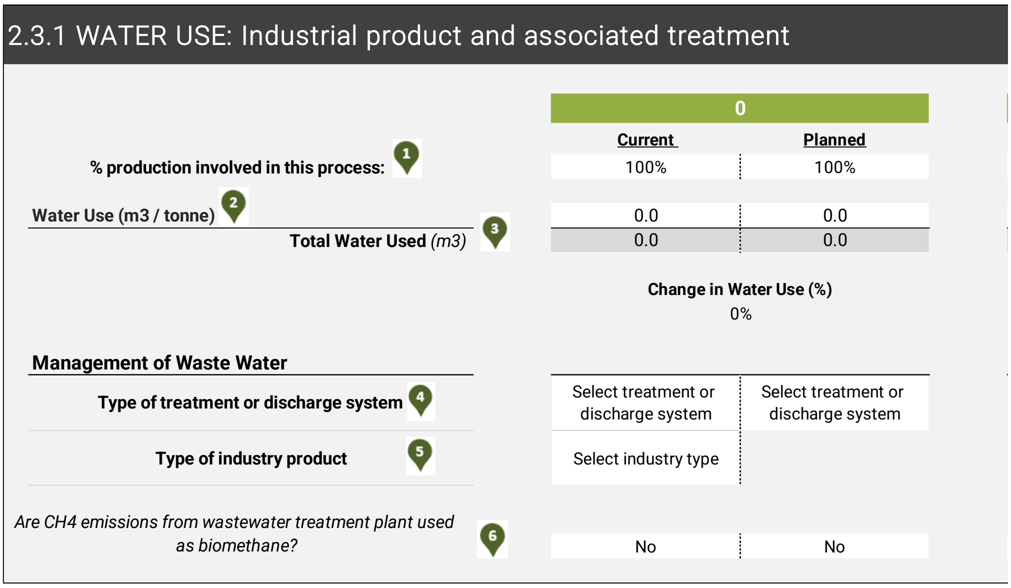
### 3.2.6 Water use: Industrial product and associated treatment

The water use section requires to enter data on the amount of water used in processing activities, and the share of the production requiring water use. The tool automatically calculates the amount of water used, for the average individual actor within category, and on a yearly basis.

If some wastewater management is foreseen, the second part of the section can be informed with the type of treatment or discharge system and the type of industry product.

**Figure 21** shows how the Water use section looks like in the tool, while **Table 21** describes how users should fill in the corresponding cells in the tool.

### Figure 21. Water use in processing – Instructions




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

### Table 21. Water use in processing – Instructions

| | | |
|---|---|---|
| 1 | **% production involved in this process** | Users should specify the share of production (i.e. of the amount processed) requiring water use. |
| 2 | **Water use** | Users should specify the amount of water used in processing per tonne of product processed – in $m^3$/tonne. |
| 3 | **Total water used** | *No action required.* The tool automatically calculates it based on the amount of product to be processed and the amount of water used per tonne of product. |
| 4 | **Type of treatment or discharge system** | Users may select the treatment or discharge system, if any, to define the management of wastewater. |
| 5 | **Type of industry product** | Users may select the type of industry product to define the management of wastewater, if applicable. |
| 6 | **Are $CH_4$ emissions from wastewater treatment plant used as biomethane?** | Users may specify whether $CH_4$ emissions from wastewater treatment plant used as biomethane, by selecting “Yes/No” from the list. By default this is set to “No”. |

Source: Authors’ own elaboration.

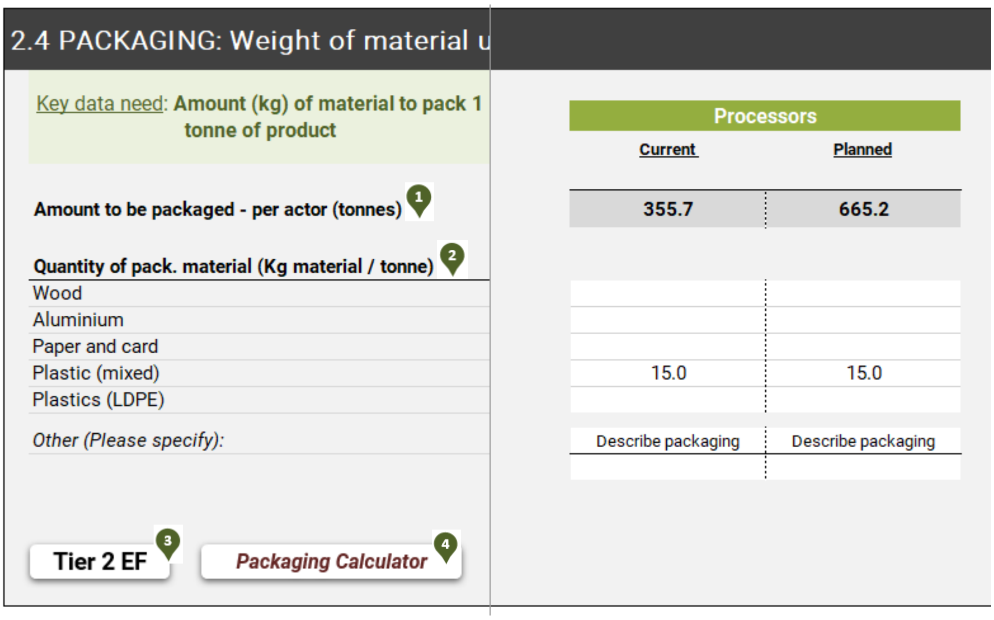
## 3.2.7 Packaging: weight of material used

The packaging section requires users to enter the amount of packaging material to pack one tonne of product, in kilograms. The tool automatically retrieves the amount to be packaged at the individual actor level, based on previous data entry in the “Functional analysis” module. In case users have specific packaging emission factors, they can fill in Tier 2 section with ad hoc data.

The Help tab also provides a “Packaging calculator” that may aid in calculating the weight of packaging material.

**Figure 22** shows how the Packaging section looks like in the tool, while **Table 22** describes how users should fill in the corresponding cells in the tool.

**Figure 22. Packaging – GHG emissions**




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 22. Packaging – Instructions**

| | | |
|---|---|---|
| 1 | **Amount to be packaged** | *No action required.* The tool automatically calculates it based on previous data entry. The amount will be always visible, and users should fill in the Packaging section if they want to analyse packaging for the analysed actor, otherwise they should keep the section blank. The unit of measure is tonnes, and it is for the average actor within the category. |
| 2 | **Quantity of packaging material** | MANDATORY ACTIVITY DATA, if users want to analyse packaging. Users are required to directly enter the quantity of packaging material in the corresponding material's row – in kilograms per tonne of product. The tool allows for wood, aluminium, paper and card, plastic (mixed), plastic (LLDPE). In case users need other types of materials, they should specify the material under the "Other" label, and report the corresponding emission factor in the Tier 2 section. |
| 3 | **Tier 2 data** | User can also use the "Tier 2 EF" section (by clicking on the relative icon), to input more accurate emission factors in relation to packaging materials. The user can report in the designated white cells the specific emission factors in $tCO_2$-e/tonne of material. This can be specified for both the current and planned scenarios. |
| 4 | **Packaging calculator** | Users may use the calculator in the "Help" tab to derive the amount of packaging material needed to pack one tonne of product. |

Source: Authors' own elaboration.

### 3.2.8 Storage: electricity use and refrigerant leakage

The storage section primarily requires inputting the amount of electricity use and refrigerant leakage, on a yearly basis, at the individual level. The tool automatically retrieves the amount to be stored at the individual actor level.

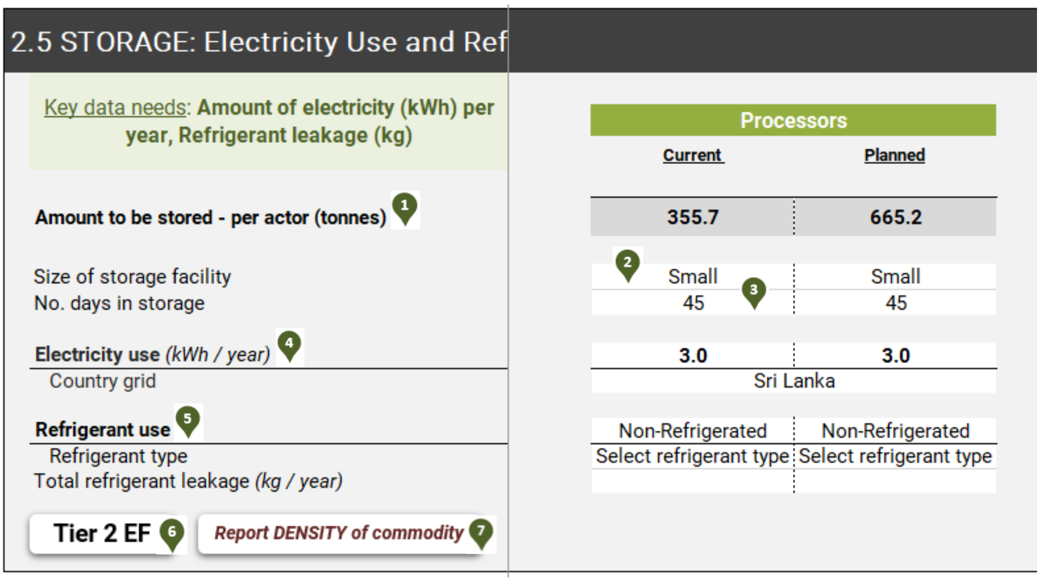
This section also requires the user to define the size of the storage facility choosing from a drop-down list, as *Small*, *Medium*, *Large* or *Very large*. Details on the corresponding volume and storage capacity corresponding to the sizes listed are reported in the Help tab to guide users in the choice.

Further, this section requires the users to report the number of days the commodity stays in storage. By default, this number is 365 days, and users may overwrite it in case of more precise data.

Depending on the commodity, users may report the density of the commodity in Tier 2 section. By default, the tool assumes a density equal to 1, however, for specific commodity categories[7] users should refine the value in the Tier 2 section.

**Figure 23** shows how the Storage section looks like in the tool, while **Table 23** describes how users should fill in the corresponding cells in the tool.

**Figure 23. Storage – GHG emissions**




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 23. Storage – Instructions**

| | | |
|---|---|---|
| 1 | **Amount to be stored** | *No action required.* The tool automatically calculates it based on previous data entry. The amount will be always visible, and users should fill in the Storage section if they want to analyse storage for the analysed actor, otherwise they should keep the section blank. The unit of measure is tonnes, and it is for the average actor within the category. |
| 2 | **Size of storage facility** | Users are required to select from a drop-down list whether the storage is *Small*, *Medium*, *Large* or *Very large*. Details on the corresponding volume and storage capacity corresponding to the sizes listed are reported in the "Help" tab to guide users in the choice. |
| 3 | **Days in storage** | Users may overwrite the number of days the commodity analysed stays in the storage, which is 365 by default in the tool. |

[7] For the following commodity classes with density significantly different from 1, users may report refined values: coffee, tea, cereals and cereal products, nuts and seeds, legumes, vegetables. Users may retrieve the values from the document at the following link: https://www.fao.org/3/ap815e/ap815e.pdf

| | | |
|---|---|---|
| 4 | **Electricity use** | MANDATORY ACTIVITY DATA, if users want to analyse storage. Users are required to report the quantity of electricity used per year for storage – in kWh/year. |
| | **Country grid** | Users are required to select the country grid from the drop-down list with countries. |
| 5 | **Refrigerant use** | Users are required to select if the storage is refrigerated or not, selecting from a drop-down list. |
| | **Refrigerant type** | Users are required to select the refrigerant type from a drop-down list, if storage is refrigerated. |
| | **Total refrigerant leakage** | MANDATORY ACTIVITY DATA, if users want to analyse refrigerated storage. Users are required to report the amount of refrigerant leakage per year – in kg/year. |
| 6 | **Tier 2 data** | User can also use the "Tier 2 EF" section (by clicking on the relative icon), to input more accurate emission factors in relation to electricity and/or GWP of refrigerants. The user can report in the designated white cells the specific emission factors in $tCO_2$-e/MWh (for electricity) and in $kgCO_2$-e/kg (for refrigerants). This can be specified for both the current and planned scenarios. |
| 7 | **Report DENSITY of commodity** | Users may specify the density of the commodity, for particular groups of commodity (by default the tool assumes density equal to 1): coffee, tea, cereals and cereal products, nuts and seeds, legumes, vegetables. Users may use the following document to source densities: https://www.fao.org/3/ap815e/ap815e.pdf |

