SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

PARTNER ORGANIZATIONS

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WWF

FOREST, LAND, AND AGRICULTURE SCIENCE BASED TARGET SETTING GUIDANCE

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The initiative is a collaboration between CDP, the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF) and one of the We Mean Business Coalition commitments. The SBTi defines and promotes best practice in science-based target setting, offers resources and guidance to reduce barriers to adoption, and independently assesses and approves companies' targets.

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FOREWORD

Implementation of the Paris Agreement calls for ambitious climate action on a global scale. We see this transition accelerating globally with every sector in every market undergoing transformation. Non-state actors play a key role in driving change and have begun to take action, with more than 2000 companies committed to set greenhouse gas (GHG) emission reduction targets in line with the Paris Agreement goals through the Science Based Targets initiative (SBTi). Leading businesses recognize the timeliness of this opportunity and the imperative to be part of the solution.

The land sector has a crucial role to play in this process. The forest, land and agriculture (FLAG) sector, also known in the scientific community as the agriculture, forest, and other land use (AFOLU) - or the land sector, has been historically difficult to evaluate through GHG accounting and target setting approaches. Even so, FLAG represents about 25% of net anthropogenic GHG emissions (10–12 GtCO2e per year) with about half from agriculture and half from land use, land-use change, and forestry (LULUCF) (Roe et al., 2019).

To meet the goals of the Paris Agreement, a broad set of mitigation strategies will be needed to both reduce emissions and enhance sinks. GHG emissions from the FLAG sector need to be halved by 2050, and at the same time agricultural production is expected to increase by about 50 percent from the current levels to meet increased food demand (WRI, 2019). Reducing emissions in the land sector is feasible through reduced land-use change, reduced agricultural emissions, and reduced emissions via demand shifts. In addition, mitigation in the land sector also requires accounting for GHG removals (enhancing sinks) due to the potential for forests and soils to store carbon. GHG removals can be achieved by restoring natural ecosystems, improving forest management practices, and enhancing soil carbon sequestration. Companies setting ambitious science-based targets on FLAG emissions can send a strong signal to increase the level of ambition of local, regional and national policies.

Science-based targets specify how much and how quickly a company needs to reduce its greenhouse gas emissions in line with the Paris Agreement. This report shows the conclusions of a group of experts that have focused on developing best practices for science-based target-setting in the FLAG sector over the past two years. By using the FLAG tool and this guidance, companies with FLAG-related emissions can get on track and set targets in line with a 1.5°C world.

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ABOUT THIS GUIDANCE

This document supports companies that are interested in setting science-based targets for Forest, Land, and Agriculture-related greenhouse gas (GHG) emissions and removals according to the new, refined pathways in the Forest Land and Agriculture (FLAG) tool. It builds on the existing manual and guidance of the Science Based Targets initiative (SBTi) for setting science-based targets. Companies in land-intensive sectors have a critical role to play in the transition to a low-carbon economy. Agriculture, Forestry and Other Land Use (AFOLU) emissions represent nearly a quarter of global greenhouse gas (GHG) emissions.

The FLAG tool and guidance were developed following an extensive review of available data. Input and feedback on the tool and guidance was provided through seven meetings of an 18-member consultative group along with 6 technical expert review meetings. The guidance is undergoing a public consultation for review and feedback and will be updated based on input received.

This document contains guidance on how to set targets for FLAG-related emissions across different scopes and for different tool end-users. Examples of end-users include agricultural commodities producers including animal sources (e.g. meat and dairy), pulp and paper product producers, wood product producers and retailers, food retailers, companies that use inputs derived from FLAG sectors (e.g. cosmetics, textile, leisure), and companies that generally have a large FLAG-related footprint (i.e. significant AFOLU emissions per unit of product). Policymakers can also use this guidance to inform the development of programs and regulations.

This document describes the SBTi FLAG criteria and recommendations for FLAG target setting. It also provides detailed guidance on the use of the FLAG tool.

Quick guidance to this document

1	Introduction	Provides background information: ● *Fundamentals* about FLAG target setting; ● *Overview* of (how to use) this guidance; ● *Overall description of the FLAG criteria*
2	Getting started: who sets a FLAG target, covering which emissions	Provides clarification about: ● *Who*: which companies need to set a FLAG target; ● *When*: how much time from the publication of this guidance companies have to set their FLAG targets; ● *What options* the SBTi offers for FLAG target setting and *what must be the emissions coverage*.
3	Overall guidance on science-based target-setting for FLAG	Provides a practical step-by-step on *how* to set a FLAG target.
4	Methodological choices	Describes the methodological choices made to build the tool and to produce this guidance document.

1 INTRODUCTION

The Science Based Targets initiative (SBTi) drives ambitious climate action in the private sector by enabling companies to set science-based emission reduction targets. Science-based targets (SBTs) show companies how much and how quickly they need to reduce their greenhouse gas (GHG) emissions to align with the Paris Agreement and prevent the worst effects of climate change.

This guidance document and science-based targets for FLAG apply specifically to the land-related emissions (and qualified removals) in a company's direct emissions and supply chain.

1.1 What are science-based targets (SBTs)

GHG emissions reduction targets are considered “science-based” if they are in line with what the latest climate science says is necessary to meet the goals of the Paris Agreement - to limit global warming to well-below 2°C above pre-industrial levels and pursue efforts to limit warming to 1.5°C.

The SBTi currently validates scope 1 and 2 SBTs that are in alignment with limiting global warming to well-below 2°C as a minimum level of ambition. However, in response to the urgency and scale of the climate emergency, the SBTi has updated its general criteria. From 15 July 2022 onwards, the SBTi will only validate targets aligned with 1.5°C for scope 1 and 2 and a minimum level of ambition of well-below 2°C for scope 3.

1.2 What are FLAG science-based targets (SBTs)?

FLAG SBTs are science-based targets that apply to a company’s Forest, Land, and Agriculture-related emissions including CO_2 emissions associated with land use change (LUC) (i.e. biomass and soil carbon losses from deforestation and forest degradation, conversion of coastal wetlands and peatland burning) and emissions from land management (i.e. N_2O and CH_4 from enteric fermentation, biomass burning, nutrient management, fertilizer use, and manure management; and - CO_2 emissions from machinery and fertilizer manufacture) (see detailed description in table 6).

The SBTi provides two approaches to FLAG target-setting to enable companies to calculate GHG reduction targets in line with the Paris Agreement:

- The FLAG sector approach for companies with diversified FLAG emissions, and;
- The FLAG commodity approach that includes 10 commodity pathways: beef, chicken, dairy, corn/maize, palm oil, pork, rice, soy, wheat, and timber & wood fiber.

Both sector-based and commodity-based FLAG targets are consistent with scenarios that limit global temperature increase to 1.5°C. A company's overall target classification (1.5°C or well-below 2°C) will be determined based on the ambition of its non-FLAG scope 1, 2 & 3 target.

Companies may combine multiple commodity pathways and the sector pathway as appropriate for target setting.

1.3 How do FLAG SBTs differ from non-FLAG SBTs?

Many companies with land-intensive operations are reporting their emissions publicly and have committed to or set targets through the Science Based Targets initiative (SBTi) using the methods mentioned above. Many are also reporting their emissions publicly. However, few comprehensively account for AFOLU emissions or removals in their targets or disclosures. A key barrier has been the lack of available standards, guidance and methods—a barrier which is removed with the FLAG SBT guidance along with the forthcoming Greenhouse Gas Protocol Land Sector and Removals Guidance (expected end of 2022).

Companies that set a FLAG target are setting a FLAG-specific target for the portion of their emissions that are related to the land sector, including, but not limited to, emissions from forestry, deforestation, and agricultural production up 'to the farm gate' (not including energy related emissions from processing phases). All other non-FLAG emissions in a company's inventory should be covered by SBTs that use other approved SBT methods. These methods include:

- Absolute Contraction
- Physical intensity convergence using the appropriate Sectoral Decarbonization Approach (SDA)
- Renewable electricity (scope 2 only)
- Supplier or customer engagement
- Physical intensity contract
- Economic intensity

For more information on non-FLAG targets see the SBTi Corporate Manual, the SBTi Criteria and Recommendations, and the Net-Zero Standard, as well as any relevant sector guidance.

It is important to note that because FLAG SBTs are separate from non-FLAG SBTs, FLAG abatement cannot be used to meet non-FLAG abatement targets (e.g., emission reductions from agricultural activities in a company's supply chain cannot be used to meet facility or office emission reduction targets). That is, companies cannot account for biogenic removals in their value chains to meet *non-FLAG targets*. Biogenic removals may be accounted for to meet *FLAG targets*.

