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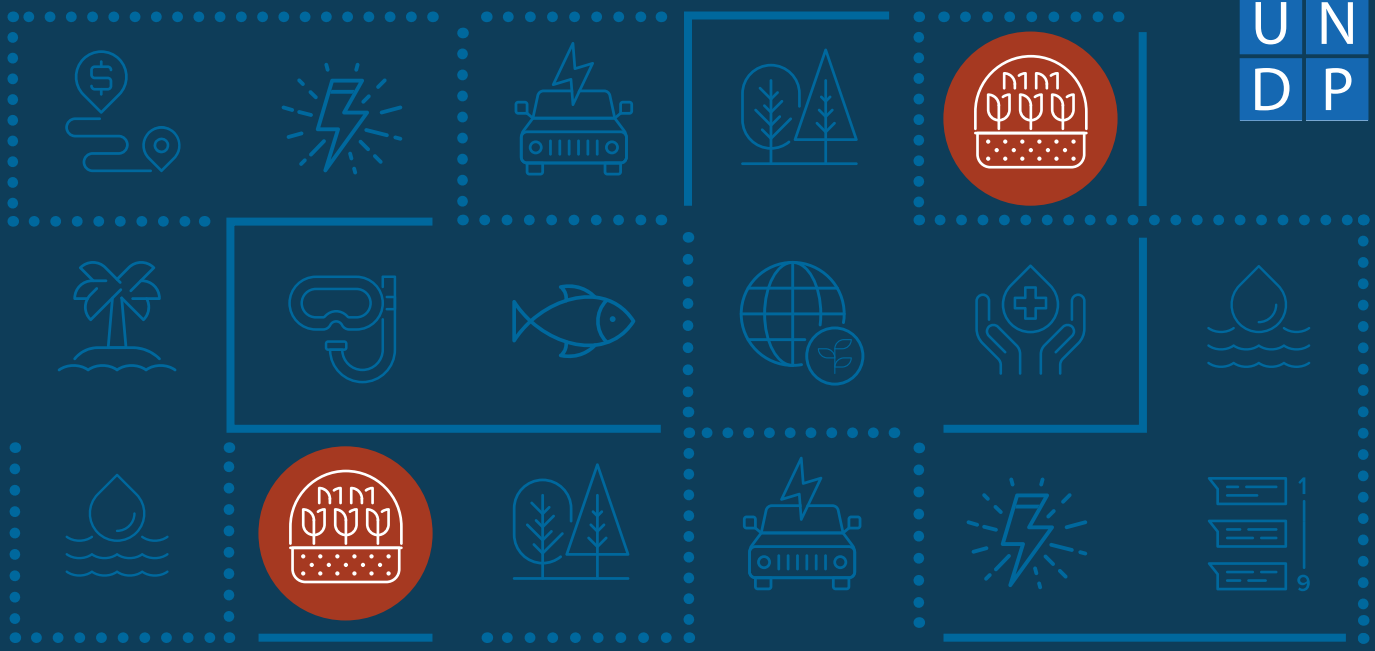
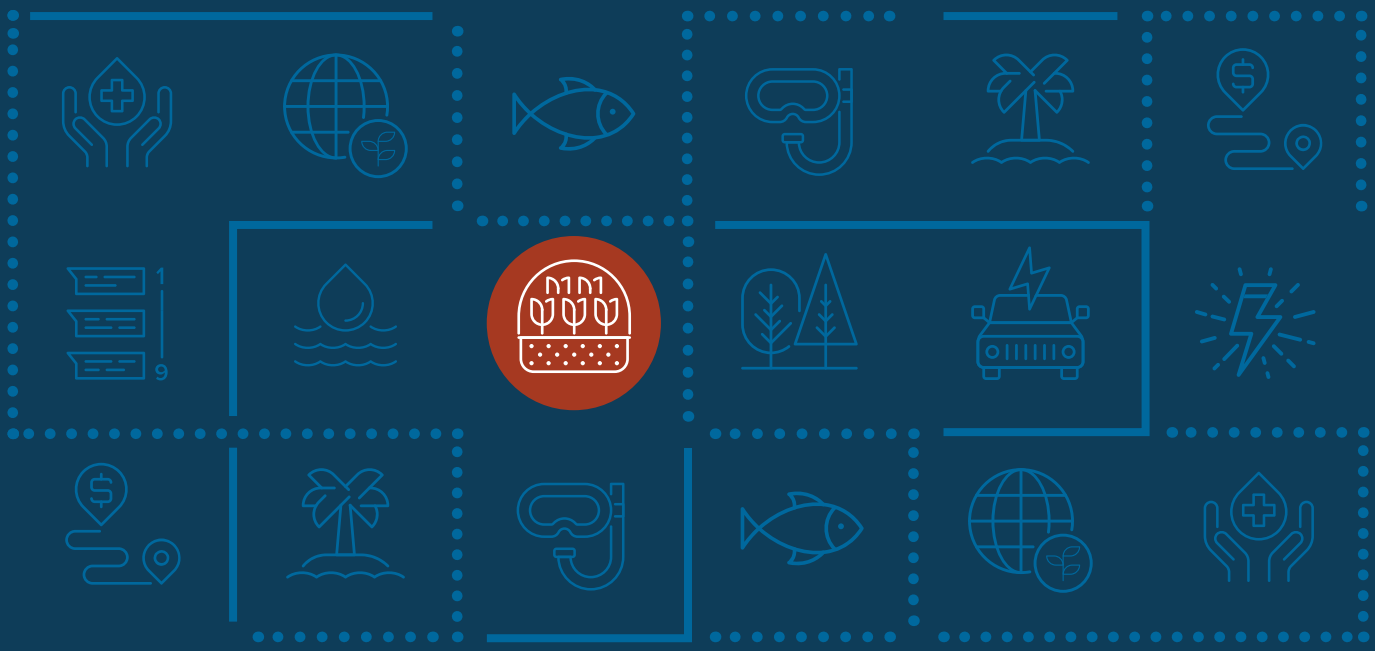