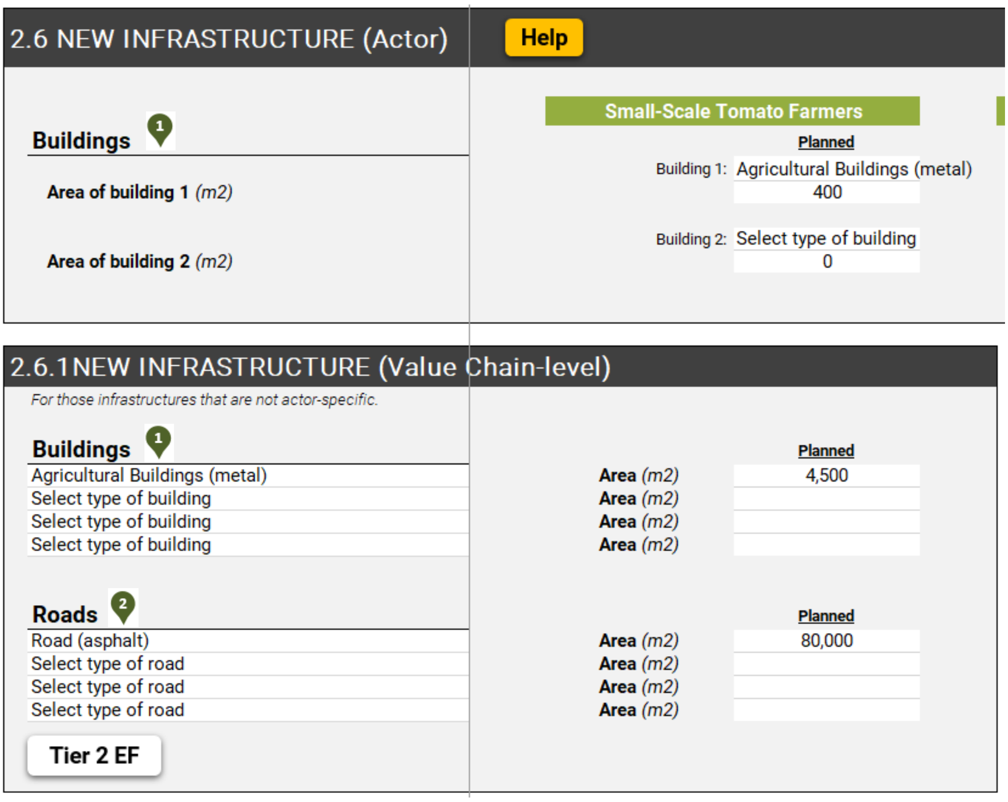
Source: Authors' own elaboration.

### 3.2.9 New infrastructure (actor-level; value chain-level)

The new infrastructure section is divided into two parts – one for infrastructure (buildings) at the actor level e.g. construction of a small storage on-farm, one for infrastructure at the value chain level e.g. construction of a regional warehouse. The latter may include both buildings and roads. The distinction is made to not attribute overall value chain emissions to a specific category of actors. Data needs are area of buildings and roads (both in $m^2$).

**Figure 24** shows how the New infrastructure section looks like in the tool, while **Table 24** describes how users should fill in the corresponding cells in the tool.

### Figure 24. New infrastructure – GHG emissions




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

### Table 24. New infrastructure – Instructions

| | | |
|---|---|---|
| 1 | **Buildings** | Users are required to select the type of building from a drop-down list, and to enter the corresponding area, in $m^2$. Up to four new buildings are allowed per actor. |
| 2 | **Roads** | Users are required to select the type of road from a drop-down list, and to enter the corresponding area, in $m^2$. This is generally derived from the *length* of new roads and average road *width*. |

Source: Authors' own elaboration.

## 3.3 Socioeconomic assessment module

The socioeconomic module collates all the information required to conduct the socioeconomic assessment to measure value created, employment generated and women and youth participation across different actors and activities along the value chain.

Similar to the "GHG assessment" module, this module includes a vertical layout for up to nine actors, while it displays costs, revenues, and employment data horizontally. Data should be entered for both the current and the planned value chain scenarios. To simplify data entry, costs, prices, taxes and salaries must be specified in local currency. Note that in the case of international value chains, the currency must reflect the country of each category of actor.

The tool makes use of Excel's conditional formatting feature to hide the sections for the non-existing categories of actors, based on user inputs in the "Functional analysis" module, automatically turning the cells into grey.

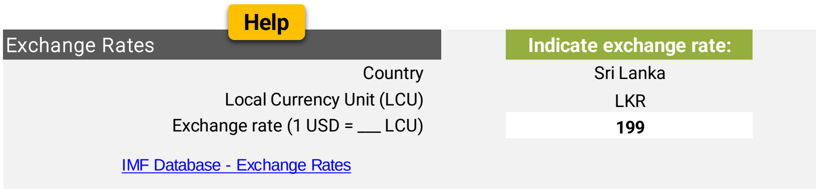
The next sections provide step-by-step guidance for the compilation of the costs, revenues, and employment data. As regards to costs, they are broken down into the following four categories: input costs, labour costs, fixed capital costs and other costs.

### 3.3.1 Exchange rates

If users are interested in visualizing the results in USD, they are required to specify the exchange rate with local currency (though data entry is always in local currency).

In case of a domestic value chain, users need to enter only one exchange rate (**Figure 25**). In case of an international value chain, a small table summarizing the local currency of each category of actors depending on their location will pop up, and users need to enter the corresponding exchange rate below.

**Figure 25. Exchange rates section (for domestic value chain)**




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

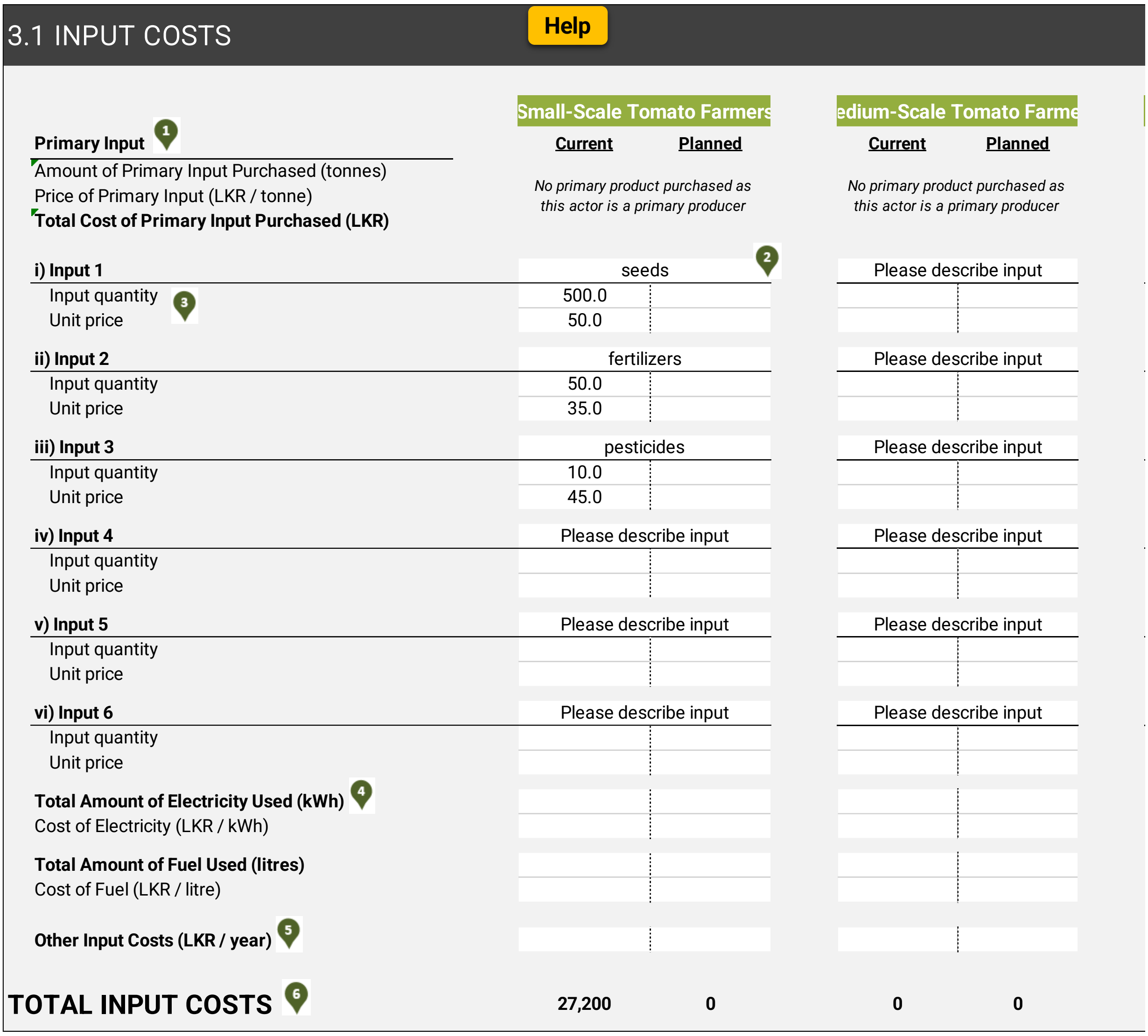
### 3.3.2 Input costs

“Input costs” are *intermediate* input costs – any goods entering the production process and totally consumed during a production period. The cost of intermediate inputs is obtained by multiplying their purchase price e.g. their price when they enter the process of production, by the amount of the corresponding inputs used. They include the cost of fertilizers, seeds, feed, packaging material, electricity, fuel, and water used, and the cost of the primary input.

Users must enter input costs for the average individual actor within each category, on an annual basis. Users may describe the input used, report the corresponding quantity used, and unit price. For non-producers categories of actors, the tool requires users to report the price of the primary input, to calculate the total cost of primary input purchased. The tool automatically calculates the amount of primary input purchased. For costs that do not fit in the available data entry cells, users may use the “Other input costs” row. Moreover, should users lack the disaggregated input costs, they may report under that row (“Other input costs”) total input costs directly.

**Figure 26** represents the Input costs section layout in the tool, while **Table 25** reports the data required to compile this section.

## Figure 26. Input costs



| 3.1 INPUT COSTS | Small-Scale Tomato Farmers | | edium-Scale Tomato Farme | |
|---|---|---|---|---|
| **Primary Input** | Current | Planned | Current | Planned |
| Amount of Primary Input Purchased (tonnes) | No primary product purchased as this actor is a primary producer | | No primary product purchased as this actor is a primary producer | |
| Price of Primary Input (LKR / tonne) | | | | |
| **Total Cost of Primary Input Purchased (LKR)** | | | | |
| **i) Input 1** | seeds | | Please describe input | |
| Input quantity | 500.0 | | | |
| Unit price | 50.0 | | | |
| **ii) Input 2** | fertilizers | | Please describe input | |
| Input quantity | 50.0 | | | |
| Unit price | 35.0 | | | |
| **iii) Input 3** | pesticides | | Please describe input | |
| Input quantity | 10.0 | | | |
| Unit price | 45.0 | | | |
| **iv) Input 4** | Please describe input | | Please describe input | |
| Input quantity | | | | |
| Unit price | | | | |
| **v) Input 5** | Please describe input | | Please describe input | |
| Input quantity | | | | |
| Unit price | | | | |
| **vi) Input 6** | Please describe input | | Please describe input | |
| Input quantity | | | | |
| Unit price | | | | |
| **Total Amount of Electricity Used (kWh)** | | | | |
| Cost of Electricity (LKR / kWh) | | | | |
| **Total Amount of Fuel Used (litres)** | | | | |
| Cost of Fuel (LKR / litre) | | | | |
| **Other Input Costs (LKR / year)** | | | | |
| **TOTAL INPUT COSTS** | 27,200 | 0 | 0 | 0 |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

## Table 25. Input costs – Instructions

| | | |
|---|---|---|
| 1 | **Amount of primary input purchased** | *No action required.* The tool automatically retrieves the amount of product purchased by each actor (at the individual actor level). This corresponds to the amount of primary input (value chain commodity analysed) an average actor is buying from the previous actor(s). |
| | **Price of primary input** | Users must enter the unit price paid to buy the primary input. |
| | **Total cost of primary input purchased** | *No action required.* The tool automatically calculates the cost of product purchased multiplying the total quantity purchased by the corresponding unit price. |
| 2 | **Please describe input** | Users should define the input (e.g. fertilizers) and report the total quantity used per individual actor per year. |
| 3 | **Input quantity** | Users must report the quantity of the input specified above used over a year. No restriction is put on the units to be reported. However, users must report consistent units for quantity and unit price. |
| | **Unit price** | Users must report the unit price of the above-mentioned input. The unit for the price must be consistent with the unit for the quantity reported above. |

| | | |
|---|---|---|
| 4 | **Total amount of electricity/fuel used** | Users may report the amount of electricity/fuel used per year. |
| | **Cost of electricity/fuel** | If the respective quantity is reported, users may report the corresponding electricity/fuel unit price. |
| 5 | **Other input costs** | Users may use this data entry cell for input costs that do not fit elsewhere. They may use this cell also to report total input costs, should they not have access to disaggregated input costs. |
| 6 | **TOTAL INPUT COSTS** | *No action required.* The tool calculates and displays the total input costs for the average actor within category. |

Source: Authors' own elaboration.