1.4 FLAG criteria overview

Relevant criteria for FLAG targets are summarized in Table 1 below. Additional detail on each criterion is found in the sections listed.

Table 1. Summary of criteria and recommendations in this guidance linked to the relevant section

Topic	Criteria/ Recommendation	Description
Companies required to set FLAG targets	FLAG-C1 Sections 2.1	The SBTi requires companies that meet either of the following two criteria to set a FLAG-target: *i)* Companies with land intensive activities in their value chain from the following FLAG-designated sectors are required to set FLAG targets: • Forest and Paper Products – Forestry, Timber, Pulp and Paper, Rubber • Food Production – Agricultural Production • Food Production – Animal Source • Food and Beverage Processing • Food and Staples Retailing • Tobacco *ii)* Companies in any other SBTi-designated sector that have A) more than 20% of revenues coming from forests, land or agriculture; OR B) companies with FLAG-related emissions that total more than 20% of overall emissions across scopes 1, 2 and 3. **NOTE: Consultation feedback welcome on preference for an A) revenue-based or B) emissions-based criteria.**
Companies recommended to set FLAG targets	FLAG-R1 Section 2.1	Companies with FLAG-related emissions that are not required to set a FLAG target, are still encouraged to set FLAG targets.
Interim voluntary reporting period	FLAG-R2 FLAG-C2 Section 2.1.1	In an initial period following the FLAG tool and guidance release (March 2022-September 2022), the use of the FLAG tool to set FLAG targets is voluntary but recommended. From September 2022 onward, companies that meet the FLAG criteria (as per FLAG-C1) and are in the process of setting targets will be required to include FLAG targets.
Target boundaries and emissions coverage	FLAG-C3 Section 2.1.2	The FLAG target must cover at least 95% of FLAG-related scope 1 and 2 emissions. The FLAG target must cover at least 67% of FLAG-related scope 3 emissions. FLAG-related scope 3 emissions that are included in the FLAG target are separate from a company's non-FLAG 67% scope 3 target coverage.

Topic	Criteria/ Recommendation	Description
	FLAG-C4 Section 3.1	Companies must calculate their FLAG base year emissions (tCO2e) in line with the forthcoming GHG Protocol Land Sector and Removals Guidance (expected end of 2022).
	FLAG-R3 Section 3.1	The SBTi recommends that companies that will be required to set FLAG targets initiate GHG accounting from land and set FLAG targets even while waiting for the release of the GHG Protocol Land Sector and Removals Guidance (expected end of 2022). Once a public draft of the upcoming GHG Protocol is available (expected April 2022), SBTi recommends using that draft for accounting guidance.
Land related emissions, removals, & storage accounting	FLAG-C5 Sections 3.1.1, 3.1.2, 3.1.3	Companies that meet the relevant criteria are required to account for their land related emissions and removals, and include them in a FLAG target-starting in September 2022. Land related emissions accounting must include: *i)* Land use change (LUC): CO_2 emissions from land use change, including those associated with livestock feed. *ii)* Land management (non-LUC emissions): emissions from land management (primarily N_2O and CH_4). CO_2 emissions related to on-farm vehicle and to fertilizer production are also included, as these emissions are commonly embedded in accounting tools and emission factors associated with land management. *iii)* Carbon removals and storage: carbon sequestration from improved forest management, agroforestry, afforestation/reforestation, soil organic carbon and biochar. Emissions and removals from the production and end use of bioenergy shall *not* be included in FLAG target setting and shall be addressed in accordance with SBTi general criteria on bioenergy (See criterion C10, and recommendations R3 and R4)
	FLAG-R4 Section 3.1.1	SBTi recommends including indirect Land Use Change (iLUC) in the target boundary. This is consistent with the land reporting metrics outlined by GHG Protocol Land Sector and Removals Guidance.

Topic	Criteria/ Recommendation	Description
Zero deforestation commitments	FLAG-C6 Section 3.2	Companies setting FLAG targets are required to publicly commit to zero deforestation covering all scopes of emissions. Commitment language will be posted on the SBTi website, along with the SBT language, and should take the following form: "[*Company X*] commits to no deforestation across the value chain throughout the SBT target period, with a cut-off date of 2020." **NOTE: Consultation feedback welcome on any clarification needed for this criterion.**
	FLAG-R5 Section 3.2	SBTi highly recommends that companies align deforestation commitments with the Accountability Framework initiative (AFi) guidance.
FLAG target setting	FLAG-C7 Section 3.3	Companies must keep FLAG and non-FLAG targets and accounting separate. For the purposes of FLAG targets, relevant emissions include all emissions related to agriculture (to farm gate, excluding processing), land use change, and land management, including forestry (to yard excluding processing).
Level of ambition	FLAG-C8 Section 3.3	Both commodity-based and sector-based FLAG targets are consistent with scenarios that limit global temperature increase to 1.5°C. A company's overall target classification will be determined based on the ambition of its non-FLAG Scope 1 & 2 target.
Tool usage	FLAG-C9 Section 3.3.1	Companies with emissions associated with one of the nine available agricultural commodity pathways that account for 10% or more of a company's total FLAG emission (across all scopes) may use the commodity pathway for that commodity. Companies with emissions related to *timber & wood fiber* accounting for 10% or more of their FLAG emissions are *required* to use the commodity pathway for timber & wood fiber available in the commodity tool.
Base and target years	FLAG-C10 Section 3.3.2	In alignment with SBTi criteria, targets must cover a minimum of 5 years and a maximum of 10 years from the date the target is submitted to the SBTi for an official validation.

Topic	Criteria/ Recommendation	Description
		The base year must be no earlier than 2015.
Target validation and reporting	FLAG-R6 Section 3.3.2	In addition to a near-term FLAG target, companies are encouraged to develop a long-term FLAG target with a target year before 2050 aligned with the Net Zero Standard.
	FLAG-C11 Section 3.3.4	Companies must report removals and emissions separately for both baseline and annual emissions accounting.
	FLAG-C12 Section 3.3.4	When aggregating targets, companies must report on sub-targets in addition to the overarching, aggregated target.
Target communication	FLAG-R7 Section 3.3.5	Where relevant, companies are encouraged to consolidate FLAG commodity targets and the FLAG sector target into one combined FLAG target using the aggregator tool, though reporting on sub-targets is still required.
Target recalculation	FLAG-C13 Section 3.3.6	From April 2022, companies that submit targets for recalculation based on SBTi recalculation criteria must also set a FLAG target if the impacted target(s) include FLAG related emissions.

2 GETTING STARTED: WHO SETS A FLAG TARGET, COVERING WHICH EMISSIONS

This chapter provides additional detail on the SBTi-designated sectors that are required to set a FLAG target; FLAG tool options and interim period for using them; and specifications on emissions coverage.

2.1 Companies required to set a FLAG target

The SBTi requires companies that meet either of the following two conditions to set a FLAG-specific target, separate from its target/s for other emissions (FLAG-C1):

> *i)* Companies from the following SBTi-designated sectors are required to set a FLAG target: forest and paper products (forestry, timber, pulp and paper, rubber); food production (agricultural production); food production (animal source); food and beverage processing: food and staples retailing; and tobacco.
>
> *ii)* Companies in any other SBTi-designated sector which have more than 20% of revenues coming from forests, land or agriculture; OR companies which have FLAG-related emissions that total more than 20% of overall emissions across all scopes.
>
> Land intensive activities are likely to be relevant in the GHG inventories (especially in scope 3, category 1) of companies from the following sectors: retailing; containers and packaging; hotels, restaurants, leisure, and tourism services; textiles manufacturing, spinning, weaving & apparel; textiles, apparel, footwear and luxury goods; consumer durables, household and personal products, tire, building products, home building and construction materials. Other sectors may also be relevant for FLAG targets.

Further details on companies required to set FLAG targets are included in sections 3.2 and 3.3.

After the FLAG tool and guidance are finalized in March 2022, any company may set a FLAG target in addition to its other SBTi target/s. Companies with FLAG-related emissions that are not required to set a FLAG target are still encouraged to do so (FLAG-R1). All companies will be required to include FLAG-related emissions in their inventories in accordance with the GHG Protocol Land Sector and Removals guidance when it is released (expected end of 2022). Science-based FLAG targets will increase the credibility of the corporate climate commitments and help the companies initiate mitigation action in line with Paris Agreement goals.

2.1.1 Interim voluntary period for FLAG tool use

It is common practice in the SBTi to provide a six-month period for companies to familiarize themselves with the SBTi's new guidance and adjust their strategies accordingly.