GUIDEBOOK

on the methodology for financial assessments to address climate change

CHAPTER VI: AGRICULTURE SECTOR

(mitigation of climate change)



2026

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About this publication

This methodology is an update to the first financial assessment methodology, which was released in 2009. The objective of this methodology is to support countries to implement their climate targets and to identify, reallocate, mobilize and manage the required financial resources and to create a fiscal framework conducive for climate action.

The update to this methodology was developed under UNDP's Climate Promise by the *Pledge to Impact* Programme. Delivered in collaboration with a wide variety of partners, the initiative has supported over 120 countries to enhance and implement Nationally Determined Contributions (NDCs) under the Paris Agreement. From Pledge to Impact is generously supported by the governments of Germany, Japan, United Kingdom, Sweden, Belgium, Spain, Iceland, the Netherlands, Portugal and other UNDP core contributors. This programme underpins UNDP's contribution to the NDC Partnership.

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About this Guidebook

As countries identify their national climate change targets—notably through Nationally Determined Contributions (NDCs) under the Paris Agreement—the need exists to break down targets into concrete steps of action, determine a financial framework to implement actions and achieve targets, and identify policy measures to facilitate the necessary changes that support low-emission development and a low-carbon future.

A key component to support this transformation is through assessing national investment flows and financial flows to address climate change. Many countries have used this method to articulate an effective and appropriate national response to climate change.

This Guidebook responds to the needs of countries to have a clear approach to support the implementation of national climate targets in the context of sustainable development that duly accounts for their national circumstances, capacities and resources.

Between 2008 and 2024, 60 investment flow and financial flow assessments were conducted worldwide, with more than 1,000 national stakeholders engaged in the technical and political aspects of the assessments. Since the adoption of the Paris Agreement and the development of NDCs, the methodology has helped countries utilize financial assessments to develop a pathway to NDC implementation.

While this methodology was first developed in 2008, an update has taken place in 2025. This Guidebook is a living document, which will continue to be improved based upon the experiences of those using it. Over the years, the methodology to carry out financial assessments to address climate change has been continually reviewed and updated regarding its user friendliness, feasibility of implementation and sectoral scope. Comments are invited. Please send feedback to Susanne Olbrisch (susanne.olbrisch@undp.org).

For more information, visit https://climatepromise.undp.org/tags/investment-and-financial-flows-assessments.

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List of acronyms and abbreviations

AFOLU	Agriculture, Forestry and Other Land Uses
BAU	Business-as-usual
BS	Baseline scenario
CBD	Convention on Biological Diversity
CH_4	Methane
CHP	Combined heat and power
CO_2	Carbon dioxide
FDI	Foreign direct investment
FF	Financial Flow
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse gas
IF	Investment Flow
IPCC	Intergovernmental Panel on Climate Change
LT-LEDS	Long-term Low-Emission Development Strategy
LULUCF	Land Use, Land-Use Change and Forestry
N_2O	Nitrous oxide
NDC	Nationally Determined Contribution
NGO	Non-governmental organization
O&M	Operation and maintenance
OECD	Organisation for Economic Co-operation and Development
REDD	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
UN FAO	United Nations Food and Agriculture Organization
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

Chapters I and II of this guide provide methodology on how to carry out a financial assessment. This chapter provides additional information needed to carry out a financial assessment in the **agriculture sector**. To avoid repetition, some of the information provided in Chapter II that is relevant to all sectors is not included in this chapter. Careful reading of Chapter II before this chapter is highly recommended.