### 3.3.3 Labour costs and labour requirements

Labour costs are associated with employed labour force perceiving a salary, as opposed to the "non-remunerated (family) labour".

The tool adopts a different approach to collect data on employment and labour costs for primary producers and non-producers:

- Primary producers: the tool gathers labour requirement data in *person-day* per year. Users may define the labour activity and report the corresponding number of person-days required for that activity. The tool automatically calculates the total. Users must then report the average daily wage paid.
- Non-producers: the tool collects labour requirements in terms of number of *full-time and part-time employees*. Users may define the employee and report the corresponding number. The tool automatically calculates the total. Users must then report the average monthly wage paid to employees.

The average daily and monthly wages should refer to the salary of employees and should not take into consideration any unpaid labour.

Users may also specify the percentage of non-remunerated labour – which often reflects family labour, in order to properly calculate labour costs; and report (separately) the percentage of women and youth (15 to 24 years old inclusive) employed.

For non-producers, users may also report the number of employees in managerial position (*managers*). This number sums up to the number of full-/part-time employees already reported, for the total number of employees. Users then should report the average monthly wage for managers and may also specify the percentage of women in managerial position.

At the beginning of the Labour cost and Labour requirement section, users may also modify the default number of working days per year (250) and working days per month (21), simply overwriting the numbers that appear in the corresponding cells.

**Figure 27** shows the labour cost and requirements section, while **Table 26** summarizes general data requirements.

## Figure 27. Labour costs and labour requirements

### a. Primary producers sub-section

**3.2 LABOUR COSTS & LABOUR REQUIREMENTS** Help

| | | |
|---|---|---|
| **One Full-Time Equivalent Position:** | 1 **250** | **days** |
| Number of working days per month: | 21 | days |

| **Primary Producers** | Small-Scale Tomato Farmers | | edium-Scale Tomato Farme | |
|---|---|---|---|---|
| **Labour requirements (person-days / year)** 2 | Current | Planned | Current | Planned |
| seeding | 20.0 | | | |
| fertilizer application | 15.0 | | | |
| weeding | 15.0 | | | |
| harvesting | 30.0 | | | |
| Please define labour activity | | | | |
| Please define labour activity | | | | |
| ***Total labour requirements (person-days / year)*** | 80.0 | 0.0 | 0.0 | 0.0 |
| **% of Non-Remunerated (family) Labour** 3 | 40% | 0% | 0% | 0% |
| **% Women employed** | 20% | 0% | 0% | 0% |
| **% Youth** *(aged 15 to 24 inclusive)* 4 | 0% | 0% | 0% | 0% |
| **Average Daily Wage (LKR / person-day)** 5 | 250.0 | | | |

### b. Non-producers sub-section

| **Non-Primary Producers** | Processors | |
|---|---|---|
| **Full-Time Employees (No. Employee / year)** 6 | Current | Planned |
| workers | 5.0 | |
| electrician | 1.0 | |
| Please define employee | | |
| ***Total Full-Time Employees (No. / year)*** | 6.0 | 0.0 |
| **Part-Time Employees (No. Employee / year)** | | |
| workers | 2.0 | |
| Please define employee | | |
| Please define employee | | |
| ***Total Part-Time Employees (No. / year)*** | 2.0 | 0.0 |
| **% of Non-Remunerated Labour** | 0% | 0% |
| **% Women employed** | 0% | 0% |
| **% Youth** *(aged 15 to 24 inclusive)* | 0% | 0% |
| **Average Monthly Wage (LKR / month)** 7 | 400.0 | |
| **Managers (No. Employee / year)** | | |
| Please define employee | 1.0 | |
| Please define employee | | |
| **% Women in managerial positions** | 0% | 0% |
| **Average Monthly Wage (LKR / month)** | 650.0 | |
| | Current | Planned |
| **Other Labour Costs (LKR / year)** 8 | | |
| **TOTAL LABOUR COSTS** 9 | **34,250** | **0** |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 26. Labour costs – Instructions**

| | | |
|---|---|---|
| 1 | **One full-time equivalent position** | This refers to the number of working days over a year, on average. By default, the tool assumes that a full-time equivalent position is equivalent to working on average 250 days a year. This value (250 days) may be changed by the user if more precise information is available. |
| | **Number of working days per month** | By default, the tool assumes 21 days as the average number of working days per month. This value (21 days) may be changed by the user if more precise information is available. |
| 2 | **Primary producers – Labour requirements:** ***Number of person-days*** | The number of person-days required refers to the number of workers required per day to perform a task, e.g. 15 person-days for harvesting. Users may specify the labour activities in column C. The number should be on an annual basis. |
| 3 | **% non-remunerated labour** | It refers to the share of unpaid labour, if any. It can also be named as family labour, if not remunerated. |
| 4 | **% women** | It refers to the share of women employed. This can be specified for person-days labour requirements, full-/part-time employees, and for managers. This aims at exploring women participation along the chain. |
| | **% youth** | It refers to the share of youth employed. This can be specified for person-days labour requirements, full-/part-time employees, and for managers. This aims at exploring youth participation along the chain. |
| 5 | **Average daily wage** | This is the salary paid per day to remunerated workers – this applies to the labour requirements listed in person-days – in LCU/day. |
| 6 | **Non-producers – Labour requirements:** ***Full-time/part-time employees*** | The number of full-time/part-time workers employed per year. By default, the tool assumes part-time jobs as half of a full-time job. |
| | **Non-producers – Labour requirements:** ***Managers*** | The number of workers in managerial positions per year. |
| 7 | **Average monthly wage** | This refers to the wage/salary paid per month to remunerated workers – this applies to the labour requirements listed in full-time/part-time/managers. |
| 8 | **Other labour costs** | Users may use this data entry cell for labour costs that do not fit elsewhere. They may use this cell also to report total labour costs, should they not have access to disaggregated labour costs. |
| 9 | **TOTAL LABOUR COSTS** | *No action required.* The tool calculates and displays the total labour costs for the average actor within category. |

Source: Authors' own elaboration.

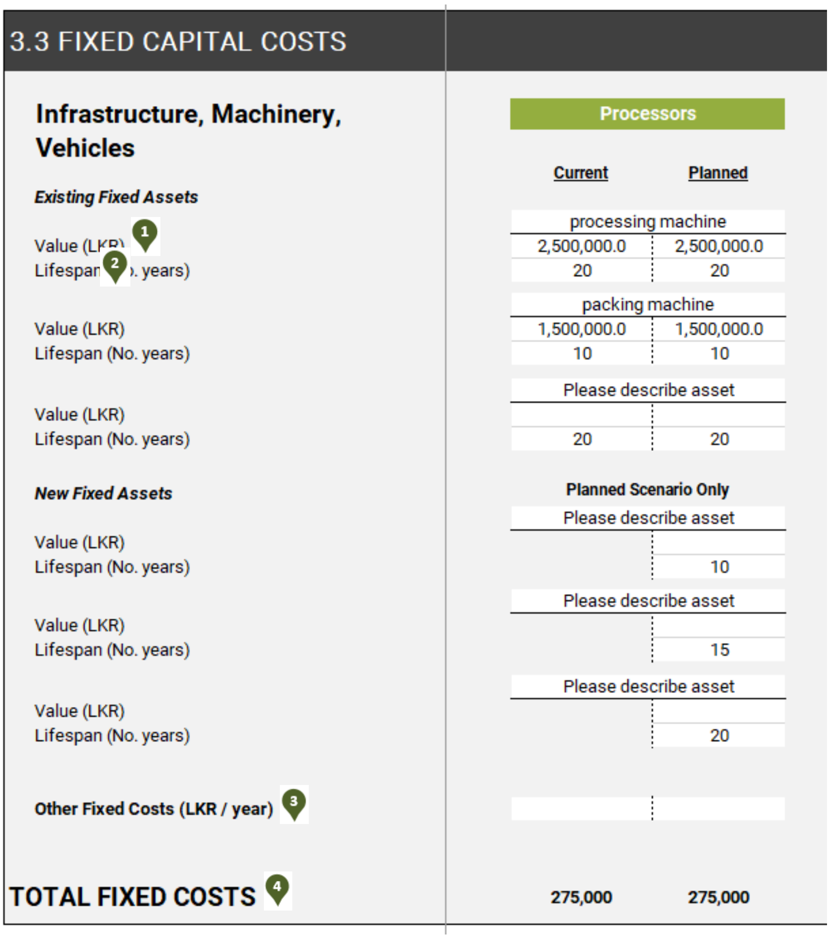
### 3.3.4 Fixed capital costs

Users are required to enter costs associated with fixed capital assets (infrastructure, machinery and vehicles) for the average actor. Fixed capital costs section is divided into two parts: existing fixed assets (for both current and planned scenarios), and new fixed assets (for the planned scenario only). **Figure 28** shows how the section appears within the tool, while **Table 27** summarizes data requirements to compile the sections.

Users should identify and describe any existing fixed capital assets of the average actor within a category. Users should specify both the value of the fixed asset (purchase price, in local currency) as well as the expected lifetime of the asset (in years). By default, the tool assumes 10/15/20 years of lifetime for assets. The user can modify these numbers (overwriting them) as needed. For existing fixed assets, information is entered once for both current and planned scenarios, while for new fixed assets, data is recorded only in the planned scenario.

Users should only enter information about fixed capital assets of the actor if the asset is directly used for activities relating to the commodity of the value chain.

**Figure 28. Fixed capital costs**




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 27. Fixed costs – Instructions**

| | | |
|---|---|---|
| 1 | **Value** | This is the total asset value (e.g. the price of a harvester). |
| 2 | **Lifespan** | The duration of this asset/the number of years this asset is providing value.<br>Assumption: the asset provides the same quantity of services in all the periods of its economic life, until it completely wears out. |
| 3 | **Other fixed costs** | Users may use this data entry cell for fixed costs that do not fit elsewhere. They may use this cell also to report total fixed costs, should they not have access to disaggregated fixed costs. |
| 4 | **TOTAL LABOUR COSTS** | *No action required.* The tool calculates and displays the total fixed costs for the average actor within category. |

Source: Authors' own elaboration.

### 3.3.5 Other annual costs

In this section, users are prompted to enter information about any other annual costs that the average actor within the category incurs.

Users may then enter other annual costs for the average actor within each category (see **Figure 29**). These include taxes paid in the year of the analysis; costs related to machinery maintenance/repair; costs related to cleaning agents; the annual cost for renting land, buildings, or equipment; the interest on loans, if any; costs related to marketing and promotion; and insurance costs. If there are other annual costs which are not mentioned in the list, users can report them under "Other (please describe)". **Table 28** provides instructions for date entry on other costs.

Users could include other annual costs related to the operation of the business, if they have a connection with the commodity of the assessed value chain.