In an initial period following the FLAG tool and guidance release (April 2022-September 2022), the use of the FLAG tool to set targets for forest, land, and agriculture emissions is voluntary but recommended (FLAG-R2). From September 2022 onward after the FLAG tool and guidance have been available for six months, companies operating under the conditions specified in section 2.1 (FLAG-C1) will be required to set a FLAG target (FLAG-C2).

Table 2. Expected evolution of FLAG target setting

Companies in the target setting process	**FLAG target setting timelines**		
	April 2022-Sept 2022	**Sept 2022 onward**	**June 2023 onward**
	Interim period: FLAG tools and guidance are released	*FLAG has been available for 6 months*	*FLAG and GHG Protocol guidance have both been available for 6 months (expected)*
Companies in the process of setting SBTs	**Recommended**	**Required**	**Required**
Companies in the process of recalculating SBTs	**Required**	**Required**	**Required**
Companies in the process of setting Net Zero targets	**Required**	**Required**	**Required**

*From June 2023, companies that need to recalculate targets based on new GHG Protocol Guidance must share plans on recalculation and resubmission with SBTi in alignment with their regular reporting cycle.

As indicated in table 2, the voluntary interim period does not apply to companies that are in process of recalculating SBTs (see more in section 3.3.6) or to companies in the process of setting Net Zero targets.

2.1.2 FLAG pathway options

The SBTi provides two approaches to FLAG target-setting, including:

- a FLAG sector approach for companies with diversified FLAG emissions and removals potential, and
- a commodity-based approach with 10 commodity pathways including: beef, chicken, dairy, maize, palm oil, pork, rice, soy, wheat, and timber & wood fiber.

Companies may combine multiple commodity pathways and the sector pathway as appropriate for target setting.

2.2 Target boundaries and emissions coverage

As per SBTi overall guidance, the FLAG target must cover at least 95% of FLAG-related scope 1 and 2 emissions and 67% of FLAG-related scope 3 emissions (FLAG-C3).

In alignment with SBTi criteria and recommendations, a scope 3 target is required if a company's scope 3 emissions are 40% or more of total scope 1, 2, and 3 emissions across all categories, including FLAG and non-FLAG emissions. For companies that meet the 40% threshold and are therefore required to have a scope 3 target, FLAG and non-FLAG emissions must be separated and each category covered at 67% (see example in Table 3).

Table 3. Examples of scope 3 target coverage at 67% for FLAG and non-FLAG emissions.

	Company A			**Company B**		
	Total	FLAG	Non-FLAG	*Total*	FLAG	Non-FLAG
Total scope 3 emissions	*1000*	800	200	*1000*	500	500
Target must cover (67%)	*670*	536	134	*670*	335	335

Table 4. Tool use and target boundaries by sector

SECTOR		Emissions coverage		User description	FLAG approach
		Scope 1	Scope 3*		
Food & Ag	• Food Production – Agricultural Production • Food Production – Animal Source	95%	67%	Land owner/ farming company with feedstock/livestock production corresponding to one or more FLAG specific agricultural pathways (existing FLAG commodity pathway).	**Sector** approach *or* **Commodity** approach
				Land owner/ farming company with feedstock/livestock production other than the 10 FLAG specific pathways.	**Sector** approach
	• Food and Beverage Processing • Food and Staples Retailing • Tobacco	–	67%	Companies with diversified land use intensity activities in their value chain.	
				Company with FLAG specific commodity production (commodity tool existing pathway) in their value chain.	**Sector** approach *or* **Commodity** approach
Forest	• Forest and Paper Products – Forestry, Timber, Pulp and Paper, Rubber	95%	67%	Company in the forest product industry; or landowner or land manager in the forestry product industry.	**Commodity** approach
Other**	• Consumer, Durables, Household and Personal Products • Containers and Packaging • Hotels, Restaurants, and Leisure, and Tourism Services • Textile Manufacturing, Spinning, Weaving & Apparel • Textile, Apparel, Footwear and Luxury Goods • Retailing • Tire • Any other with significant land emissions	95%	67%	Companies with emissions related to **timber & wood fiber** accounting for 10% or more of their FLAG emissions	**Commodity** approach
				Company with FLAG specific commodity production (commodity tool existing pathway) in their value chain.	**Sector** approach *or* **Commodity** approach
				Company with diversified land use intensity activities in their value chain.	**Sector** approach

*Scope 3 emissions coverage does not apply to agricultural companies with land partners. Companies using other land (externally owned) to their own production must include their land related emissions at 95%.
**If A) > 20% revenues coming from forests, land or agriculture; OR if B) > 20%of overall GHG emissions associated with land intensity activities.

3 OVERALL GUIDANCE ON SCIENCE-BASED TARGET-SETTING FOR FLAG

After a company has determined whether to set a target and what the target should encompass (Chapter 2), Chapter 3 provides guidance on the main steps to set FLAG targets. It specifies the conditions for embarking on the FLAG target-setting journey: prerequisites associated with land related GHG accounting (section 3.1), and the requirement to make a commitment to zero deforestation (section 3.2). Section 3.3 provides guidance on which FLAG tool should be used for target-setting and provides the step-by-step guidance on the target-setting process.

3.1 Accounting for land-related emissions

Science-based targets (SBTs) are based on the emissions calculated and reported by the company. As such, companies should strive to use the best available data in their GHG emissions accounting. To set a FLAG target, companies must first accurately calculate their land-related emissions (i.e. FLAG base year emissions as specified in the FLAG tool).

The two FLAG approaches available with this guidance (FLAG sector approach and FLAG commodity approach) seek to align with the upcoming GHG Protocol Land Sector and Removals Guidance which is expected to be published at the end of 2022. The guidance will explain how companies should account for emissions and removals from land management, land use change, biogenic products, technological CO_2 removals, and related activities in GHG inventories. It will take a value chain approach to provide corporate level accounting and reporting guidance, which will be especially valuable given the limited guidance on corporate level AFOLU inventories to date. Moreover, the guidance will apply to emissions both upstream and downstream and apply to both producers and consumers, with the main focus on accounting and reporting emissions for different carbon pools: land, geologic, and product. FLAG guidance may be updated as needed to align with GHG Protocol Land Sector and Removals Guidance once finalized.

Starting in September 2022, companies that fall under the relevant sector classifications and emission thresholds will be required to account for FLAG-related emissions and appropriate removals/storage in alignment with the forthcoming GHG Protocol Land Sector and Removals Guidance and to include them in their target boundary (FLAG-C4). While the GHG Protocol guidance is still under development, companies with land-intensive operations can still prepare for and set FLAG targets. The SBTi recommends that companies interested in setting FLAG targets prior to GHG Protocol Land Sector and Removals Guidance finalization proceed with target-setting using currently available references below (see FLAG-R3).

BOX 1. Current available guidance

While the GHG Protocol Land Sector and Removals Guidance is under development, we recommend the use of "Accounting for Natural Climate Solutions Guidance" (Quantis, 2019) which provides the most complete available guidance for companies to account for FLAG-related emissions. Once a public draft of the GHG Protocol Land Sector and Removals Guidance is available, SBTi recommends using that draft. Additional guidance documents that may be of use are listed below in Table 3.

Table 5. Guidance documents for calculating FLAG emissions

Publisher	Document
GHG Protocol	• Land Sector and Removals Guidance (public draft expected Apr, 2022) • Corporate Standard • Scope 3 Standard • Product Standard • Agriculture Guidance
IPCC	• Guidelines for National GHG Inventories. • 2006 Guidelines, Good Practice Guidance for LULUCF • 2019 Refinement
ISO	• ISO 14064 1:2018
Quantis	• Accounting for Natural Climate Solutions Guidance
Gold Standard	• Value Change Initiative. • Value Chain (Scope 3) Interventions & Soil Organic Carbon Guidance

The following sections 3.1.1-3.1.3 provide a description of the emissions and removals covered under the FLAG pathways. Table 6 below indicates these sources according to the three main categories covered in the FLAG pathways: land use change (LUC) emissions, land management, and carbon removals & storage.