6.1 Introduction

Agriculture accounts for the major share of human use of land and is a major source of greenhouse gas (GHG) emissions. Lands used for agricultural production, consisting of cropland, managed grassland and permanent crops, including agro-forestry and bio-energy crops, occupy about 40 percent of the earth's land surface.[1] According to the Intergovernmental Panel on Climate Change (IPCC), agriculture releases into the atmosphere significant amounts of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), adding up to around 10-12 percent of the total global anthropogenic GHG emissions.

According to the IPCC Sixth Assessment Report, Working Group III: Mitigation of Climate Change, Chapter 7, "Total global net anthropogenic GHG emissions from the Agriculture, Forestry and Other Land Uses (AFOLU) sector were, around 21 percent of total global net anthropogenic GHG emissions over the period 2010 to 2019."

Total global net anthropogenic GHG emissions from AFOLU were around 21 per cent of total global net anthropogenic GHG emissions over the period 2010-2019.[2]

In its Fourth Assessment Report (2007), the IPCC explains that "CO_2 is released largely from microbial decay or burning of plant litter and soil organic matter. CH_4 is produced when organic materials decompose in oxygen-deprived conditions, notably from fermentative digestion by ruminant livestock, from stored manures and from rice grown under flooded conditions. N_2O is generated by the microbial transformation of nitrogen in soils and manures and is often enhanced where available nitrogen (N) exceeds plant requirements, especially under wet conditions."[3]

CO_2 emissions from agricultural soils are not normally estimated separately, as they are included in the land use, land use change and forestry sector. The United States Environmental Protection Agency estimated in the year 2022 that GHG emissions from the agriculture sector accounted for 11 percent of global anthropogenic emissions.[4]

According to the OECD-FAO Agricultural Outlook 2024-2033 report, "Agriculture's global greenhouse gas intensity is projected to decline, although direct emissions from agriculture will likely increase by 5 percent. If food loss and waste could be halved, however, this would have the potential to reduce both global agricultural GHG emissions by 4 percent and the number of undernourished people by 153 million by 2030."

The IPCC identified three mechanisms through which agriculture can make a significant contribution to mitigation of GHG emissions. This can be done by introducing mitigation technologies and practices in the three areas described below.

- Reduce emissions through more efficient management of carbon and nitrogen flows in agricultural ecosystems. Modest mitigation potential is available from reductions in methane and nitrous oxide emissions in some agricultural systems.

[1] Food and Agriculture Organization of the United Nations (FAO) (2007). "FAOSTAT, 2007."

[2] IPCC (2023). Sixth Assessment Report, Working Group III: Mitigation of Climate Change.

[3] Smith, P., D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko (2007). "Agriculture." In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[4] United States Environmental Protection Agency (EPA) (2022). "Agriculture Sector Emissions."

- Enhance removal of atmospheric CO_2 by recovering carbon lost by agricultural ecosystems through improved management. A large proportion of the mitigation potential of agriculture arises from soil carbon sequestration.

- Displace emissions by using crops and residues from agricultural lands as a source of fuel.

However, there is no universally applicable list of mitigation practices; practices need to be evaluated for individual agricultural systems and settings.

Mitigation measures for the agriculture sector generally can take place on two levels: 1) field-level measures; and 2) research, education, assistance, infrastructure and institutional measures. Below are more details on how this can be done at these two levels.[5]

Field-level measures

Cropland management

- **Agronomy:** Improved agronomic practices that increase yields and generate higher inputs of carbon residue can lead to increased soil carbon storage, including improving crop varieties; featuring perennials in crop rotations; making greater use of temporary cover crops (between successive crops or between rows of plantations); avoiding bare fallows.

- **Nutrient management:** Nitrogen applied in fertilizers, manures, biosolids and other N sources is not always used efficiently by crops. Consequently, improving N use efficiency can reduce N_2O emissions and indirectly reduce GHG emissions from N fertilizer manufacture. Improved practices include improving nitrogen-use efficiency by reducing leaching and volatilization, reducing offsite N_2O emissions, adjusting fertilizer application to crop needs (synchronization), using slow-release fertilizers, applying N when crop uptake is guaranteed, placing N in soil (e.g. banding) to enhance accessibility, and avoiding N applications in excess of crop demands.

- **Tillage/residue management:** Advances in weed control methods and farm machinery now allow many crops to be grown with minimal tillage (reduced tillage) or without tillage (no-till), also by managing tillage and residues.

- **Water management:** Expanding the area (where water reserves allow) that receive supplementary water through irrigation or using more effective irrigation measures can enhance carbon storage in soils through enhanced yields and residue returns.