**Figure 29. Other annual costs**

| 3.4 OTHER ANNUAL COSTS | Processors | |
|---|---|---|
| | Current | Planned |
| Taxes (1) | 15,000.0 | 15,000.0 |
| Machinery Maintence/Repair | 50,000.0 | 50,000.0 |
| Cleaning Agents (detergents, disinfectants, etc) | | |
| Rent (Land) | | |
| Rent (Buildings) | 30,000.0 | 30,000.0 |
| Rent (Equipment) | | |
| Interest on Loans | | |
| Marketing & Promotion | | |
| Insurance | | |
| Other (please describe) (2) | | |
| Other (please describe) | | |
| TOTAL OTHER COSTS (3) | 95,000 | 95,000 |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

**Table 28. Other annual costs – Instructions**

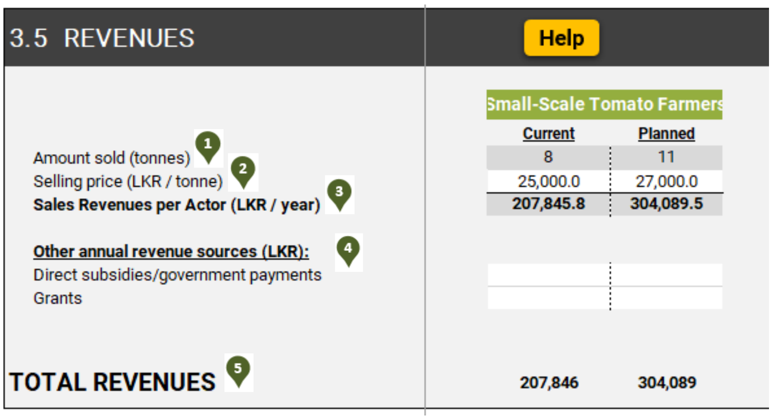
| | | |
|---|---|---|
| 1 | **[List of other costs]** | These include taxes paid in the year of the analysis; costs related to machinery maintenance/repair; costs related to cleaning agents; the annual cost for renting land, buildings, or equipment; the interest on loans, if any; costs related to marketing and promotion; and insurance costs. |
| 2 | **Other costs** | Users may use this data entry cell for other annual costs that do not fit elsewhere. They may use this cell also to report total other costs, should they not have access to disaggregated other annual costs. |
| 3 | **TOTAL OTHER COSTS** | *No action required.* The tool calculates and displays the total other annual costs for the average actor within category. |

Source: Authors' own elaboration.

### 3.3.6 Revenues

In this section the user must enter the price at which every average actor sells the product to the next one in the value chain (e.g. a selling price) (see **Figure 30**). Users may also enter any annual subsidies or grants that are associated with the production of the commodity for the average actor, if applicable.

## Figure 30. Prices and subsidies in the revenues section




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

## Table 29. Prices and subsidies – Instructions

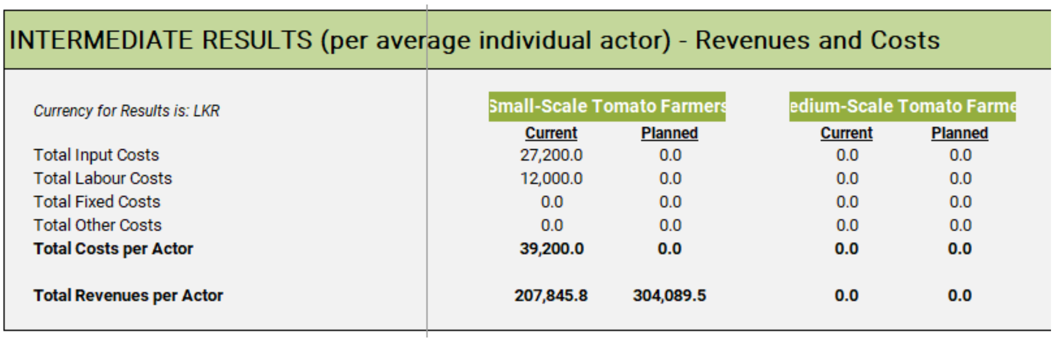
| | | |
|---|---|---|
| 1 | **Amount sold** | *No action required.* The tool automatically retrieves the amount sold to the next actor(s) in the value chain based on previous data entry – for the average individual actor on an annual basis. |
| 2 | **Selling price** | Users must enter the selling price that is the price at which the actor offers the product for sale to the next actor. |
| 3 | **Sales revenues per actor** | No action required. The tool calculates and displays the revenues from selling the commodity at the indicated price. |
| 4 | **Other annual revenue sources** | Users may enter additional sources of revenue; in case the actor receives subsidies or government payments in relation with the commodity of the analysed value chain. |
| 5 | **TOTAL REVENUES** | *No action required.* The tool calculates and displays the total revenues for the average actor within category. |

Source: Authors' own elaboration.

### 3.3.7 Intermediate results

The tool aggregates all the input and labour costs, fixed costs, other costs, and revenues to calculate and display the total costs and total revenues per actor, on an annual basis.

## Figure 31. Intermediate results




Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

# PART 4. Interpretation of the results

This section discusses the different results generated by the EX-ACT VC tool, which are organized under two modules – the first module summarizes estimated environmental indicators, while the second presents the calculated socioeconomic indicators. This section also explains how to interpret the results of different indicators and how they can be used in design or evaluation of a value chain project or policy.

## 4.1 Environmental results

The "Environmental results" module summarises the environmental indicators estimated by the EX-ACT VC tool, namely – GHG emissions, food loss, and water usage, under two main sections: "Main results, value chain level", and "Detailed results".

### 4.1.1 Main results, value chain-level

The "Environmental results" module begins with a summary table that presents key environmental indicators at the value chain level. This table provides a quick overview of value chain's environmental performance. The indicators reported (see **Figure 32**) are i) **total GHG emissions** – in tonnes of $CO_2$-e per year, and ii) **GHG emissions per unit of value added** – in tonnes of $CO_2$-e per unit of value added; iii) **total food loss** – in tonnes, and iv) **total value of food loss** – in LCU per year; v) **total water use** – in litres per year, and vi) **water use efficiency** – in USD per $m^3$. The results are presented for both the current and planned scenarios, highlighting the absolute change and percentage change between the two scenarios.

Three indicators (i.e. GHG emissions per unit of value added, total food loss, and water use efficiency) are flagged with the SDG marker, and the corresponding SDG indicator is displayed alongside the table.

**Figure 32. Main environmental results, value chain level**

Main Results, *Value Chain Level*

| | Current | Planned | Change | Change (%) |
|---|---|---|---|---|
| Total GHG Emissions (tCO2-e / year) | 1,303 | 3,968 | 2,665 | 205% |
| GHG Emissions per unit of Value Added (tCO2-e / VA) | 0 | 0 | 0 | 146% |
| Total Food Loss (tonnes) | 2,323 | 1,397 | -926 | -40% |
| Total Value of Food Loss (LCU / year) | 30,889,250 | 20,177,829 | -10,711,421 | -35% |
| Total Water Use (litres / year) | 0 | 0 | 0 | 0% |
| Water use efficiency (USD / m3) | - | - | - | - |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

### 4.1.2 Detailed results – GHG emissions

This section reports the total GHG emissions for the entire value chain, measured in tonnes of $CO_2$-e per year. Additionally, GHG emissions estimated for each category of actor and activity across the value chain is reported (see **Figure 33**). The results are presented for both the current and planned scenario. The tool also reflects the change between the two scenarios (both the absolute value and in percentage) which represents the net impact of GHGs that were emitted, reduced, or avoided due to a value chain project or policy.

To visually indicate the impact directionality of a project or policy, a coloured marker is placed next to the value of the change. A green marker signifies a *positive impact* of a project or policy on environment indicating a reduction in GHG emissions. A yellow marker denotes *no impact* from the project or policy on GHG emissions. And finally, a red marker indicates *negative impact* representing an increase in GHG emissions.

This information can help users identify potential entry points for subsequent interventions and investments aimed at reducing GHG emissions within the assessed value chain.

However, it is important to acknowledge certain limitations of the tool. Firstly, it employs a simple cost-effective approach that relies on activity-based calculations to quantify GHG emissions. Consequently, the accuracy of the estimations is contingent upon the quality of both the activity data and any associated emission factors. Secondly, EX-ACT VC tool does not include the calculation of emissions resulting from food loss, thereby compromising the completeness of the evaluation. The tool does not provide any explicit quantitative or qualitative assessments of uncertainty associated with the use of default emission factors. This lack of uncertainty reporting limits the understanding of potential variations in GHG emissions estimates. Furthermore, as the tool only provides an annual assessment of the agrifood VC, it is unable to capture the GHG impacts arising from any feedback loops and dynamic interactions that may occur over a specific time-period within the value chain. To enhance the accuracy of GHG emissions indicators for project or policy evaluation, users are encouraged to use Tier 2 or Tier 3 emission factors and associated activity data, whenever available.

**Figure 33. GHG emissions results, by actor and by activity**

GHG Emissions (tonnes of CO2-e)

| *Total GHG Emissions, entire Value Chain:* | 1,303 | 3,968 | | |
|---|---|---|---|---|
| ***GHG Emissions, by Category of Actor:*** | **Current** | **Planned** | **Change** | **Change (%)** |
| *A: Small-Scale Tomato Farmers* | 500 | 652 | 152 | 30% |
| *B: Medium-Scale Tomato Farmers* | 350 | 350 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *D: Wholesalers* | 15 | 18 | 2 | 15% |
| *E: Processors* | 438 | 2,949 | 2,511 | 573% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| ***GHG Emissions, by Activity:*** | **Current** | **Planned** | **Change** | **Change (%)** |
| *Primary Production* | 850 | 850 | 0 | 0% |
| *Transport* | 0 | 64 | 64 | 0% |
| *Processing* | 247 | 463 | 215 | 87% |
| *Wastewater* | 0 | 0 | 0 | 0% |
| *Packaging* | 206 | 374 | 168 | 82% |
| *Storage* | 0 | 30 | 30 | 0% |
| *New Infrastructure - Actor level* | - | 2,187 | 2,187 | 0% |
| *New Infrastructure - VC level* | - | 6,857 | 6,857 | 0% |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

## GHG emission intensity – for primary production and processing

This section reports the GHG emission intensity at primary production and processing level (**Figure 34**). The GHG emissions are reported in tonnes of $CO_2$-e per tonne of *initial* product for primary production, and in tonnes of $CO_2$-e per tonne of *final* product for processing. The results are displayed for both the current and planned scenario, along with the absolute change between the two.

Examining the GHG emission intensity provides valuable insights into the efficiency of production and processing operations and facilitates coherent comparisons with other value chain analyses. A reduction in emission intensity signifies a decline in the amount of GHG emissions generated per unit of output during production or processing activities. This reduction reflects an improvement in the efficiency of the process, resulting in fewer emissions being produced for the same level of output. Conversely, an increase in emission intensity indicates an increase in the quantity of GHG emissions generated per unit of output, which suggests a decline in the efficiency of the process, as more emissions are being produced for the same level of output.

**Figure 34. GHG emission intensity, by activity**

| *GHG Emission Intensity, by Activity:* | Current | Planned | Change |
|---|---|---|---|
| *Primary Production (tCO2e / tonne of initial product)* | 0.080 | 0.078 | -0.002 |
| *Processing (tCO2e / tonne of final product)* | 0.070 | 0.070 | 0.000 |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

## Monetary value of GHGs emitted in the value chain

The EX-ACT VC tool calculates the monetary value of total GHG emissions from the value chain multiplying the total GHG emissions by the social cost of carbon (SCC). The values are reported for both the current and planned scenario and the change between the two (see **Figure 35**).

The impact of agrifood VC project or policy is positive if the monetary value of emissions decreases, and the impact is negative if the monetary value of emissions increases. This indicator is directly influenced by the total GHG emissions derived in the environmental assessment.

The SCC is one useful tool to monetize the climate change damage avoided when agrifood VC projects or policies reduce GHG emissions. Scientists estimate the SCC using Integrated Assessment Models (IAMs) that represent our society, climate, and the way they interact. These models are inherently uncertain and incomplete, and the SCC estimates vary widely because of different assumptions these different models follow about future emissions, climate response, discount rates and damage functions (Pindyck, 2019).

The EX-ACT VC tool uses default global SCC estimates from Nordhaus (2017), but the users are encouraged to explore and enter a range of values based on several other global, regional, or country level SCC estimates where available when they wish to reflect fundamentally different future assumptions and to align the project or policies in that direction.