Table 6. GHG emissions covered in the FLAG Pathways

Land use change (LUC) emissions	• CO_2 emissions from direct LUC associated with deforestation and forest degradation. • CO_2 emissions from indirect LUC associated with deforestation and forest degradation.
Land management (non-LUC emissions)	• CH_4 emissions from manure management • Enteric CH_4 emissions (Meat-Beef, Dairy) • CH_4 emissions from flooded soil (for lowland rice only) • Direct and indirect N_2O emissions from manure management • Fertilizer: direct N_2O emissions from soil due to fertilizer application • Fertilizer: indirect N_2O emissions from leaching, runoff and volatilization • N_2O emissions from crop residue • CH_4 and N_2O emissions from agricultural waste burning • CO_2 emissions from machinery used on farm • CO_2 emissions from fertilizer production
Carbon removals & storage	• Forest management: carbon sequestration from improved forest management activities. • Afforestation and reforestation: *i)* carbon sequestration from afforestation and reforestation (forest as defined in FAO); *ii)* carbon sequestration by shifting from non-forest cover to forest cover at 30% tree cover threshold (mix of plantation forestry and natural forest regrowth). • Agroforestry: carbon sequestration from adding aboveground woody carbon storage in agriculture systems (crop and pasture pixels with <25% tree cover). • Soil organic carbon: carbon sequestration by shifting from current management to no-till management. • Biochar from crop residues: carbon sequestration by amending agricultural soils with biochar.

Sources: compiled from Roe et al. 2019, and Smith et al. 2016.

Please note that the FLAG pathways do not include land use emissions associated with bioenergy feedstock in their current version. Bioenergy emissions and removals cannot be included in FLAG target setting, but must be included in non-FLAG target setting. The SBTi provides specific guidance for including bioenergy emissions as per criterion 10 (C-10), and related recommendations (R-3 and R-4) in the SBT Criteria and Guidance document.

3.1.1 Land Use Change (LUC) emissions

Land use change (LUC) involves a change from one land use category to another. *Direct* Land Use Change (dLUC) occurs when carbon stocks decline due to a change in land use. *Indirect* land-use change (iLUC) occurs when carbon stocks on other lands decline as a consequence of change in land use within the area of focus. From the perspective of a company, iLUC is defined by the GHG Protocol as a recent (i.e., previous 20 years) carbon stock loss due to land conversion on lands not owned or controlled by the company, or in its supply chain, induced by change in demand for products produced or sourced by the company.

iLUC is often mediated by markets or driven by policy shifts in land use that cannot be directly attributed to land-use management decisions of individuals or groups (IPCC, 2006). Hence, emissions associated with iLUC cannot be measured but are instead estimated. These estimates use econometric models that make assumptions about future impacts (e.g. future yield improvement, where expansion and abandonment take place, role of climate change effects, CO_2 fertilization effects on yield) and the interactions between different input parameters (e.g. trade patterns, feed composition, role of by-products, reference period). Consequently, accounting for iLUC emissions is always subject to high uncertainty.

The SBTi recommends but does not require companies to include iLUC in target calculations, but does require that direct Land Use Change (dLUC) be quantified and included in the target boundary, consistent with GHG Protocol guidance (FLAG-C5). dLUC may be estimated quantitatively from the changes in carbon stocks (i.e., in biomass, dead organic matter and soil carbon pools) over an assessment period (i.e., 20 years or harvest cycle/ rotation period if greater than 20 years) associated with previous/converted land (e.g., grassland; forest land, pasture) and the land use after conversion (e.g., soya, palm oil, etc.) (IPCC, 2006). For consistency with the methods used in the FLAG pathways, the IPCC, and GHG Protocol Land Sector and Removals Guidance, companies must allocate emissions from land use change over 20 years (using linear discounting) following the land use change event (IPCC, 2003; Quantis, 2019).

Companies shall use the most representative actual data to calculate LUC emissions[1]. Although companies are not required to include iLUC in their accounting or target setting, the FLAG sector pathway implicitly includes iLUC because it accounts for all global LUC. The FLAG commodity pathways include country-level iLUC, as estimates in LUC are derived from country-level data. Thus, companies are encouraged to include iLUC in target setting, if they have access to iLUC data associated with their land activities in order to have a more comprehensive FLAG target (FLAG-R4).

[1] Actual data demonstrating the occurrence of positive or no LUC emissions resulting from other changes in land use (e.g. degraded land to agriculture) can be used by companies if those are reported from reliable company's specific GHG accounting, including objective evidence (*e.g.* audited information).

3.1.2 Land management (non-LUC emissions)

Companies are required to account for land management emissions (alongside LUC CO_2 emissions) and include them in their target boundary (FLAG-C5). These emissions include all land-related emissions excluding those related to land use change. They constitute all net biogenic CO_2 emissions related to land management impacts on carbon stock changes within a given land use, as well as other anthropogenic GHGs from management of agriculture systems: organic and inorganic inputs or outputs from agriculture that release significant amounts of N_2O and CH_4 to the atmosphere (see table 6).

Fossil fuel CO_2 emissions from machinery such as tractors and irrigation pumps are not technically 'land-based emissions' but may be integrated in companies' FLAG emissions accounting and target boundary, following common practice in land emissions accounting. Similarly, energy emissions embedded in fertilizer inputs may be integrated in companies' FLAG emissions accounting and target boundary. These emissions may alternatively be included in a non-FLAG target; companies should ensure that they are accounted for but not double counted across FLAG and non-FLAG targets.

3.1.3 Carbon removals & storage

The GHG Protocol Land Sector and Removals Guidance defines net biogenic CO_2 emissions as instances where net land carbon stock decreases occur, and defines net biogenic CO_2 removals as instances where net land carbon stock increases occur, are stored for a period of time, and meet certain reporting criteria (WRI, 2020). Biogenic removals are usually associated with one or more of the following carbon pools: biomass (above and below ground), dead organic matter (dead wood and litter), and soil organic matter.

In FLAG target development, emissions and removals must be reported separately. The overarching FLAG target may net emissions and removals because in an inventory accounting approach, changes may be accounted as emissions or removals dependent on the starting point. Removals may only be included in FLAG targets when the appropriate specifications are met, following GHG Protocol Land Sector and Removals Guidance (FLAG-C5). Removals may not be used to meet any other non-FLAG targets under SBTi. (For example, removals from soil carbon may be included in a FLAG target, but would have no impact on a non-FLAG target. See section 3.3 for additional example.)

In accordance with GHG Protocol Land Sector and Removals Guidance, companies should only include CO_2 removals with ongoing storage and monitoring (e.g. afforestation / reforestation, agricultural soil carbon with increased soil carbon with increased carbon stock remained in the soil or vegetation)[2] in net GHG targets, since only removals with ongoing storage contribute to reducing cumulative global emissions which drive climate change. Further details on the

[2] 'Ongoing storage' is also sometimes referred to as 'permanence''. Various types of carbon sinks have an inherent risk of future reversals. The permanence of carbon stock relates to the longevity of the stock (i. e. how long the increased carbon stock remains in the soil or vegetation. (IPCC, 2014).

specifications of ongoing storage will be elaborated based on GHG Protocol; in the meantime, companies should refer to Quantis NCS guidance and GHG Protocol Land Sector and Removals drafts (expected April 2022).

Forest restoration that occurs on working lands (for example, silvopasture) is included in the FLAG sector target, but reforestation outside of working lands is otherwise excluded from targets because these efforts are generally outside of company supply chains. Models will be updated as needed to align with GHG Protocol guidance on this topic.

Product carbon storage is not included in FLAG targets, following current GHG Protocol accounting guidance. Data used for FLAG target development do not include product carbon storage. Should GHG Protocol Land Sector and Removals guidance issue new direction on product carbon storage, additional review would be needed to assess feasibility and intent for target setting. SBTi FLAG addresses removals in coordination with the GHG Protocol Land Sector and Removals Guidance with particular attention to in-scope removals for land intensive sectors, and does not include removals that are not part of a FLAG target or that are outside the FLAG sector (e.g. direct air capture or other technological removals).

3.1.4 Data Quality

Companies must use data that are the most representative of the actual FLAG related emissions. Companies should collect high quality ('primary') data from suppliers and other value chain partners for scope 3 activities deemed most relevant and/or strategically targeted for GHG reductions. Companies setting FLAG targets should follow data quality guidelines provided by the GHG Protocol Land Sector and Removals Guidance. Additional guidance on data quality issues for scope 3 emissions is provided in Chapter 7 of the GHG Protocol Value Chain (Scope 3) Standard.

The embedded decarbonization pathways in both the FLAG sector and commodity approaches are global (see this document, Chapter 4), meaning the tool provides no regional breakdowns. However, companies should use the most granular data available in developing their annual inventories.

Default activity data are acceptable, but they are less accurate and limit a company's ability to track performance and progress towards targets. Thus, when used, the source and potential uncertainty of the adopted default data should be clearly disclosed.

Regardless of limitations around data quality, companies are encouraged to set science-based targets as soon as possible. Companies can have targets in place while continuing to improve their reporting through collaboration with suppliers. Any adjustments to accounting methodologies should be disclosed and implemented in accordance with the GHG Protocol Corporate and Value Chain Standards. Any impact of those adjustments on the company targets should be assessed in line with SBTi criteria and recommendations, which call for target recalculation when major changes in inventories occur.