- **Rice management:** Methane emissions during the growing season can be reduced by various practices. For example: draining wetland rice once or several times during the growing season reduces CH_4 emissions; rice cultivars with low exudation rates could offer an important methane mitigation option; in the off-rice season, methane emissions can be reduced by improved water management, especially by keeping the soil as dry as possible and avoiding water logging; methane emissions can be reduced by adjusting the timing of organic residue additions or by producing biogas for use as fuel for energy production.

- **Agro-forestry:** Producing livestock or food crops on land that also grows trees for timber, firewood and other tree products can help reduce emissions.

[5] Based on the IPCC (2007). "Agriculture," In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change." and FAO (2008). Climate Change Adaptation and Mitigation in the Food and Agriculture Sector. Rome.

- **Land cover change:** This will allow or encourage the reversion of cropland to another land cover, typically one similar to the native vegetation.

Grazing

- **Grazing intensity:** The intensity and timing of grazing can influence the removal, growth, carbon allocation and flora of grasslands, thereby affecting the amount of carbon accrual in soils.
- **Increased productivity (including fertilization):** Carbon storage in grazing lands can be improved by a variety of measures that promote productivity. As an example, alleviating nutrient deficiencies by fertilizer or organic amendments increases plant litter returns and, hence, soil carbon storage.
- **Nutrient management:** This includes practices for additional nutrient uptake in plants, meaning that less plants would be needed for grazing.
- **Fire management:** This includes activities to reduce the intensity or frequency of on-site biomass burning, hence reducing emissions.
- **Species introduction:** Introducing grass species with higher productivity, or carbon allocation to deeper roots, can increase soil carbon.

Management of organic/peaty soils

- Emissions from drained organic soils can be reduced to some extent by practices such as avoiding row crops and tubers, avoiding deep ploughing and maintaining a shallower water table.

Restoration of degraded lands

- Degraded lands can be restored through re-vegetation (e.g., planting trees or grasses), improving fertility by nutrient amendments, applying organic substrates such as manures, biosolids and composts, reducing tillage and retaining crop residues and conserving water.

Manure management

- Methane emissions from manure stored in lagoons or tanks can be reduced by cooling, use of solid covers, mechanically separating solids from slurry and by capturing and burning the CH_4 emitted. Examples include preventing methane emissions from manure heaps and tanks, producing biogas and composting manure.

Bioenergy

- Agricultural crops and residues can be used as sources of feedstocks for energy to displace fossil fuels. A wide range of materials have been proposed for use, including grain, crop residue, cellulosic crops (e.g., switchgrass, sugarcane) and various tree species.

Research, education, assistance, infrastructure and institutional measures

Research

- Resources can be allocated to agronomic and engineering research on improved mitigation strategies, including demonstrations and trials and diffusion of new field-level practices.

Extension and training

- Public resources can be allocated to agricultural extension and training programmes to disseminate information about and training in improved agricultural practices and to encourage their adoption.

Seasonal weather forecasting

- Improved and expanded seasonal weather forecasting can reduce production risk and optimize resource use.

Infrastructure development

- Both public and private infrastructure investments may be needed in the agriculture and other sectors to support agricultural mitigation measures, including new freshwater supply infrastructure.

Other institutional development

- Mitigation in agriculture at the regional and national levels requires the integration of long-term mitigation strategies into agricultural development policy and planning, land-use planning and regulatory structures and overall development policy. Public resources will be needed for such measures, as well as institutional capacity building and improved management and governance systems.

6.2 Application of financial assessment methodology to mitigation in the agriculture sector

This section describes how the financial assessment methodology in Chapter II would be applied to mitigation in the agriculture sector.

As described in Chapter II, the financial assessment involves a series of steps, which are:

Step 1. Establish key parameters of the assessment.

Step 2. Compile historical IF, FF and O&M cost data (and subsidy cost data if included explicitly) and other input data for scenarios.

Step 3. Define baseline scenario.

Step 4. Identify annual IF, FF and O&M costs (and subsidy costs if included explicitly) for the baseline scenario.

Step 5. Define target scenario.

Step 6. Identify annual IF, FF and O&M costs (and subsidy costs if included explicitly). for the target scenario

Step 7. Calculate the changes in IF, FF and O&M costs (and in subsidy costs if included explicitly) needed to implement target scenario.

Step 8. Identify policy implications.

Step 1.

Establish key parameters of the assessment.

Define detailed scope of the sector.