Despite the many uncertainties, caveats, and contention points surrounding the SCC, it still may offer an added lens through which costs associated with GHG emissions can be assessed, providing a better picture of a project or policy viability in monetary terms.

**Figure 35. Monetary value of GHGs emitted in the value chain**

| Monetary Value of GHGs emitted in the value chain | | | |
|---|---|---|---|
| Social Cost of Carbon (USD / tCO2-e) | $44.15 | | |
| | Current | Planned | Change |
| *Total Value* *(USD / tCO2-e / year)* | $57,531 | $175,183 | $117,653 |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

### 4.1.3 Detailed results – Food loss

This section displays the food loss (in tonnes) along the entire value chain and the food loss occurring at each category of actor identified (see **Figure 36**). Results are reported for both the current and planned scenario and also the comparative change between the two scenarios.

The impact of agrifood VC project or policy on the environment is positive if the food loss value decreases and the percentage of change between the two scenarios is negative.

**Figure 36. Food loss results, by actor and by activity**

| Food Losses (tonnes) | | | | |
|---|---|---|---|---|
| ***Total Food Losses, entire Value Chain:*** | 2,323 | 1,397 | | |
| ***Food Losses, by Category of Actor:*** | **Current** | **Planned** | **Change** | **Change (%)** |
| *A: Small-Scale Tomato Farmers* | 1,236 | 747 | -488 | -40% |
| *B: Medium-Scale Tomato Farmers* | 519 | 312 | -207 | -40% |
| *N/A* | 0 | 0 | 0 | 0% |
| *D: Wholesalers* | 225 | 204 | -20 | -9% |
| *E: Processors* | 344 | 133 | -211 | -61% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| ***Food Losses, by Activity:*** | **Current** | **Planned** | **Change** | **Change (%)** |
| *Primary Production* | 1,068 | 534 | -534 | -50% |
| *Transport* | 686 | 526 | -161 | -23% |
| *Processing* | 0 | 0 | 0 | 0% |
| *Wastewater* | 237 | 0 | -237 | -100% |
| *Packaging* | 0 | 0 | 0 | 0% |
| *Storage* | 331 | 337 | 6 | 2% |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

## Monetary value of food losses

In this section, the monetary value of food losses is reported for each category of actors of the value chain, based on the category's average selling price (**Figure 37**). This aims at capturing the foregone revenue from not selling the part of product that is lost instead. The impact is negative if the value increases – which may be driven either by the increase in food loss amount, or by the increase in the selling price (or both). The impact is positive if the value decreases – and users should understand which is the factor driving the change and if it is in line with (project) objectives.

**Figure 37. Monetary value of food losses**

| Monetary Value of Food Losses (LCU / year) | | | |
|---|---|---|---|
| Average Price per tonne (LCU / tonne) | | | |
| | **Current** | **Planned** | **Change** |
| *A: Small-Scale Tomato Farmers* | 30,889,250 | 20,177,829 | -10,711,421 |
| *B: Medium-Scale Tomato Farmers* | 13,488,930 | 8,744,400 | -4,744,530 |
| *N/A* | 0 | 0 | 0 |
| *D: Wholesalers* | 6,738,608 | 6,130,925 | -607,683 |
| *E: Processors* | 12,033,170 | 4,656,531 | -7,376,639 |
| *N/A* | 0 | 0 | 0 |
| *N/A* | 0 | 0 | 0 |
| *N/A* | 0 | 0 | 0 |
| *N/A* | 0 | 0 | 0 |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

### 4.1.4 Detailed results – Water usage

This section reports the water usage (in litres) for all the actors engaged in any processing activities and also per tonne of final product both for the current and planned scenario. It also disaggregates water usage by category of actor (see **Figure 38**). The user can also compare the difference in water usage from the current and the planned scenario.

The impact of agrifood VC project or policy on environment is positive if the amount of water used in absolute terms and per quantity of final output decreases. This indicator can be particularly useful for projects whose emphasis is on resource management. It is important to note here that the tool uses a simplified approach to calculate water use and does not distinguish between the types of water source (Mekonnen and Hoekstra, 2011). Users who are interested in differentiating water sources need to perform such exercise outside the scope of the EX-ACT VC tool.

**Figure 38. Water use in processing, by actor**

| Water Use in *processing* (litres) | | | | |
|---|---|---|---|---|
| ***Total Water Use in processing, entire value chain:*** | 1,613 | 2,219 | | |
| ***Water Use, per tonne of final product*** (litres / tonne) | **Current** | **Planned** | **Change** | **Change (%)** |
| | 0 | 0 | 0 | 0% |
| ***Water Use, by Category of Actor:*** | **Current** | **Planned** | **Change** | **Change (%)** |
| *A: Small-Scale Tomato Farmers* | 0 | 0 | 0 | 0% |
| *B: Medium-Scale Tomato Farmers* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *D: Wholesalers* | 0 | 0 | 0 | 0% |
| *E: Processors* | 1,613 | 2,219 | 0 | 38% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

## 4.2 Socioeconomic results

The "Socioeconomic results" module in the tool reports estimated socioeconomic indicators, under two main sections: "Main results, value chain level", and "Detailed results", per category of actor analysed.

The results will be estimated either in USD or in a local currency unit dependent on the country, based on the selection made at the beginning of the module ("Please select currency for the Results") by the user. In case of an international value chain, the currency may differ throughout the categories of actors, according to their location.

In general, the impact of an agrifood VC project or policy in terms of economic and employment dimensions is positive if each measure in **Figure 39** increases from the current scenario and the change between the current and planned scenario is positive.

Users can identify potential trade-offs between value-added and how it is being distributed among the two major production factors namely capital (total net income) and labour (wages). The relative changes in capital and labour compensation provide users insights into any inequalities arising from the agrifood VC project or policy and can help users identify entry-points for interventions. The users also have a holistic view that allows them to identify entry-points for job creation and redistribution of non-remunerated family labour. The accuracy and completeness of the socioeconomic analysis depend on the user inputs.

### 4.2.1 Main results, value chain-level

The first section of socioeconomic results shows a summary table of indicators at the value chain level (**Figure 39**), providing a quick overview of value chain socioeconomic performance. It is divided into sub-sections which aim at exploring a specific aspect of the value chain. These are i) Production and

Productivity, ii) Value-added, iii) Profitability, iv) Employment generation, v) Women participation, and vi) Youth participation. Every sub-section displays a set of indicators, each of which aims at answering to a specific question, reported in the paragraphs below.

All results are reported for the current and planned scenarios, and for the change between the two – both in absolute terms and in percentage. A coloured marker helps users to capture whether the effect of interventions is positive (green), negative (red), or neutral (yellow).

Some indicators are marked with the SDG symbol as they correspond to an SDG indicator, which is reported to the right of the main results' table. The SDG markers represent allow to show how agrifood VC project or policy aligns with progress towards achieving the corresponding SDG target. It is important to highlight that the SDG analysis is adjusted to the scope of the VC analysed and provides a partial assessment. The tool only estimates the selected SDG indicators, while it is then users' task, if interested, to compare the outcomes to the corresponding SDG target.

## Production and productivity

- Total production (of both initial product, and processed product): Does production increase with the project?
- Average yield (at primary production), and productivity (at processing): Does productivity increase with the project?

## Value-Added

- Total gross production value: Does the value of production increase with the project?
- Total gross/net value added: How much value does the value chain create for the economy?
- Share of net value added, by category of actors: What is the contribution of the actors to value creation?

## Profitability

- Profit margin, by category of actors: How profitable are value chain activities for the actors involved?

## Employment generation

- Total number of jobs created, for the entire value chain: Does the value chain create employment opportunities?
- Total number of jobs created by category of actors: How is employment distributed across the value chain?
- Share of remunerated jobs: Which type of employment opportunities are created (i.e. if remunerated)?
- Average daily wage: Which type of employment opportunities are created (i.e. if fairly remunerated)?

## Women participation

- Number of actors that are women (ownership dimension): How many women in the value chain are owners of a business?
- Number of jobs covered by women (employment dimension): Do women have access to employment opportunities in the value chain?
- Number of women in managerial position (leadership dimension): Do women have access to leadership positions?

## Youth participation

- Number of actors that are young (15–24 years old) (ownership dimension): How many young people in the value chain are owners of a business?
- Number of jobs covered by young people (employment dimension): Do young people have access to employment opportunities in the value chain?

## Figure 39. Main socioeconomic results, value chain level

**Main Results,** *Value Chain Level*

| *Production and Productivity* | Current | Planned | Change | Change (%) |
|---|---|---|---|---|
| Total Primary Production (tonnes / year) | 22,300 | 22,300 | 0 | 0% |
| Average Yield - primary product (tonnes / ha) | 14.9 | 14.9 | 0.0 | 0% |
| Total Amount Processed (tonnes / year) | 3,557 | 6,652 | 3,096 | 87% |
| Average Yield - processed product (tonnes / ha) | 0.6 | 0.6 | 0.0 | 0% |
| Production per labour unit of small-scale food producers | 2,598.1 | - | - | - |
| ***Value-Added*** | **Current** | **Planned** | **Change** | **Change (%)** |
| Total Gross Production Value (LKR / year) | 301,610,750 | 338,922,171 | 37,311,421 | 12% |
| Total Gross Value Added (LKR / year) | 274,410,750 | 338,922,171 | 64,511,421 | 24% |
| Total Net Value Added (LKR / year) | 271,660,750 | 336,172,171 | 64,511,421 | 24% |
| Share of Net Value-Added, by Category of Actors (%) | | | | |
| *A: Small-Scale Tomato Farmers* | 101% | 101% | 0% | 0% |
| *B: Medium-Scale Tomato Farmers* | 0% | 0% | 0% | 0% |
| *N/A* | 0% | 0% | 0% | 0% |
| *D: Wholesalers* | 0% | 0% | 0% | 0% |
| *E: Processors* | -1% | -1% | 0% | -19% |
| *N/A* | 0% | 0% | 0% | 0% |
| *N/A* | 0% | 0% | 0% | 0% |
| *N/A* | 0% | 0% | 0% | 0% |
| *N/A* | 0% | 0% | 0% | 0% |
| ***Profitability*** | **Current** | **Planned** | **Change** | **Change (%)** |
| Profit Margin (%) | | | | |
| *A: Small-Scale Tomato Farmers* | 126% | 111% | -15% | -12% |
| *B: Medium-Scale Tomato Farmers* | 0% | 0% | 0% | 0% |
| *N/A* | 0% | 0% | 0% | 0% |
| *D: Wholesalers* | 0% | 0% | 0% | 0% |
| *E: Processors* | 0% | 0% | 0% | 0% |
| *N/A* | 0% | 0% | 0% | 0% |
| *N/A* | 0% | 0% | 0% | 0% |
| *N/A* | 0% | 0% | 0% | 0% |
| *N/A* | 0% | 0% | 0% | 0% |
| Average Income of Small-Scale Producers | 262,411 | 338,922 | 76,511 | 29% |
| ***Employment generation*** | **Current** | **Planned** | **Change** | **Change (%)** |
| Total Number of Jobs Created (No. / year) | 470 | 0 | -470 | -100% |
| Total Number of Jobs Created by Category (No. / year) | | | | |
| *A: Small-Scale Tomato Farmers* | 320 | 0 | -320 | -100% |
| *B: Medium-Scale Tomato Farmers* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *D: Wholesalers* | 0 | 0 | 0 | 0% |
| *E: Processors* | 150 | 0 | -150 | -100% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| *N/A* | 0 | 0 | 0 | 0% |
| Share of Remunerated Jobs (%) | 73% | 0% | -73% | -100% |
| Average Daily Wage - Primary production (LKR / year) | 41.7 | 0.0 | -41.7 | -100% |
| Average Daily Wage - Post-primary production (LKR / year) | 8.3 | 0.0 | -8.3 | -100% |
| ***Women participation*** | **Current** | **Planned** | **Change** | **Change (%)** |
| Number of actors who are women *(Ownership)* | 595 | 595 | 0 | 0% |
| Number of women employed *(Employment)* | 64 | 0 | -64 | -100% |
| Number of women in managerial positions *(Leadership)* | 0 | 0 | 0 | 0% |
| Proportion of women in managerial positions | 0 | - | - | - |
| ***Youth participation*** | **Current** | **Planned** | **Change** | **Change (%)** |
| Number of actors who are young *(Ownership)* | 216 | 216 | 0 | 0% |
| Number of young people employed *(Employment)* | 0 | 0 | 0 | 0% |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)*. Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

## 4.2.2 Detailed results, by category of actors

This section of the socioeconomic results module details the economic and employment indicators for each category of actors identified, and displays one results "block" for each category. Results are reported both for the *individual average actor* and for the *entire category* (see **Figure 34**).