3.2 Zero deforestation commitments

In addition to the GHG accounting of land- related emissions, the SBTi requires the implementation of zero deforestation commitments as a complementary step in the target-setting and validation process (FLAG-C6). Because reducing emissions from deforestation is one of the highest priorities across FLAG decarbonization pathways, as represented by hundreds of companies participating in zero deforestation commitments across the New York Declaration on Forests, the Consumer Goods Forum, and others, a commitment to zero deforestation is an additional requirement for FLAG target setting and SBTi validation. Companies setting FLAG targets are required to publicly commit to zero deforestation covering all scopes of emissions. Commitment language will be posted on the SBTi website, along with the SBT language, and should take the following form:

"[Company X] commits to no deforestation across the value chain throughout the SBT target period, with a cut-off date of 2020."

Companies are recommended to meet their zero deforestation commitments as soon as possible. Alignment of deforestation targets with the Accountability Framework initiative (AFi) guidance is recommended and reflects current best practice (FLAG-R5).

Within the Integrated Assessment Models (IAMs) on which FLAG pathways are based, emissions from deforestation are combined with other conversion of natural lands, including the burning of peat. For this reason, we also recommend that companies set a zero land conversion and peat burning target across their value chains, and companies are recommended to meet their zero conversion and peat burning commitments as soon as possible. This is not a requirement for SBTI target validation; however, it would likely be difficult to achieve a company's FLAG target without stopping these activities within their value chains.

3.3 Practical steps to set a FLAG target

Companies that set FLAG targets are required to keep FLAG and non-FLAG targets and accounting separate (FLAG-C7). This separation is important because FLAG targets can include appropriate biogenic removals while non-FLAG targets do not include removals. Removals are included in FLAG targets because they are an important part of land-based mitigation: more than 50% of the global mitigation opportunity related to land is from removals. Of course, science-based targets aligned with the Paris Agreement also require significant emissions reductions from fossil fuels (non-FLAG), not based on removals, so FLAG and non-FLAG targets are kept separate to ensure preservation of science-based targets.

FLAG targets are calculated by using the FLAG sector approach (absolute contraction method) or the FLAG commodity approach (physical intensity convergence method) (see more on the methods in Appendices 1 and 2). Intensity pathways are available for 10 commodities: beef, dairy,

pork, chicken, rice, soy, palm oil, maize, wheat, and timber & wood fiber. FLAG targets can be expressed on an absolute basis (tCO_2e) or intensity basis (e.g. tCO_2e/ t of fresh weight, for the commodity tool only).

Both the FLAG sector approach and commodity approach are consistent with scenarios that limit global temperature increase to 1.5°C. (FLAG-C8).

The following subsections describe the steps companies setting FLAG targets need to undertake, from choosing the appropriate FLAG approach to communicating and reviewing the FLAG target.

3.3.1 Choosing the appropriate tool for the FLAG target setting

Companies may choose the appropriate approach(es) according to the sector(s) in which they operate in order to set a FLAG target (see table 7).

Table 7. Typology of FLAG tools and users

Approach	Users
FLAG Sector Approach	Companies with diversified land-intensive activities in their supply chain, and/or with limited access to data from suppliers; companies with land-based emissions that are not covered by the commodity approach.
Calculate targets for diversified FLAG emissions	Companies with emissions associated with a commodity included in the commodity approach, but where emissions from the commodity in question are less than 10% of the company's overall FLAG emissions.
FLAG Commodity Approach	
Calculate targets for FLAG commodity-specific emissions • *Beef* • *Chicken* • *Dairy* • *Maize* • *Palm oil* • *Pork* • *Rice* • *Soy* • *Wheat* • *Timber & wood fiber*	Companies with emissions associated with one of the nine available agricultural commodity pathways that account for 10% or more of a company's total FLAG emission may use the commodity pathway for that commodity. Companies with emissions related to **timber & wood fiber** accounting for 10% or more of their FLAG emissions are required to use the commodity pathway for timber & wood fiber available in the commodity tool.

Companies may use both FLAG sector and commodity approaches: a single company may have one or more commodities for which the commodity tool is suitable, and other FLAG emissions for which the FLAG sector tool is appropriate. Companies can aggregate commodity and sector approaches into a combined FLAG target using the FLAG target aggregator.

Companies with emissions associated with one of the nine available agricultural commodity pathways that account for 10% or more of a company's total FLAG emission (across all scopes) may use the commodity pathway for that commodity.

Companies with emissions related to *timber & wood fiber* accounting for 10% or more of their FLAG emissions are *required* to use the commodity pathway for timber & wood fiber available in the commodity tool. (FLAG-C9).

3.3.2 Definition of a target period

All new near-term science-based targets must cover a minimum of 5 years and a maximum of 10 years from the date the target is submitted to the SBTi for validation. SBTi recommends that companies keep the same target timeframe (base year and target year) across FLAG and non-FLAG targets when possible (FLAG-C10).

Companies are encouraged to develop long-term targets in addition to near-term targets (i.e., long-term science-based targets in line with SBTi Net Zero criteria) (FLAG-R6). Companies wishing to commit to Net-Zero targets must also set near term (5-10 years from submission) FLAG targets. As indicated in table 2, companies that meet FLAG criteria as per FLAG-C1, and wish to set Net Zero targets, must also include FLAG near term targets from April 2022 and on.

When using the FLAG tool, the users must provide two data items related to the target period: the FLAG base year and the FLAG target year.

FLAG base year

Base years are used to calculate the ambition of most types of targets and to track progress against all targets. The earliest base year that can be selected by the company in the current version of the FLAG tool is 2015. For companies using the FLAG sector approach for a base year prior to 2018 (the first year for which data are available in the FLAG sector approach), linear back casting of the FLAG sector approach will be required.

FLAG target year

All new near-term science-based targets must cover a minimum of 5 years and a maximum of 10 years from the date the target is submitted to the SBTi for validation. SBTi recommends that companies keep the same target timeframe across FLAG and non-FLAG targets when possible (FLAG-C10). The SBTi criteria on forward-looking ambition also applies to FLAG targets.

3.3.3 Entering base year FLAG emissions in the FLAG tool

FLAG base year emissions shall be expressed in tonnes of carbon dioxide equivalent using GWP 100. Base year emissions must include (see section 3.1):

- Land management / Land use emissions;
- LUC emissions (at least direct LUC); and
- Removals

Companies are not required to include indirect land use changes (iLUC) in their GHG inventories, but the SBTi highly recommends taking iLUC into account following GHG Protocol Land Sector and Removals guidance on land tracking metrics. Note that the models considered in both FLAG tools capture both LUC and iLUC emissions in the target development (see more in chapter 4). Table 8 summarizes data needs in addition to the base year, target year, and base year emissions for each FLAG approach.

Table 8. Data needs for FLAG target development

TOOL	FLAG **SECTOR** APPROACH	FLAG **COMMODITY** APPROACH
Target Setting Approach	Absolute Contraction	Intensity based
Scenario	1.5 C[a]	
DATA types	DATA needs	
FLAG Base year	*required*	*required*
FLAG Target year [b]		
FLAG Base year emissions (tCO_2e) [c]		
Commodity production in base year (kg or m^3)	*N.A.*	
Production target year (definition)		
Disaggregated LUC emissions from other FLAG (non-LUC) emissions (tCO_2e)		*optional*

[a] 1.5°C is the temperature target available for all FLAG pathways. Commodity pathways were originally developed for 2°C, but in extensive consultation were determined applicable for 1.5°C because mitigation associated with agriculture is broadly consistent between 1.5°C and 2°C scenarios.
[b] The target year must cover 5-10 years from the date of the target submission (section 3.2.3).
[c] GHG accounting of land-related emissions in the FLAG base year, including LUC and other FLAG related emissions. LUC emissions must include at least direct emissions from land use change; it is recommended to include indirect emission from land use change as well.

In the FLAG Sector approach**,** the FLAG base year emissions are the total land-related activity emissions in tonnes of CO_2e in a company's full GHG inventory for the selected FLAG base year. In the sector-based approach, LUC (direct and indirect) related to deforestation and removals is covered by allocating emissions reductions and removals across the entire FLAG sector.

In the FLAG Commodity approach, FLAG base year emissions are the land-related emissions associated with the company's commodity production or procurement in the selected FLAG base year. The FLAG commodity tool also covers LUC (direct and indirect) related to deforestation and removals. These removals are subtracted from the total commodity emissions to provide a net emission value per year in the unit of tons of CO_2e.