Based on the national target that is being assessed (NDC, LT-LEDS) in this step the subsector activities of the agriculture sector to be included in the financial assessment are defined. The agriculture sector includes production of food crops (both food for human consumption and fodder), animals and their products, floral crops and nursery plants, biofuel crops (e.g., maize, sorghum, switchgrass, oil palm, jatropha), non-food crops (e.g., oilseeds, gums and resins, beverage crops such as coffee, tea cacao, tobacco, fibres such as cotton, silk and hemp, construction crops such as bamboo and hemp, and pharmaceutical, herbal and aromatic plants).[6]

Countries may choose to include production of some or all the significant crop species/varieties and animal species/breeds produced domestically. Crop production can be divided into annual and perennial crops and animal production can be divided into intensive and extensive production systems. Countries may also choose to only focus on certain agro-ecological regions, rather than the entire country, if appropriate.[7]

Which subsectors are included should depend on the national target being assessed (NDC, LT-LEDS, other). This choice should also depend on data availability, the structure of national government entities in which data reside and the scope of related assessments that have been completed, especially the consideration of sector emissions in national inventories, studies included in the National Communications and other mitigation potential assessments that have been completed.

Linkages between the agriculture sector and other sectors, as well as potential overlaps among mitigation and adaptation measures in the agriculture sector, should be considered to avoid double-counting of investment and financial flows.

Specify base year and assessment period.

The base year should be the most recent year for which information is available, e.g. 2025 if available. The assessment period should match the time horizon of the target that is being assessed. NDCs often have a timeline until 2030, LT-LEDS often until 2050.

Identify the target to be assessed and mitigation measures.

Based on the target being assessed, a set of mitigation options must be identified for each subsector of the agriculture sector included in the assessment (see Table 6.1 for examples of mitigation options).

[6] Many types of crops have several, and at times competitive, uses, e.g. maize for human food and fodder.

[7] Food processing has not been included in the scope of the agriculture sector as defined in this chapter in line with the IPCC, which quantifies emissions from agriculture, as well as with the International Standard Industrial Classification (ISIC) and many other classifications. Including a subsector of manufacturing in this assessment may create double accounting for costs, particularly if a country undertakes an assessment of its manufacturing sector and could lead to problems of disaggregation of statistics.

Table 6.1: Agricultural mitigation measures (examples)

Level of action	Mitigation measure	Examples of options
Field level	Cropland management	Agronomy
		Nutrient management
		Tillage/residue management
		Water management
		Rice management
		Agro-forestry
		Land cover change
	Grazing land management / pasture improvement / land cover change	Grazing intensity
		Increased productivity
		Nutrient management
		Fire management
		Species introduction
	Management of organic/ peaty soils	Avoid drainage of wetlands
	Restoration of degraded lands	Erosion control, organic amendments, nutrient amendments
	Livestock management	Improved feeding practices
		Specific dietary additives
		Structural and management changes
		Animal breeding
	Manure/ biosolid management	Improved storage and handling
		Anaerobic digestion
		Efficient use as nutrient source
	Bio-energy	Energy crops, solid, liquid, biogas, residues
Research, education, assistance, infrastructure and institutional	Sector-wide	Research, including demonstration/trials and diffusion of new field-level practices
		Extension and training
		Forecasting, early warning
		Disaster management
		Infrastructure development
		Other institutional development, including capacity building and improved management and governance systems

The selection of field-level mitigation options should be based primarily on the sectoral scope, prior analysis of mitigation options, technical feasibility, economic feasibility, logistical feasibility and sectoral acceptability of the options. Consideration should be given to the emission reductions potential and social and non-GHG environmental benefits and costs of the options. To avoid analysts spending large amounts of time analyzing options that are technically feasible but not economically feasible, the national team can use economic analyses to prioritize the mitigation measures to be considered in the assessment.

Given the numerous linkages between agriculture and other sectors, a potential exists for creating synergies between agricultural mitigation and mitigation in other sectors. For example, agricultural mitigation measures that require irrigation practices have an impact on energy and water supplies.

The main links of the agriculture sector to other sectors are:

- to the water management sector through agricultural demand for freshwater for both production and processing and the potential for agricultural contamination of water supplies (e.g., through pesticide runoff);
- to the energy sector through agricultural biofuel production and through agricultural demand for energy;
- to the health sector through the production of safe and secure food supplies
- to the waste management sector through food processing waste generation; and
- to ecosystem health through pollutant runoff and nitrogen loading of ground and surface water from pesticide and fertilizer use and from inadequate management of animal wastes in confined animal operations.

Countries should be alert to such synergies and cross sectoral effects and discuss them qualitatively in their reports.

Select analytical approach.

Countries need to determine the analytical approach to be used to develop baseline and target scenarios and associated streams of annual IF, FF and O&M costs. Different useful models exist for assessing the amount and level of emissions associated with agricultural practices and crop/livestock decision patterns in farming, the mitigation potential of various cropping systems and the technological feasibility of various mitigation options. For example, FarmSim, Environmental Policy Integrated Climate (EPIC) Model, Pasture simulation model (PaSIm) and Crop Environment Resources Synthesis (CERES), among others.