### Value added

The results in the economic analysis are categorized in terms of value added and the distribution of such value-added wealth among different production factors. The gross production value, gross value added, net value added, and net income are reported for each of the category of actor identified.

An overview of costs for each category is also shown among economic results. Input costs, labour costs, fixed costs, and other costs are reported, with the aim of identifying whether the interventions have implied some substantial (and which) cost changes. Then, the cost per tonne and net income per tonne are reported, to capture any efficiency changes, and also to enhance comparability of results with other analyses; and the selling price per tonne is displayed based on data previously entered to capture price increases/reductions.

The impact of agrifood VC project or policy in terms of economic dimension is positive if each measure in see **Figure 40** increases from the current scenario and the change between the current and planned scenario is positive.

### Employment

Employment generated within each category of actors is summarized for both current and planned scenarios as well as for the change between the two. The tool reports (see **Figure 40**): the total number of jobs created, the number of remunerated/non-remunerated (family labour) jobs, the number of jobs covered by women, and the number of jobs covered by young people. The impact of an agrifood VC project or policy on employment is positive if the number of jobs increase.

The tool also presents the average daily wage of employed workers for the current and planned scenario as well as the change between the two (see **Figure 40**). The wage reported is for the average actor. To capture whether it is fair remuneration, users may compare it with minimum wage, or other wage thresholds.

### Figure 40. Detailed results, by category of actors

Detailed Results, *by Category of Actors*

| Category A: Small-Scale Tomato Farmers | *Individual Actor* | | | *Category of Actors* | | |
|---|---|---|---|---|---|---|
| Value-Added | | | | | | |
| *Currency for results is: LKR* | **Current** | **Planned** | **Change** | **Current** | **Planned** | **Change** |
| **Gross Production Value** | 301,611 | 338,922 | 37,311 | 301,610,750 | 338,922,171 | 37,311,421 |
| **Gross Value Added** | 274,411 | 309,062 | 34,651 | 274,410,750 | 309,062,171 | 34,651,421 |
| **Net Value Added** | 268,911 | 302,062 | 33,151 | 268,910,750 | 302,062,171 | 33,151,421 |
| **Net Income** | 256,911 | 280,462 | 23,551 | 256,910,750 | 280,462,171 | 23,551,421 |
| **Input Costs** | 27,200 | 29,860 | 2,660 | 27,200,000 | 29,860,000 | 2,660,000 |
| **Labour Costs** | 12,000 | 21,600 | 9,600 | 12,000,000 | 21,600,000 | 9,600,000 |
| **Fixed Costs** | 5,500 | 7,000 | 1,500 | 5,500,000 | 7,000,000 | 1,500,000 |
| **Other Costs** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Cost per tonne** | 5,377 | 5,191 | -186 | | | |
| **Net income per tonne** | 30,902 | 24,902 | -5,999 | | | |
| **Selling price per tonne** | 0 | 0 | 0 | | | |
| Employment | | | | | | |
| | **Current** | **Planned** | **Change** | **Current** | **Planned** | **Change** |
| **Number of Jobs created** | 0.3 | 0.3 | 0.0 | 320.0 | 320.0 | 0.0 |
| Remunerated | 0.2 | 0.3 | 0.1 | 192.0 | 288.0 | 96.0 |
| Non-Remunerated | 0.1 | 0.0 | -0.1 | 128.0 | 32.0 | -96.0 |
| Jobs covered by Women | 0.1 | 0.1 | 0.0 | 64.0 | 64.0 | 0.0 |
| Jobs covered by Youth | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Average daily wage (LKR / day)** | 83.3 | 100.0 | 16.7 | | | |

Note: Screenshot of the EX-ACT VC tool.

Source: FAO. 2023. *EX-Ante Carbon-balance Tool for Value Chains (EX-ACT VC).* Version 3. Rome. [Cited 28 August 2023]. www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en

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# Glossary

| | |
|---|---|
| **Agrifood value chain** | Agrifood value chain links several people and activities to bring an agricultural commodity from production in the field to the consumer, through several stages such as processing, packaging, and distribution. Every stage of the value chain progressively creates added value that accumulates in the product until it reaches the final consumer. |
| **Carbon balance** | The carbon balance is the net balance from all greenhouse gases expressed in tonnes of carbon dioxide equivalent ($tCO_2$-e) that were emitted, avoided, or sequestered due to project implementation as compared to a business as usual scenario. |
| **Carbon footprint** | The carbon footprint of a product is the total amount of greenhouse gases emitted during production, processing, transporting, packaging, and storing the product, expressed in tonnes of carbon dioxide equivalent ($tCO_2$-e) per tonne of the product. |
| **Category of actor** | A category of actor in the value chain is defined as a type of individuals, households, farms, firms, etc., who share similar activities performed (e.g. farmers) and scale (e.g. small, medium and large). |
| **Climate change mitigation** | Climate change mitigation encompasses a set of actions and interventions to prevent, reduce or remove greenhouse gas emissions. |
| **Domestic value chain** | A domestic value chain is a production process that takes place within the boundaries of a given country. It requires producing the outputs within the country using only domestically sourced inputs. |
| **Family labour** | Family labour (or workers) are members of a family, who help each other to run an agricultural holding or other businesses and who are not formally considered as employees. |
| **Food loss** | Food loss is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retailers, food service providers and consumers. It refers to any food that is discarded, incinerated, or otherwise disposed of along the food supply chain from harvest/slaughter/catch up to, but excluding, the retail level, and does not re-enter in any other productive utilization, such as feed or seed. (FAO, 2019a). |
| **Food waste** | Food waste is the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers (FAO, 2019a). |
| **Global value chain** | Global value chains are the linked sets of value creating activities all the way from basic raw material sources for component suppliers through the ultimate end-use product delivered into the final customer's hands. All the activities involved in this process may involve foreign sourced inputs and internationally marketed outputs. |
| **Greenhouse gases** | Greenhouse gases or GHGs absorb and emit radiant energy within the thermal infrared range, causing the greenhouse effect, which results in increased temperatures on Earth. In the context of EX-ACT VC tool, GHGs are three of the six gases listed in the Kyoto Protocol: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$). |
| **Hired labour** | Hired labour are workers who are employed in both the formal and informal economy by others (such as people, organizations or enterprises who are termed employers) and receive a salary/wage as compensation for work. |
| **On-farm employment** | Employment of workforce for tasks that deal with on-farm production activities (e.g. sowing and harvesting). |

| | |
|---|---|
| **Off-farm employment** | Employment of workforce in all agriculture-related activities that occur beyond the farm, that begin with post-harvest activities and end with retailing (e.g. primary or secondary processing, packaging, transportation and distribution). |
| **Selling price** | The selling price is the price at which the value chain actor (e.g. producer, wholesaler and retailer) offers the product for sale to the next actor in the value chain. It should exceed the purchase price by the actor's marketing margin, and – if any – transportation and market charges and incidental expenses. |
| **Small-scale producer** | For the purpose of this guidelines, following FAOs relative approach (FAO, 2017) small-scale producers can be defined using two criteria: physical size of the farm as expressed by land size in hectares and total livestock heads; economic size of the farm with total revenues measured in Purchasing power parity (PPP). Small-scale producers are those falling in the bottom 40 percent of the distribution of land size, total livestock heads or total revenues measured in PPP. |
| **Social cost of carbon (SCC)** | The social cost of carbon is the estimated monetary value for the damage caused by an incremental increase (by convention, one metric tonne) of $CO_2$ emissions in a given year. Estimates of the SCC come from Integrated Assessment Models (IAMs) which aim to predict the effects of climate change under various future scenarios and assumptions and allow to estimate the monetary value of the climate change impacts. |

# Annex 1. Origins and development of EX-ACT VC

The first version of EX-ACT VC was released in 2016 and in 2020 it underwent a significant revision to increase its flexibility and comprehensiveness. The main objective of the tool remains the same: to assess environmental impacts of value chains, in terms of climate mitigation potential, including an analysis of the socioeconomic performance in terms of value added, income and jobs generated throughout the chain.

A major structural change involved the removal of the calculation of the land-based GHG emissions at the farm level (production), which was performed through the partial inclusion of the FAO's Ex-Ante Carbon-balance Tool (EX-ACT).[8] The underlying rationale was to increase the flexibility of the analysis and to foster the synergies of using both tools. Nevertheless, the revised version allows to account for the on-farm GHG emissions (e.g. from land use change or agriculture intensification, etc.), by retrieving results from separate analyses using EX-ACT or other on-farm GHG accounting tools. In this way, it is possible to account fully for land-based emission sources of the product, in addition to the emissions from off-farm stages of the value chain (e.g. from activities beyond production).

The revision involved an expansion of the scope of the socioeconomic assessment aimed at including the imbalanced power relations and participation levels between men and women, and across different age groups, in particular youth, in the agrifood value chain. These imbalances, which can take different forms, such as the access to physical capital, services, and opportunities, the control of assets, and the ability and willingness to participate in decision-making process, can affect the efficiency and competitiveness of a value chain. For these reasons, a quantitative component aimed at analysing women and youth participation along stages of the value chain was added.

Similarly, to enhance the scope of the analysis, the revision also established a link to the Sustainable Development Goals (SDGs), introducing an "SDG tracker" to track progress – at the value chain level – towards selected SDG targets. While agrifood value chains are inherently linked to many SDGs, the tool, at this stage, tracks performance towards five SDGs, namely: Zero Hunger (SDG 2); Gender Equality (SDG 5); Clean Water and Sanitation (SDG 6); Industry Innovation and Infrastructure (SDG 9); and Responsible Production and Consumption (SDG 12).

Within the objective of providing a tool with an entirely quantitative approach, the qualitative resilience component was removed. In fact, resilience by itself entails another complex system where quantitative approaches are scarce.

On the methodological side, the tool's revision aimed at increasing its flexibility, by allowing the users to map unique agrifood VCs; enhancing its comprehensiveness, by allocating environmental and socioeconomic results, both at the actor and activity level; and increasing transparency by directly showing the flow of commodity throughout the value chain.

All these modifications lead to the framework depicted in **Figure 1.**

[8] The Ex–Ante Carbon–balance Tool (EX–ACT) 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. It is a land–based accounting system, estimating carbon stock changes (e.g. 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 for the on–farm activities and the specific duration of a project.

# Annex 2. Additional information on methodological guidelines

## A.2.1 Identifying the value chain

As explained in Section 1.4 and 1.5, the EX-ACT VC tool currently allows the assessment of a single commodity or product. Therefore identifying a value chain to assess in EX-ACT VC tool will be straightforward for projects and policies dealing only with a single commodity or product. However, agrifood value chains are complex, with often a single commodity being transformed into multiple products. For projects and policies dealing with either multiple commodities or multiple products, it is necessary to identify and prioritize which commodity or product is to be analysed. The following resources can guide users in selecting value chains for EX-ACT VC assessments:

1. Guidelines for value chain selection by ILO (accessible at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/instructionalmaterial/wcms_416392.pdf).
2. Making Value Chains Work Better for the Poor by the United Kingdom of Great Britain and Northern Ireland Department for International Development (DFID) (available at: www.fao.org/3/at357e/at357e.pdf).