LUC and non-LUC (land management) emissions may optionally be input separately when using the FLAG Commodity approach, but not for the FLAG Sector approach. In the Commodity approach, base year emissions may be entered either as a total emissions value or separate values for LUC and non-LUC emissions. If companies enter only total emissions, a default value for LUC emissions is assigned.

The FLAG approaches do not include land use emissions associated with bioenergy feedstocks in their current version. WWF has been studying this topic in alignment with the development of the upcoming GHG Protocol Land Sector and Removals guidance, and will include an explicit and pragmatic modeling approach for companies at a later date. While waiting for the upcoming GHG Protocol Land Sector and Removals guidance, the SBTi provides specific guidance to include those emissions in its overall non-FLAG specific target setting as per C10 V.5. (see section 3.1.4).

3.3.4 FLAG target validation

To begin the target validation process, companies must submit the FLAG-specific SBTi science-based target submission addendum. The addendum requires disclosure of emissions per scope in the base year, activity figures, and other data to perform the assessment.

Although companies are required to set net FLAG targets – land-related emissions combined with removals – in the validation process, companies must report emissions reductions and removals accounting separately (FLAG-C11). This is important to maintain a focus on reducing cumulative emissions to the atmosphere, while separately increasing CO_2 removals.

Companies using aggregated FLAG sector (absolute contraction) and FLAG commodity (intensity) approaches are required to provide the calculation details separately for each FLAG pathway included in target development. For aggregated FLAG targets, companies only need to meet the overarching target, not each sub-target (per commodity, for example).

However, for transparency, companies must report on sub-targets in addition to the overarching, aggregated target (FLAG-C12).

3.3.5 Communication of the FLAG target

Companies must communicate their FLAG target by indicating the base year and target year selected, and the percentage reduction (either absolute or intensity) in the target period (see Box 2).

For the sake of clarity, companies setting a FLAG target for multiple commodity categories or using a combination of the sector pathway and the commodity pathway can aggregate results to obtain a single GHG reduction target by using weighted averages per the FLAG target aggregator (FLAG-R7). The FLAG Commodity approach provides a function to translate intensity targets to absolute numbers which may be combined with absolute targets for the communication of one single FLAG target.

BOX 2. Shorter statements are clearer and more transparent

- Absolute target (FLAG-Sector approach):

  [Company name] commits to reduce absolute [*enter scopes]* FLAG GHG emissions [*percent reduction] %* by [*target year]* from a [*base year]* base year.

- Intensity target (FLAG-Commodity approach):

  [Company name] commits to reduce [*enter scopes]* FLAG GHG emissions [*percent reduction] %* per [*unit]* by [*target year]* from a [*base year]* base year. [This may include multiple % targets per commodity, or a single averaged target across commodities.]

3.3.6 FLAG target review process and target recalculation

The SBTi regularly updates its criteria and methods to reflect current best practices and the latest science. Thus, setting targets under the SBTi includes a continual engagement process that involves target review and company target updates. In general, the criteria review process happens every two years.

To ensure consistent performance tracking over time, targets must be recalculated to reflect any significant changes that would compromise a target's relevance and consistency. The SBTi recommends that companies publicly report company-wide GHG emissions inventory and progress against published targets on an annual basis. At a minimum, targets should be reassessed every five years.

From April 2022, companies that meet the FLAG criteria as per FLAG-C1, and submit targets for recalculation based on SBTi recalculation criteria, will be required to account for their FLAG related emissions and set a FLAG target (FLAG-C13).

Please note that some companies setting FLAG targets before the release of the new GHG Protocol Guidance will need to share plans on recalculation and resubmission with SBTi in alignment with their annual inventory and reporting cycle (see table 2).

Companies should notify the SBTi of any significant changes and report these major changes publicly.

A target recalculation should be triggered by significant changes in:

- Scope 3 emissions become 40% or more of aggregated scope 1, 2 and 3 emissions
- Emissions of exclusions in the inventory or target boundary change significantly
- Significant changes in company structure and activities (e.g. acquisitions, divestitures, mergers, insourcing or outsourcing, shifts in goods or service offerings)
- Significant adjustments to the base year inventory or changes in data to set targets such as growth projections (e.g. discovery of significant errors or a number of cumulative errors that are collectively significant)
- Other significant changes to projections/assumptions used in setting the science-based targets

The SBTi reserves the right to withdraw or adjust the tool at any time for updates and/or amendments to its calculations or third-party data. Adjustments can include changes to the decarbonization pathways embedded in the tool, which need to reflect model improvements and changes in the remaining carbon budget available as the world strives to mitigate GHG emissions across all sectors in the economy. For further details, please refer to the terms of use and disclaimer in the FLAG tool.

4 METHODOLOGICAL CHOICES

SBTi FLAG combines two mitigation approaches for determining the FLAG target:

i) a FLAG Sector approach for companies with diversified emissions or which are further from direct production;

ii) a FLAG Commodity approach including 10 specific FLAG commodities for companies with focused commodity emissions.

This chapter provides an overview of the methodological choices covering the development of the FLAG tool, and explains how FLAG pathways align with the latest climate science that would limit global temperature rise to 1.5 C above pre-industrial levels. Appendices 1 and 2 provide detailed information about data and further information on the methods used.

4.1 Robust science-based 1.5°C aligned pathways

The FLAG Sector pathway has been developed from Roe et al. (2019), 'Contribution of the land sector to a 1.5°C world', a scientific research review paper published in *Nature Climate Change* on the land sector's contribution to limiting warming to 1.5°C.

Roe et al. compiled all of the available studies, including the relevant scenarios from the SSP and IAMC databases along with the relevant bottom-up peer reviewed studies, to inform an implementation roadmap to 2050 for land sector mitigation. Land sector mitigation includes reducing emissions from land use change, reducing emissions from agriculture, shifting to plant-based diets, reducing food waste, restoring forests, improved forest management and agroforestry, and enhanced soil carbon sequestration and biochar in agriculture.

This study was derived from four complementary analyses: (1) review of 1.5°C scenarios across all sectors, (2) comparative analysis of top-down modeled pathways in the land sector, (3) bottom-up assessment and synthesis of land-sector mitigation potential and (4) a geographically explicit road-map of priority mitigation actions to fulfill the 1.5°C land-sector transformation pathway by 2050, informed by the first three analyses (for details see the Supplementary Information from Roe et al. (2019).

The FLAG Commodity pathway models are described in Smith et al. (2016), 'Science based GHG Emissions targets for agriculture and forestry commodities' a report by the University of Aberdeen, Ecofys, and PBL Netherlands Environmental Assessment Agency. The commodity pathways data are developed from the IMAGE 3.0 Integrated Assessment Model.

4.2 Two approaches to account for land related emissions and removals

4.2.1. FLAG Sector pathway

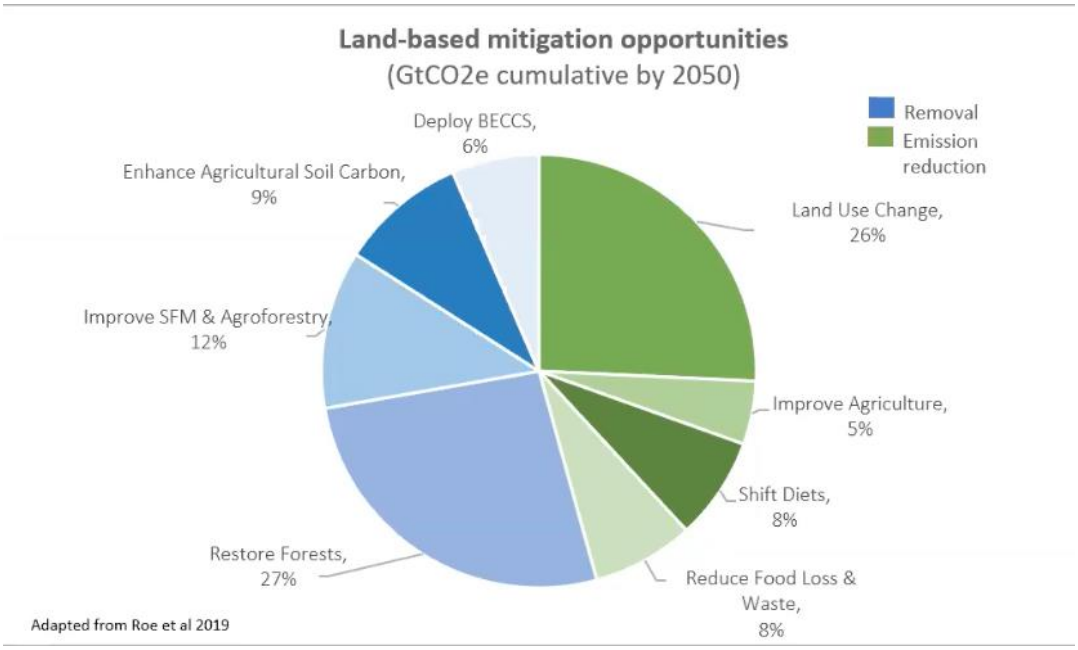
The FLAG Sector pathway uses integrated assessment models net CO_2, CH_4 and N_2O emissions trajectories for AFOLU and BECCS, and bottom-up studies of the range of technical, economic and sustainable mitigation potential of 24 land-based activities to review and categorize mitigation into seven priority mitigation measures (wedges), namely:

- Land Use Change,
- Improve Agriculture,
- Shift Diets,
- Reduce Food Loss and Waste,
- Restore Forests,
- Improve SFM & Agroforestry, and
- Enhance Agriculture Soil Carbon

These categories were determined after the study established a viable mitigation target (sum of emission reductions and removals) for the land sector of approximately 14 GtCO2e yr−1 (15 GtCO2e yr−1 with BECCS) in 2050. After this target was established, it was then divided into the buckets, or wedges, as listed in the categories above.