Mitigation measures and their costs, appropriateness and feasibility are highly site-specific. Therefore simple, spreadsheet based, bottom-up approaches are recommended that rely on an in-country understanding of the agriculture sector and how it is likely to evolve over time. Projections should be based on national and international demand of agricultural goods produced by the country and on in-country expertise related to the agronomic applicability, costs, feasibility and cultural acceptance of options. Sectoral plans and projections for agricultural production need to also be considered.

Step 2.

Compile historical IF, FF, O&M cost data (and subsidy cost data if included explicitly), and other input data for scenarios.

Compile historical annual IF and FF data, disaggregated by investment entity and source.

The methodology recommends that countries compile 10 years of historical investment and financial flows data, i.e., for the base year and the previous nine years. At a minimum, countries should collect at least three years of data (i.e., for the base year and two years during the previous decade). Data should be compiled for each investment type and should be annual, be disaggregated by investment entity and, if possible, by funding source and be divided into investment flows and financial flows (see Chapter II, Table 2.3: 'Template for one year of historical investment and financial flows data').

In the agriculture sector, investment flows would include assets such as machinery (e.g., mechanized ploughs, planters, harvesters, milking machines), wells and irrigation equipment, buildings (e.g., animal housing, greenhouses) and food processing facilities (e.g., slaughter houses, sugar production facilities, canning facilities).

Investment flows would also include assets for research, education, assistance and institutional support (e.g., meteorological equipment, vehicles). Financial flows would include non-asset investments in the research, education, assistance and institutional areas (e.g., labour costs).

The investment and financial flows data needed will likely reside in several national locations including ministry records and plans, statistical agencies, extension agencies, research institutions and national accounts, as well as with private sector stakeholders, including farmers associations, industry records and non-governmental organizations. Several FAO databases may be useful data sources too (FAO agricultural databases are described further below).

Note that sectoral and subsectoral definitions and disaggregation will vary among data sources, so assumptions may need to be made and documented to reconcile datasets and extract data needed from aggregated and/or disaggregated categories. For example, the United Nations system of national accounts utilizes the International Standard Industrial Classification (ISIC) classification system in which crop and animal production is included in Section A (agriculture, forestry and fishing) and the processing of agricultural products is included in Section C (manufacturing). This means, for example, that the production of cattle is in Section A, but the processing of meat and dairy products is in Section C. Even at the most disaggregated level in the ISIC system (the "class" level), multiple agricultural activities are combined so that investment information for each activity cannot be separated without making assumptions and/or using supplementary information. For example, class 0119 (growing of other non-perennial crops) includes both fodder crops and flowers.

Compile historical annual O&M cost data, disaggregated by investment entity and funding source.

Historical O&M data are needed to provide a historical basis from which to estimate future O&M costs for new physical assets and to provide data for the first year of the scenarios (note that in the context of agriculture, physical assets include croplands and pasture).

Annual O&M costs for the physical assets that are in operation during the historical period should be collected for the same years for which historical investment and financial flows data are collected. Information about the expected lifetimes of assets such as buildings, machinery and equipment that are in operation during the historical period and annual fluctuations in O&M costs (if any), also need to be collected.

O&M data should be collected at a level of disaggregation consistent with the investment and financial flows data. O&M data for assets purchased during the historical period should be tracked separately from the O&M data for assets purchased before the historical period (see Chapter II, Table 2.4: 'Template for three years of historical O&M cost data for an investment flow in 2023').

O&M data are a particularly important part of agricultural baseline and mitigation costs since many field-level agricultural costs are O&M costs. Significant O&M costs are likely to include agricultural inputs, such as seeds, plants, fertilizers and other soil amendments, animal stock and animal feed, energy usage (electricity and fuels), building and equipment maintenance and/or leasing, real estate expenses and insurance. (Note that if the national financial assessment also includes energy sector mitigation, agricultural measures that include energy consumption should not duplicate, or be inconsistent with, energy sector measures.)

The O&M data that need to be collected may reside in one or more of the same locations as investment and financial flows data (e.g., national accounts, ministry of agriculture records and plans and reporting, industry records, statistical agencies, extension agencies, research institutions), as well as in FAO sources described below. If such data are not available, countries should utilize one of the estimation approaches described in Chapter II. In-country experts may be particularly useful for supplying cost estimates.

Compile historical annual subsidy cost data, if subsidies are included explicitly in the assessment.

There are numerous types of agricultural subsidies, including direct financial transfers (e.g., grants and low-interest loans to producers), preferential tax treatments, price supports and income guarantees and controls over access to resources, such as water. If a country chooses to include subsidies explicitly in the financial assessment, annual costs of subsidies for each type of investment during the historical period should be collected for the same years for which historical investment and financial flows data are collected. Subsidies should be compiled separately for IF, FF and O&M (see Chapter II, Table 2.5 'Template for three years of historical subsidy cost data').