## A.2.2 Mapping number of actors

**Table A1. Illustrative steps to map the number of actors**

| Actor | Calculating the number of actors |
|---|---|
| **Farmers (producer)** | • Estimate number of farmers based on hectares under each crop and yield (related to traded volumes).<br>• Cross check with district authorities for official figures.<br>• Sales of key inputs sold by input providers at bottleneck points (e.g. seed). |
| **Aggregators** | • Interviews with village leaders/community.<br>• Number of aggregators under each trader/wholesaler.<br>• Estimate the total volume of sales and the typical volume per transport unit (trucks, motorbikes, carts, boats, etc.). Then estimate the number of people required per transport unit, the time required to transport and the number of full-time equivalents this generates. |
| **Processors** | • Identify the number of processors in an area from official sources (e.g. registration certificates).<br>• Identify the number of informal processors from key informant interviews such as government officials (involved in registration, tax collection, distribution of utilities, etc.), aggregators, processors, and wholesalers. |
| **Wholesalers** | • Identify the number of wholesalers in an area from official sources (e.g. registration certificates).<br>• Identify the number of informal wholesalers from key informant interviews, such as government officials (involved in registration, tax collection, and distribution of utilities etc.) processors, wholesalers and retailers. |
| **Retailers** | • Based on the total traded volume of a product in a value chain and the average daily turnover of the sample retailers, the user can calculate how many retailers are involved. |

Source: Authors' own elaboration.

# Annex 3. Country level grid emission factor

For electricity consumption, EX-ACT for VC proposes two sets of emission factors related to the energy grid following the Harmonized IFI Default Grid Factors (IFI, 2021). The default is the Operating Margin (OM) emission factor, representing electricity generation from existing power plants with the highest variable operating costs to dispatch the electricity across the system.

Users can also choose to adopt a Combined Margin (CM) emission factor, which additionally accounts for the annual emission intensities of new electricity generation projected over the next 8 years under the Stated Policy Scenario (STEPS) of the most recent IEA World Economic Outlook. As a result, CM emission factors thus take stock of projected changes in emissions of the electricity generation systems.

**Table A2. Grid emission factors, in $tCO_2$-e/MWh**

| Country | EF OM | EF CM | Country | EF OM | EF CM | Country | EF OM | EF CM |
|---|---|---|---|---|---|---|---|---|
| Afghanistan | 0.414 | 0.193 | Gabon | 0.946 | 0.533 | Oman | 0.479 | 0.320 |
| Åland Islands | N/A | 0.256 | Gambia | 0.753 | 0.591 | Pakistan | 0.592 | 0.386 |
| Alabania | N/A | 0.226 | Georgia | 0.289 | 0.135 | Palau | 0.753 | 0.497 |
| Algeria | 0.528 | 0.397 | Germany | 0.650 | 0.313 | Palestine | N/A | 0.517 |
| American Samoa | 0.753 | 0.516 | Ghana | 0.495 | 0.276 | Panama | 0.477 | 0.230 |
| Andorra | 0.188 | 0.070 | Gibraltar | 0.779 | 0.369 | Papua New Guinea | 0.597 | 0.315 |
| Angola | 1.476 | 0.748 | Greece | 0.507 | 0.346 | Paraguay | N/A | 0.00001 |
| Anguilla | 0.753 | 0.472 | Greenland | 0.264 | 0.105 | Peru | 0.473 | 0.252 |
| Antigua and Barbuda | 0.753 | 0.489 | Grenada | 0.753 | 0.523 | Philippines | 0.672 | 0.525 |
| Argentina | 0.478 | 0.288 | Guadeloupe | 0.753 | 0.433 | Pitcairn | N/A | 0.451 |
| Armenia | 0.390 | 0.205 | Guam | 0.753 | 0.428 | Poland | 0.828 | 0.532 |
| Aruba | 0.753 | 0.441 | Guatemala | 0.753 | 0.427 | Portugal | 0.389 | 0.228 |
| Australia | 0.808 | 0.421 | Guernsey | N/A | 0.256 | Puerto Rico | 0.596 | 0.362 |
| Austria | 0.242 | 0.113 | Guernsey, Bailiwick of (Sark) | N/A | 0.256 | Qatar | 0.503 | 0.258 |
| Azerbaijan | 0.534 | 0.384 | Guinea | 0.753 | 0.460 | Republic of Korea | 0.555 | 0.330 |
| Bahamas | 0.753 | 0.441 | Guinea-Bissau | 0.753 | 0.577 | Republic of Moldova | 0.541 | 0.399 |
| Bahrain | 0.726 | 0.454 | Guyana | 0.847 | 0.616 | Réunion | 0.772 | 0.421 |
| Bangladesh | 0.528 | 0.412 | Haiti | 1.048 | 0.765 | Romania | 0.489 | 0.289 |
| Barbados | 0.749 | 0.484 | Heard and McDonald Islands | N/A | 0.541 | Russian Federation | 0.476 | 0.294 |
| Belarus | 0.400 | 0.292 | Holy See | N/A | 0.256 | Rwanda | 0.712 | 0.416 |
| Belize | 0.403 | 0.183 | Honduras | 0.662 | 0.359 | Saint Barthélemy | N/A | 0.461 |
| Belgium | 0.252 | 0.124 | Hungary | 0.296 | 0.191 | Saint Helena | 0.753 | 0.456 |
| Benin | 0.745 | 0.576 | Iceland | N/A | 0.00003 | Saint Kitts and Nevis | 0.753 | 0.477 |
| Bermuda | 0.753 | 0.342 | India | 0.951 | 0.661 | Saint Lucia | 0.753 | 0.521 |

| Country | EF OM | EF CM | Country | EF OM | EF CM | Country | EF OM | EF CM |
|---|---|---|---|---|---|---|---|---|
| Bhutan | N/A | 0.388 | Indonesia | 0.783 | 0.599 | Saint Martin (French Part) | 0.753 | 0.484 |
| Bolivia (Plurinational State of) | 0.604 | 0.393 | Iran (Islamic Republic of) | 0.592 | 0.421 | Saint Pierre and Miquelon | 0.753 | 0.415 |
| Bonaire, Sint Eustatius and Saba | 0.753 | 0.400 | Iraq | 1.080 | 0.788 | Saint Vincent and the Grenadines | 0.753 | 0.499 |
| Bosnia and Herzegovina | 1.197 | 0.739 | Ireland | 0.380 | 0.189 | Samoa | 0.753 | 0.434 |
| Botswana | 1.478 | 1.070 | Isle of Man | 0.436 | 0.204 | San Marino | 0.414 | 0.224 |
| Bouvet Island | N/A | 0.290 | Israel | 0.394 | 0.258 | Sao Tome and Principe | 0.753 | 0.565 |
| Brazil | 0.284 | 0.139 | Italy | 0.414 | 0.224 | Saudi Arabia | 0.592 | 0.374 |
| British Indian Ocean Territory | N/A | 0.418 | Jamaica | 0.711 | 0.498 | Senegal | 0.870 | 0.656 |
| British Virgin Islands | N/A | 0.420 | Japan | 0.471 | 0.286 | Serbia | 1.086 | 0.678 |
| Brunei Darussalam | 0.681 | 0.407 | Jersey | N/A | 0.256 | Seychelles | 0.753 | 0.479 |
| Bulgaria | 0.911 | 0.495 | Jordan | 0.529 | 0.382 | Sierra Leone | 0.489 | 0.246 |
| Burkina Faso | 0.753 | 0.420 | Kazakhstan | 0.797 | 0.532 | Singapore | 0.379 | 0.200 |
| Burundi | 0.414 | 0.197 | Kenya | 0.574 | 0.274 | Sint Maarten (Dutch part) | 0.753 | 0.463 |
| Cabo Verde | 0.753 | 0.505 | Kiribati | 0.753 | 0.530 | Slovakia | 0.332 | 0.164 |
| Cambodia | 1.046 | 0.588 | Kuwait | 0.675 | 0.400 | Slovenia | 0.620 | 0.285 |
| Cameroon | 0.659 | 0.354 | Kyrgyzstan | 0.217 | 0.098 | Solomon Islands | 0.753 | 0.563 |
| Canada | 0.372 | 0.156 | Lao People's Democratic Republic | 1.069 | 0.555 | Somalia | 0.753 | 0.582 |
| Cayman Islands | 0.753 | 0.373 | Latvia | 0.240 | 0.117 | South Africa | 1.070 | 0.747 |
| Central African Republic | 0.188 | 0.077 | Lebanon | 0.794 | 0.567 | South Georgia and the South Sandwich Islands | N/A | 0.290 |
| Chad | 0.753 | 0.581 | Lesotho | N/A | 0.652 | South Sudan | 0.890 | 0.704 |
| Chile | 0.657 | 0.371 | Liberia | 0.677 | 0.374 | Spain | 0.402 | 0.209 |
| China | 0.899 | 0.547 | Libya | 0.668 | 0.493 | Sri Lanka | 0.731 | 0.506 |
| China, Hong Kong Special Administrative Region | 0.899 | 0.547 | Liechtenstein | 0.151 | 0.052 | Sudan | 0.736 | 0.398 |
| China, Macao Special Administrative Region | N/A | 0.512 | Lithuania | 0.211 | 0.102 | Suriname | 1.029 | 0.565 |

| Country | EF OM | EF CM | Country | EF OM | EF CM | Country | EF OM | EF CM |
|---|---|---|---|---|---|---|---|---|
| **Christmas Island** | N/A | 0.451 | **Luxembourg** | 0.220 | 0.095 | **Svalbard and Jan Mayen Islands** | N/A | 0.256 |
| **Cocos (Keeling) Islands** | N/A | 0.451 | **Madagascar** | 0.876 | 0.567 | **Sweden** | 0.068 | 0.025 |
| **Colombia** | 0.410 | 0.208 | **Malawi** | 0.489 | 0.243 | **Switzerland** | 0.048 | 0.020 |
| **Comoros** | 0.753 | 0.589 | **Malaysia** | 0.551 | 0.436 | **Syrian Arab Republic** | 0.713 | 0.546 |
| **Congo** | 0.659 | 0.405 | **Maldives** | 0.753 | 0.524 | **Tajikistan** | 0.225 | 0.106 |
| **Cook Islands** | 0.753 | 0.422 | **Mali** | 1.076 | 0.623 | **Thailand** | 0.450 | 0.351 |
| **Costa Rica** | 0.108 | 0.039 | **Malta** | 0.520 | 0.295 | **Timor-Leste** | 0.753 | 0.589 |
| **Côte d'Ivoire** | 0.466 | 0.314 | **Marshall Islands** | 0.753 | 0.561 | **Togo** | 0.859 | 0.597 |
| **Croatia** | 0.294 | 0.168 | **Martinique** | 0.753 | 0.406 | **Tokelau** | N/A | 0.451 |
| **Cuba** | 0.559 | 0.391 | **Mauritania** | 0.753 | 0.513 | **Tonga** | 0.753 | 0.533 |
| **Curaçao** | 0.876 | 0.506 | **Mauritius** | 0.700 | 0.543 | **Trinidad and Tobago** | 0.559 | 0.370 |
| **Cyprus** | 0.751 | 0.438 | **Mayotte** | N/A | 0.512 | **Tunisia** | 0.468 | 0.348 |
| **Czechia** | 0.902 | 0.461 | **Mexico** | 0.531 | 0.360 | **Türkiye** | 0.376 | 0.309 |
| **Democratic People's Republic of Korea** | 0.754 | 0.359 | **Micronesia (Federated States of)** | 0.753 | 0.557 | **Turkmenistan** | 0.927 | 0.676 |
| **Democratic Republic of the Congo** | N/A | 0.0004 | **Monaco** | 0.158 | 0.068 | **Turks and Caicos Islands** | 0.753 | 0.451 |
| **Denmark** | 0.362 | 0.155 | **Mongolia** | 1.366 | 1.002 | **Tuvalu** | 0.753 | 0.497 |
| **Djibouti** | 0.753 | 0.575 | **Montenegro** | 0.899 | 0.471 | **Uganda** | 0.279 | 0.116 |
| **Dominica** | 0.753 | 0.433 | **Montserrat** | 0.753 | 0.517 | **Ukraine** | 0.768 | 0.435 |
| **Dominican Republic** | 0.601 | 0.426 | **Morocco** | 0.729 | 0.547 | **United Arab Emirates** | 0.556 | 0.310 |
| **Ecuador** | 0.560 | 0.280 | **Mozambique** | 0.234 | 0.111 | **United Kingdom of Great Britain and Northern Ireland** | 0.380 | 0.187 |
| **Egypt** | 0.554 | 0.406 | **Myanmar** | 0.719 | 0.407 | **United Republic of Tanzania** | 0.531 | 0.336 |
| **El Salvador** | 0.547 | 0.275 | **Namibia** | 0.355 | 0.319 | **United States Minor Outlying Islands** | N/A | 0.451 |
| **Equatorial Guinea** | 0.632 | 0.361 | **Nauru** | 0.753 | 0.521 | **United States of America** | 0.416 | 0.220 |
| **Eritrea** | 0.915 | 0.704 | **Nepal** | N/A | 0.00001 | **United States Virgin Islands** | 0.650 | 0.373 |
| **Estonia** | 1.057 | 0.625 | **Netherlands (Kingdom of the)** | 0.326 | 0.203 | **Uruguay** | 0.174 | 0.065 |