The green wedges in Fig. 1 represent emission reduction measures (7.4 GtCO2e yr−1), and the blue wedges represent carbon removal measures (7.6 GtCO2e yr−1). Each wedge indicates the percentage in emission reduction activities and cumulative GtCO2e for carbon removal activities for 2050 (starting in 2020).

Figure 1. Wedges of land-based mitigation priority measures.



Although BECCS is included in land-based mitigation opportunities, as depicted in Fig. 1, it is not included in the FLAG sector pathway because there is no need to specifically incentivize deployment of BECCS within FLAG.

The science-based rate of mitigation in the FLAG Sector pathway is 3.5%/yr. This means that the reduction rate corresponding to ten years (e.g., from base year 2020 to target year 2030) is 35% reduction for a company using the FLAG Sector Pathway rate (Figure 2).

4.2.2. FLAG Commodity Pathways

The commodity approach is currently available for 10 major commodity pathways: beef, dairy, pork, poultry meat and eggs, timber & wood fiber, rice, soy, palm oil, maize, and wheat. These 10 commodities were selected because of their high carbon footprints. Timber & wood fiber was newly developed to ensure coverage of the forestry sector.

The commodity pathways as elaborated by Smith et al (2016) have been updated to include LUC emissions related to each commodity. These updates draw on data from Roe et al 2019 to ensure consistency between the FLAG sector and FLAG commodity approaches. The commodity pathways as elaborated by Smith et al (2016) have also been updated under FLAG to include removals (soil carbon, biochar, and forest carbon). Finally, the timber & wood fiber pathway, which was not elaborated in Smith et al was developed for FLAG. These three major updates for FLAG target setting under the commodity pathways (incorporation of LUC, addition of removals, and

elaboration of timber & wood fiber) were completed by a team from Quantis. The detailed methods for each of these additions can be found in the 'resources section on the SBTi FLAG website.

Table 9. Summary of FLAG pathways. Note, as appropriate, commodity pathways and the sector pathway may be combined for an aggregated FLAG target. These are draft targets; changes may occur for the final version.

Pathway name	Pathway type	Units	% reduction (2020-2030)	Annual % reduction (%/yr)
FLAG Sector approach	Absolute	GT CO2e	35%	3.5%
FLAG Commodity-Beef	Intensity	tCO2e/t fresh wt	26%	2.6%
FLAG Commodity-Dairy	Intensity	tCO2e/t fresh wt	31%	3.1%
FLAG Commodity-Chicken*	Intensity	tCO2e/t fresh wt	36%	3.6%
FLAG Commodity-Pork*	Intensity	tCO2e/t fresh wt	32%	3.2%
FLAG Commodity-Corn*	Intensity	tCO2e/t fresh wt	35%	3.5%
FLAG Commodity-Wheat*	Intensity	tCO2e/t fresh wt	36%	3.6%
FLAG Commodity-Soy*	Intensity	tCO2e/t fresh wt	38%	3.8%
FLAG Commodity-Palm Oil*	Intensity	tCO2e/t fresh wt	31%	3.1%
FLAG Commodity-Rice*	Intensity	tCO2e/t fresh wt	29%	2.9%
FLAG Commodity Timber & Wood Fiber**	Intensity	m3 solid under bark	200,000 tCO2e	-220,000 tCO2e
Non-FLAG / Mixed sector pathway	Absolute	GT CO2e	42%	4.2%

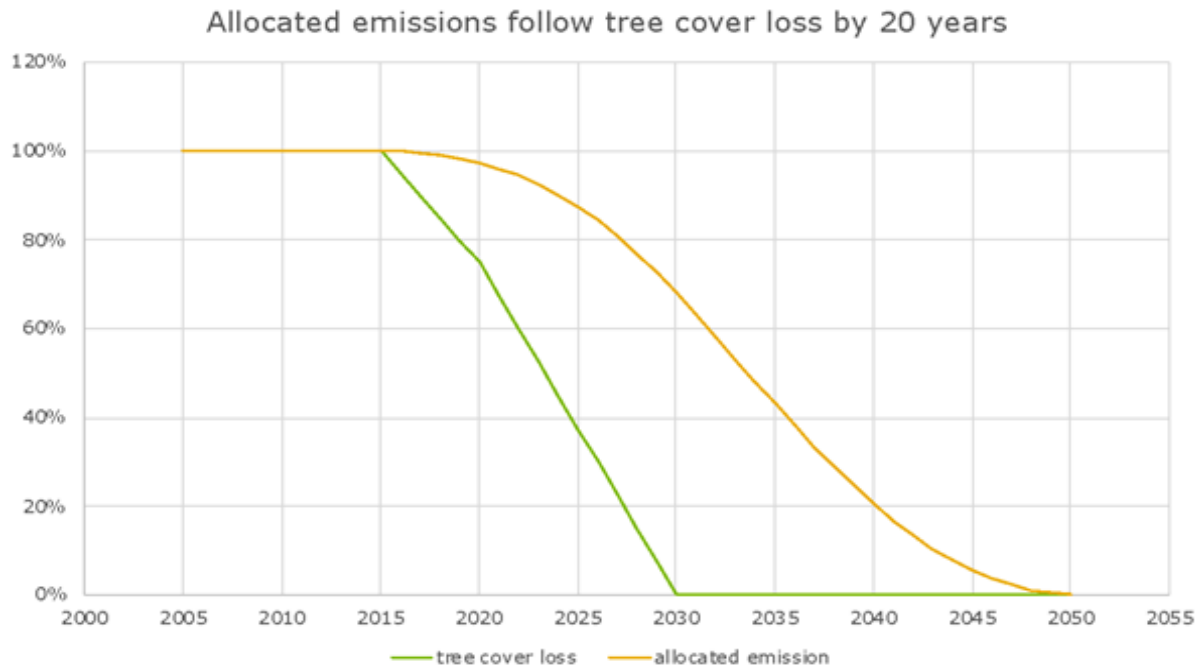
*Reduction rates listed here assume no projected growth.
**Because most of the mitigation effort under timber & wood fiber is via removals and emissions are very small, percentages are not representative for these pathways (small denominator). Instead, representative absolute values are given including emissions and removals.

4.3 How is deforestation addressed?

Deforestation-related emissions represent 12% of global emissions and 50% of AFOLU emissions (Roe et al., 2019). In addition, deforestation causes GHG emissions (e.g. from soil) that can extend beyond the year when the forest's trees are cut down.

The SBTi FLAG methodological approach allocates deforestation emissions using linear discounting over 20 years following a deforestation event (see Figure 2) – a 20-year 'legacy emissions factor' allocation rule is commonly accepted based on IPCC Good Practice Guidance for LULUCF (Penman et al., 2003) and is also reflected in the GHG Protocol (WRI and WBCSD, 2014). Given these accounting principles and in accordance with the science, the FLAG sector and FLAG commodity models achieve zero deforestation by 2030.

Figure 2. Deforestation and deforestation emissions pathways.



Because commodity-driven deforestation must stop as soon as possible in alignment with the AFI guidance, the FLAG guidance introduces criteria for companies to set zero deforestation goals (section 3.2).

4.4 Combination of up-to-date open data sources

The modeled data used in the FLAG Sector pathway (Roe et al., 2019) was primarily taken from the Shared Socioeconomic Pathway (SSP) Database (Rogelj et al., 2018) and the Integrated Assessment Modeling Consortium (IAMC) Database 1.5°C Scenario Explorer (Huppmann, al., 2018). The authors also used individual studies of 1.5°C carbon budgets (Rockström et al., 2017; Goodwin et al., 2018; Millar et al., 2018; Schurer et al., 2018; Tokarska & Gillett, 2018; Walsh et al., 2017). Relevant data supporting the findings of Roe's study are available in the Supplementary Information (Roe et al., 2019).