Information on subsidies may be available from relevant government ministries and agencies, statistical agencies, research organizations, academic institutions and private sector entities.

Compile other input data for scenarios.

In addition to historical investment and financial flows and O&M cost data, the characterization of the scenarios and estimation of annual costs for the scenarios will require the collection of other historical and non-historical data relevant to the sector. What data are needed will depend on the sectoral scope and analytical approach. The kinds of information needed may include the topics described below.

- Characterization of the agricultural production subsectors included in the analysis, including crop species and varieties, quantities produced, areas planted and harvested, yields per hectare, animal species and breeds raised, animal populations, animal product production statistics, domestic consumption and exports, agricultural inputs, management practices, employment and national land-use statistics. Information about the current situation, as well as projections over the assessment period, should be collected.

- Characterization of agricultural processing activities included in the scope. This would include the nature and scale of operations, energy and water usage and employment. Information about the current situation, as well as projections over the assessment period, should be collected.

- Characterization of mitigation options, including technical feasibility, cultural acceptability, scalability, costs (capital and O&M) and economic feasibility. Possible externalities and linkages with other sectors should be noted.

- Information about major sectoral and macroeconomic policies (both recent and expected) that could significantly affect the agriculture sector should be collected.

These data and information may be available from the national sources mentioned above for investment and financial flows and O&M cost data. While it is recommended to go directly to the agencies which are responsible for reporting within the country, FAO maintains several publicly available statistical databases and information systems that contain potential useful national agricultural statistics and related information. These include:

- **FAOSTAT**, which contains data on crop and animal production, trade and consumption, agricultural prices, agricultural resources (land, labour, machinery, fertilizers, agrochemicals) and food security, and

- **AQUASTAT**, an information system for the collection, analysis and dissemination of data and information on water resources and agricultural water management by country and by region. It also includes data on dams, irrigation system investment costs and irrigated areas.

Step 3.

Define baseline scenario.

This step entails describing what is likely to occur in the agricultural sector without additional or scaled up policies and measures to address climate change over the assessment period. It should reflect current sectoral and national plans, expected socioeconomic trends and expected investments in the sector. It should include a quantitative description of the socioeconomic factors that affect the sector (e.g., demographic change, economic growth), as well as other relevant characteristics (e.g., domestic food consumption, domestic crop, meat and dairy and production or other domestic consumption statistics, imports and exports, water supply availability and land availability). The baseline scenario description should include specific information about equipment, facility and infrastructure investments that are expected (and as is relevant) in each measure, as well as research, education, assistance and institutional investments.

Step 4.

Identify annual IF, FF and O&M costs (and subsidy costs if included explicitly) for the baseline scenario.

Identify annual IF and FF for each investment type, disaggregated by investment entity and funding source.

In this step, annual IF for the baseline scenario facility and infrastructure investments and annual FF for the baseline scenario research, education, assistance and institutional investments are identified for each subsector. As discussed in Chapter II, costs should be in real terms (i.e., inflation adjusted), in constant values of the base year (e.g. 2025), and should be in US$ or national currency. IF and FF should be reported in the year in which they are expected to be incurred and should be discounted using appropriate public and private discount rates. The annual IF and FF values for each investment type should be disaggregated by investment entity and funding source and be divided into investment flows and financial flows.

Typically, in the agriculture sector investment decisions are in many cases made by thousands of farmers and the analysis cannot be done farm by farm. In this case, a simple disaggregation by type of investment entity can facilitate the analysis without losing data quality and level of aggregation. Data sources could include model output and/or government and private sector planning documents or estimates might be derived from historical data.

The output of this step will be a stream of annual investment and financial flows for each investment type in each subsector for the entire assessment period, by investment entity and funding source. These data should be organized as in Chapter II, Table 2.6: 'Baseline scenario: *cumulative* investment and financial flows and O&M' and Table 2.7: 'Baseline scenario: *annual* investment and financial flows and O&M.'

Identify annual O&M costs for each IF, disaggregated by investment entity and funding source.

Annual values of O&M costs for assets purchased during the assessment period and for assets purchased before the assessment period and that are expected to still be in operation, need to be collected (or derived) for each subsector. Costs should be in real terms, in constant 2025 US$ or national currency, should be reported in the year in which they are expected to be incurred and should be discounted.

The annual O&M values for each investment type should be disaggregated by investment entity and funding source (as in Chapter II, Table 2.4) and be divided into O&M for assets purchased during the assessment period and for assets purchased prior to the assessment period. Again, in this case a simple disaggregation by type of investment entity can facilitate the analysis. For those assets purchased during the assessment period that are expected to still be in operation after the last year of the assessment period, annual O&M costs for each additional year the assets will be in operation should be identified, up to an additional five years after the last year of the assessment period. Possible data sources include those described above for IF and FF.