| Country | EF OM | EF CM | Country | EF OM | EF CM | Country | EF OM | EF CM |
|---|---|---|---|---|---|---|---|---|
| **Eswatini** | N/A | 0.652 | **New Caledonia** | 0.779 | 0.445 | **Uzbekistan** | 0.612 | 0.467 |
| **Ethiopia** | N/A | 0.00014 | **New Zealand** | 0.246 | 0.108 | **Vanuatu** | 0.753 | 0.504 |
| **Falkland Islands (Malvinas)** | 0.753 | 0.316 | **Nicaragua** | 0.675 | 0.372 | **Venezuela (Bolivarian Republic of)** | 0.711 | 0.368 |
| **Faroe Islands** | 0.753 | 0.320 | **The Niger** | 0.772 | 0.718 | **Viet Nam** | 0.560 | 0.318 |
| **Fiji** | 0.640 | 0.334 | **Nigeria** | 0526 | 0.358 | **Wallis and Futuna Islands** | N/A | 0.451 |
| **Finland** | 0.267 | 0.114 | **Niue** | 0.753 | 0.459 | **Western Sahara** | N/A | 0.432 |
| **France** | 0.158 | 0.068 | **Norfolk Island** | N/A | 0.451 | **Yemen** | 0.807 | 0.615 |
| **French Guyana** | 0.423 | 0.200 | **Northern Mariana Islands** | 0.753 | 0.416 | **Zambia** | 0.416 | 0.197 |
| **French Polynesia** | 0.753 | 0.412 | **North Macedonia** | 0.851 | 0.563 | **Zimbabwe** | 1.575 | 0.880 |
| **French Southern Territories** | N/A | 0.418 | **Norway** | 0.047 | 0.017 | | | |

Notes: Values in red correspond to regional averages and replace missing or zero values for Combined Margin EFs. N/A values correspond to missing or zero values for Operating Margin EFs, for which representative regional estimates could not be identified.

Source: Authors' own elaboration based on IFI (International Financial Institutions), 2021. *Methodological approach for the common fault grid emissions factors dataset*. Technical Working Group on Greenhouse Gas Accounting. IFI TWG- AHG-001. Version 3.0. December 2021. Cited 3 February 2022. https://unfccc.int/climate-action/sectoral-engagement/ifis-harmonization-of-standards-for-ghg-accounting/ifi-twg-list-of-methodologies

# Annex 4. Refrigerants and global warming potential (GWP) values

**Table A3. Major hydrofluorocarbon (HFC) molecules, environmental properties and main applications**

| Designation | Complete name | Formula | CAS number | GWP (1) | | Atmospheric lifetime (3) | Main applications |
|---|---|---|---|---|---|---|---|
| | | | | F-gas regulation AR4 (2) | AR5 (3) | | |
| **HFC-23** | Trifluoromethane | CHF3 | 75-46-7 | 14 800 | 12 400 | 222 years | - Very low temperature specialist refrigerant;<br>- by product in production of HCFC-22 and aluminum smelting;<br>- used as a feedstock. |
| **HFC-32** | Difluoromethane | CH2F2 | 75-10-5 | 675 | 677 | 5.2 years | - Refrigerant for air-conditioning;<br>- component of refrigerants for air-conditioning, commercial refrigeration and heat pumps. |
| **HFC-125** | Pentafluoroethane | CHF2CF3 | 354-33-6 | 3 500 | 3 170 | 28.2 years | - Blend component for stationary air-conditioning, commercial refrigeration and heat pumps;<br>- firefighting agent. |
| **HFC-134a** | 1,1,1,2-tetrafluoroethane | CH2FCF3 | 811-97-2 | 1 430 | 1 300 | 13.4 years | - Refrigerant for mobile air-conditioning applications (servicing only for cars);<br>- blend component for stationary- air conditioning and commercial refrigeration;<br>- propellant for pharmaceutical aerosols (MDIs); and for technical aerosols, to meet national safety standards from 2018;<br>- blowing agent component for extruded polystyrene foams (XPS). |
| **HFC-143a** | 1,1,1-trifluoroethane | CH3CF3 | 420-46-2 | 4 470 | 4 800 | 47.1 years | Blend component for commercial refrigeration. |
| **HFC-152a** | 1,1-difluoroethane | CH3CHF2 | 75-37-6 | 124 | 138 | 1.5 years | - Propellant for specialized industrial aerosols;<br>- blowing agent component for extruded polystyrene foams (XPS). |
| **HFC-227ea** | 1,1,1,2,3,3,3-heptafluoropropane | CF3CHFCF3 | 431-89-0 | 3 220 | 3 350 | 38.9 years | - Propellant for pharmaceutical aerosols (MDIs);<br>- firefighting agent;<br>- refrigerant for high-temperature environments. |
| **HFC-236fa** | 1,1,1,3,3,3-hexafluoropropane | CF3CH2CF3 | 290-39-1 | 9 810 | 8 060 | 242 years | - Firefighting agent;<br>- refrigerant for high-temperature environments. |
| **HFC-245fa** | 1,1,1,3,3-pentafluoropropane | CHF2CH2CF3 | 460-73-1 | 1 030 | 858 | 7.7 years | - Foam blowing agent for polyurethane (PUR) foams;<br>- working fluid for |

| Designation | Complete name | Formula | CAS number | GWP (1) | | Atmospheric lifetime (3) | Main applications |
|---|---|---|---|---|---|---|---|
| | | | | F-gas regulation AR4 (2) | AR5 (3) | | |
| | | | | | | | organic rankine cycles (ORC). |
| **HFC-365mfc** | 1,1,1,3,3-pentafluorobutane | CF3CH2CF2CH3 | 406-58-6 | 794 | 804 | 8.7 years | - Foam blowing agent for polyurethane (PUR) and phenolic foams;<br>- blend component for solvents;<br>- working fluid for organic rankine cycle (ORC). |
| **HFC-43-10mee** | 1,1,1,2,2,3,4,5,5,5-decafluoropentane | CF3CHFCHFCF2CF3 | 138495-42 | 1 640 | 1 650 | 16.1 years | - Solvent for specialized applications. |

Source: EFCTC (European Fluoro Carbons Technical Committee). n.d. *Fundamental properties of HFCS, HFOS, and HCFOs*. Cited 3 February 2022. www.fluorocarbons.org/hfcs-hfos-hcfos

### Table A4. Major hydrofluoroolefins (HFO and HCFO) molecules, environmental properties, and main applications

| Designation | Complete name | Formula | CAS number | F-Gas Regulation AR4 (2) unless stated | AR5 (3) unless stated | Atmospheric lifetime (3) unless stated | Ozone depleting substance (ODS) | Main applications |
|---|---|---|---|---|---|---|---|---|
| **HFO-1234yf** | 2,3,3,3-tetrafluoroprop-1-ene | CF3CF=CH2 | 754-12-1 | 4 (6) | <1 | 10.5 days | No | - Refrigerant for mobile air-conditioning, stationary air conditioning and refrigeration;<br>- blend component for HFC-HFO blends. |
| **HFO-1234ze(E)** | Trans-1,3,3,3-tetrafluoroprop-1-ene | Trans-CF3CH=CFH | 29118-24-9 | 7 (6) | <1 | 16.4 days | No | - Refrigerant for chillers, refrigeration;<br>- blend component for HFC-HFO blends;<br>- aerosol propellant;<br>- blowing agent for insulation foams. |
| **HFO-1336mzz(Z)** | Cis-1,1,1,4,4,4-hexafluorobut-2-ene | Cis-CF3CH=CHCF3 | 692-49-9 | 9 | 2 (7 &3) | 22 days (8 &3) | No | · Refrigerant for low pressure chillers, residential and high temperate heat pumps, refrigeration and air-conditioning;<br>- working fluid for organic rankine cycle (ORC);<br>- fire extinguishant;<br>- blowing agent for insulation foams. |
| **HFO-1336mzz(E)** | Trans-1,1,1,4,4,4- | Trans-CF3CH=CHCF3 | 66711-86-2 | | 7 (7) | 67 days (7) | No | - Refrigerant for medium temperature |

| Designation | Complete name | Formula | CAS number | F-Gas Regulation AR4 (2) unless stated | AR5 (3) unless stated | Atmospheric lifetime (3) unless stated | Ozone depleting substance (ODS) | Main applications |
|---|---|---|---|---|---|---|---|---|
| | hexafluorobut-2-ene | | | | | | | applications heat pumps and refrigeration systems; - working fluid for organic rankine cycle (ORC). |
| **HCFO-1233zd(E)** | Trans 1-Chloro-3,3,3-trifluoroprop-1-ene | Trans-CHCl=CHCF3 | 102687-65-0 | 4.5 | 1 | 26 days | No, a VSLS (5) | - Refrigerant for chiller applications, high temperature heat pumps; - working fluid for organic rankine cycle (ORC); - blowing agent for Insulation foams. |
| **HCFO-1224yd(Z)** | 2,3,3,3 tetrafluoro-1-chloroprop-1-ene | CF3-CF=CHCl | 111512-60-8 | na | < 1 (4) | 21 days (4) | No, a VSLS (5) | - Refrigerant for centrifugal chillers, high temperature heat pumps; - working fluid for organic rankine cycle (ORC); - blowing agent for polyurethane foams. |

Source: EFCTC (European Fluoro Carbons Technical Committee). n.d. *Fundamental properties of HFCS, HFOS, and HCFOs*. Cited 3 February 2022. www.fluorocarbons.org/hfcs-hfos-hcfos

# Annex 5. Activity data required for the off-farm GHG assessment

**Table A5. Activity data required for the off-farm GHG assessment**

| | Activity data | Units |
|---|---|---|
| **Storage (pre-processing)** | | |
| No action required | Amount stored | tonnes |
| User's task | Days in storage | Number of days |
| | Volume of storage facility | $m^3$ |
| | Electricity used | kWh/day |
| | Type of storage (selected from a drop-down list) | Non-refrigerated<br>Refrigerated |
| | Total leakage | kg/year |
| **Processing** | | |
| No action required | Amount to be processed | tonnes |
| User's task | Electricity used | kWh per tonne |
| | Country of energy grid (selected from a drop-down list) | N/A |
| | Fuel use gaseous and petroleum (selected from a drop-down list) | $m^3$/tonne of product |
| | Other solid biomass (selected from a drop-down list) | tonnes of dry matter (tdm) |
| | Other (please specify) | In case a power source not mentioned available above, the user can specify it with the EF |
| **Water use** | | |
| User's task | Share of production involved in the process | % |
| No action required | Total water used | $m^3$/tonne |
| User's task | Type of treatment (selected from a dropdown list) | N/A |
| | Industry product (selected from a dropdown list) | N/A |
| **Packaging** | | |
| No action required | Amount packaged | tonnes |
| User's task | Type of packaging (selected from a drop-down list) | N/A |
| | Weight of material used for packaging | kg/tonne |
| **Storage and display** | | |
| No action required | Amount stored/displayed | tonnes |
| User's task | Days in storage | Number of days |
| | Total volume of storage facility | $m^3$ |
| | Electricity used | kWh/day |
| | Type of conditioning (selected from a drop-down list) | N/A |
| | Total leakage | kg/year |
| **New Infrastructure** | | |
| User's task | Building (selected from a drop-down list) | $m^2$ of built-up area |

Source: Authors' own elaboration.

## EX-ANTE CARBON-BALANCE TOOL FOR VALUE CHAINS (EX-ACT VC)

The Ex-Ante Carbon-balance Tool for Value Chains (EX-ACT VC) is a quantitative multi-appraisal tool that aims to support policymakers in identifying greenhouse gas (GHG) emissions along an agrifood value chain. It analyses GHG fluxes from farm gate to shelf, as well as potential entry points for socioeconomic improvements at each stage of the value chain, allowing the projects and policies for low carbon value chains.

**WEBSITE | www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc**

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