If subsidies are included explicitly in the assessment, identify annual subsidy costs for each investment type and IF, FF and O&M costs.

If a country chooses to include subsidies explicitly in the financial assessment, annual subsidy costs should be identified for each relevant investment type and for all categories of cost (IF, FF and O&M), in the baseline scenario (see Chapter II, Section 2.2.1).

Step 5.

Define target scenario.

This step entails developing a description of what is likely to occur in each relevant agriculture subsector, over the assessment period, with the implementation of mitigation measures while also considering the likely impacts of climate change on agricultural production. This would include comprehensive descriptions of the specific mitigation measures that would be implemented and the implications of those measures for the evolution of each subsector.

The mitigation measures need to be defined clearly and completely so that IF, FF and O&M costs can be identified in the next step. This should include specific information about facility and infrastructure investments that would occur in each measure, as well as non-asset investments. In-country expertise and prior work on climate change mitigation in agriculture (e.g., National Communications, mitigation abatement cost studies, etc.) should be utilized in this step.

Countries should assess qualitatively the environmental and socioeconomic benefits and potential non-investment costs (negative externalities) of the mitigation measures.

Step 6.

Identify annual IF, FF, O&M costs (and subsidy costs if included) for the target scenario.

Identify annual IF and FF for each investment type, disaggregated by investment entity and funding source.

In this step, annual IF for the target scenario investments and annual FF for the target scenario research, education, extension and institutional flows are identified for each measure. As discussed in Chapter II, costs should be in real terms (i.e., inflation adjusted), in constant 2025 US$ or national currency, should be reported in the year in which they are expected to be incurred and should be discounted using appropriate public and private discount rates. The annual IF and FF values for each investment type should be disaggregated by investment entity and funding source and be divided into investment flows and financial flows. Data sources include those sources listed previously.

The output of this step will be a stream of annual investment flows and/or financial flows for each investment type in each subsector for the entire assessment period by investment entity and funding source. These data should be organized as in Chapter II, Table 2.8: 'Target scenario: *cumulative* investment and financial flows and O&M' and Table 2.9: 'Target scenario: *annual* investment and financial flows and O&M.'

Identify annual O&M costs for each IF, disaggregated by investment entity and funding source.

Annual O&M costs for assets purchased during the assessment period and for assets purchased before the assessment period and that are expected to still be in operation need to be collected (or derived) for each measure. Costs should be in real terms, in constant 2025 US$ or national currency, should be reported in the year in which they are expected to be incurred and should be discounted.

The annual O&M costs for each investment type should be disaggregated by investment entity and funding source and be divided into O&M for assets purchased during the assessment period and for assets purchased prior to the assessment period. For those assets purchased during the assessment period that are expected to still be in operation after the last year of the assessment period, annual O&M costs for each additional year the assets will be in operation should be identified, up to an additional five years after the last year of the assessment period. Possible data sources include those described above for IF and FF.

Identify annual subsidy costs for each relevant investment type and for IF, FF and O&M costs, if subsidies are included explicitly in the assessment.

If a country chooses to include subsidies explicitly in the financial assessment, annual subsidy costs should be identified for each relevant investment type and for IF, FF and O&M in the target scenario (see Chapter II, Section 2.2.1).

Step 7.

Calculate the changes in IF, FF and O&M costs (and in subsidy costs if included explicitly) needed to implement target scenario.

The changes in IF, FF and O&M costs that are needed to implement the target scenario are calculated in this step by subtracting baseline scenario values from target scenario values. The two objectives of this step are to determine: 1) how *cumulative* IF, FF and O&M costs would change; and 2) how *annual* IF, FF and O&M costs would change. These calculations are described in Chapter II.

Step 8.

Identify policy implications.

The purpose of this step is to identify the policy implications of the results of the previous step for the sector. In the previous step the magnitudes and timing of changes in IF, FF and O&M were calculated for each investment entity and for each funding source that will be needed to implement the target scenario.

Looking at these results, countries will determine which investment entities are responsible for the most significant (largest and/or highest priority) changes in investment and financial flows and the predominant sources of their funds.

Then the policy measures will be defined that might be used to induce those entities to implement the proposed measures and change their investment patterns (e.g. incentives, public programmes, etc.) and the additional sources of funds to meet the new investment needs. It will be particularly important to distinguish between public and private sources of finance and between domestic and foreign sources.

Policy measures include a variety of instruments, including economic instruments (e.g., taxes), regulatory instruments (e.g., fuel portfolio standards), voluntary agreements, information dissemination and strategic planning and research, development and demonstration.

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