The FLAG Commodity pathways developed from Smith et al. (2016) report are based on the IMAGE 3.0 Integrated Assessment Model, which simulates global and regional environmental consequences of changes in human activities to project future GHG emissions, in this case of particular commodities. The IMAGE 3.0 model considers 26 regions globally[3]. The IMAGE data

[3] Regarding regional disaggregation of data, the commodity approach requires setting a target against a global mitigation pathway. However, SBTi FLAG has also developed individual commodity pathways for each commodity in 26 regions of the world. These regionalized data are available at [WWF's website].

regarding oil crops (soybean and palm oil) were initially combined. They have been disaggregated based on FAO data. The commodity pathways also include use of FAOSTAT land use data[4].

[4] http://www.fao.org/faostat/en/#data

GLOSSARY

Definitions used from FAO and AFi where relevant. Others from the GHG Protocol.

Afforestation	Establishment of forest plantations on land that, until then, was not classified as forest. Implies a transformation from non-forest to forest.
Agriculture, Forests, and other Land Use (AFOLU)	Common terminology in the scientific community for what is also called the land sector and FLAG in the case of the SBTi initiative. The AFOLU category combines the LULUCF (Land Use, Land Use Change and Forestry) and Agriculture sectors into one.
Bioenergy	Energy derived from any form of biomass such as recently living organisms or their metabolic by-products.
Bioenergy and Carbon Dioxide Capture and Storage (BECCS)	The application of Carbon Dioxide Capture and Storage (CCS) technology to bioenergy conversion processes.
Biogenic CO_2e emissions	Emissions from a stationary or mobile source directly resulting from the combustion or decomposition of biologically based materials other than fossil fuels.
Biomass	Organic material both above-ground and below-ground, and both living and dead, e.g., trees, crops, grasses, tree litter, roots etc. Biomass includes the pool definition for above - and below - ground biomass.
Carbon stock	The quantity of carbon in a "pool", meaning a reservoir or system, which has the capacity to accumulate or release carbon.
Carbon dioxide equivalent (CO_2e)	A way to place emissions of various radiative forcing agents on a common footing by accounting for their effect on climate. It describes, for a given mixture and amount of greenhouse gases, the amount of CO_2 that would have the same global warming ability, when measured over a specified time period.
Carbon dioxide equivalent (CO_2e) emissions	Instances where net carbon stock decreases occur.
Carbon dioxide equivalent (CO_2e) removals	Instances where net carbon stock increases occur, are stored for a period of time, and meet certain reporting criteria.

Conversion	Change of a natural ecosystem to another land use or profound change in a natural ecosystem's species composition, structure, or function. Deforestation is one form of conversion (conversion of natural forests). Conversion includes severe degradation or the introduction of management practices that result in a substantial and sustained change in the ecosystem's former species composition, structure, or function. Change to natural ecosystems that meets this definition is considered to be conversion regardless of whether or not it is legal.
Deforestation	Loss of natural forest as a result of: i) conversion to agriculture or other non-forest land use; ii) conversion to a tree plantation; or iii) severe and sustained degradation.
Direct Land Use Change (dLUC)	Direct Land Use Change (dLUC) occurs when a new land use displaces a different former land use.
Forest	Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.
Forest, Land and Agriculture (FLAG)	Forest Land and Agriculture (FLAG) designates SBTi Forest Land and Agriculture project, sectors, methodologies, and targets. The term FLAG-related emissions and AFOLU emissions are used interchangeably in this document.
IMAGE model	IMAGE is an integrated assessment model framework that simulates global and regional environmental consequences of changes in human activities.
Indirect Land Use Change (iLUC)	Indirect land-use change (iLUC) occurs outside the area of focus as a consequence of change in use or management of land within the area of focus. iLUC is often mediated by markets or driven by policy shifts in land use that cannot be directly attributed to land-use management decisions of individuals or groups.
Integrated Assessment Models (IAM)	Models that seek to combine knowledge from multiple disciplines in the form of equations and/or algorithms in order to explore complex environmental problems. As such, they describe the full chain of climate change, from production of greenhouse gases to atmospheric responses. This necessarily includes relevant links and feedbacks between socio-economic and biophysical processes.
Land Use Change (LUC)	Land use change (LUC) involves a change from one land use category to another.

Natural forest	A forest composed of indigenous trees and not classified as a forest plantation.
Non-LUC emissions	All emissions excluding those related to land use change (LUC).
Primary Forest	Forest/Other wooded land of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.
Reforestation	Reforestation is the re-growth of forests after a temporary (< 10 years.) condition with less than 10% canopy cover due to human-induced or natural perturbations.
Scenario	A description of how the future may unfold based on 'if-then' propositions. Scenarios typically include an initial socio-economic situation and a description of the key driving forces and future changes in emissions, temperature or other climate change-related variables.
Scope 1 emissions	Emissions from operations that are owned or controlled by the reporting company.
Scope 2 emissions	Emissions from the generation of purchased or acquired electricity, steam, heating, or cooling consumed by the reporting company
Scope 3 emissions	All indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.
Uncertainty	A cognitive state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable

RESOURCES

Where do the data and methodology from the FLAG tool come from?

- Roe, S., Streck, C., Obersteiner, M., Frank, S., Griscom, B., Drouet, L., Fricko, O., Gusti, M., Harris, N., Hasegawa, T., Hausfather, Z., Havlík, P., House, J., Nabuurs, G., Popp, A., Sanz Sánchez, M., Sanderman, J., Smith, P., Stehfest, E., Lawrence, D. (2019). 'Contribution of the land sector to a 1.5 °C world'. Nature Climate Change. Accessible at: https://www.nature.com/articles/s41558-019-0591-9
- Smith, P., Dali N., Giel, L., Daan, P., Coraline, B., Detlef, V., Elke, S., Mathijs, H., Lidewij van den B. (2016). 'Science-Based GHG Emissions Targets for Agriculture and Forest Commodities.' University of Aberdeen, Ecofys, and PBL. Accessible at: https://www.pbl.nl/sites/default/files/downloads/pbl-2016-science-based-greenhouse-gas-emissions-targets-for-agriculture-and-forestry-commodities-2856.pdf

How should my company identify where to focus mitigation activities?

- WRI & WBCSD (2011). Greenhouse Gas Protocol, 'Corporate Value Chain (Scope 3) Accounting and Reporting Standard.' Accessible at: https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf
- WRI & WBCSD (2011). Greenhouse Gas Protocol, 'Product Life Cycle Accounting and Reporting Standard.' Accessible at: https://ghgprotocol.org/sites/default/files/standards/Product-Life-Cycle-Accounting-Reporting-Standard_041613.pdf
- IPCC (2019). 'Guidelines for National GHG Inventories, 2006 & 2019 Refinement.' Accessible at: https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

How can my company account and report land related emissions and removals?

The comprehensive accounting guidance will be GHG Protocol's Land Sector and Removals Guidance. While that guidance is under development, the following resources are recommended.

- Quantis (2019). 'Accounting for Natural Climate Solutions Guidance.' Accessible at https://quantis-intl.com/report/accounting-for-natural-climate-solutions-guidance/
- ISO (2018). 'ISO 14064-1, Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.' https://www.iso.org/standard/66453.html
- IPCC (2003). 'Good Practice Guidance for Land Use, Land-Use Change and Forestry.' Task Force on National Greenhouse Gas Inventories. Accessible at: https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

- Russel, S., Parsons, S. (2014). 'A New Tool for Low-Carbon Agriculture in Brazil.' GHG Protocol. Accessible at https://ghgprotocol.org/blog/new-tool-low-carbon-agriculture-brazil
- WRI & WBCSD. The Greenhouse Gas Protocol: Agricultural Guidance: Interpreting the Corporate Accounting and Reporting Standard for the agricultural sector (2014). Accessible at: https://ghgprotocol.org/sites/default/files/standards/GHG%20Protocol%20Agricultural%20Guidance%20%28April%2026%29_0.pdf

How can my company set science-based targets (SBTs)?

- Science Based Targets initiative (2020). Science-based Target-setting Manual, Version 4.1, April 2020. Accessible at https://sciencebasedtargets.org/resources/files/SBTi-Corporate-Manual.pdf
- Science Based Targets initiative (2021). SBTi Criteria and Recommendations, TWG-INF-002, Version 4.2, April 2021. Accessible at https://sciencebasedtargets.org/resources/files/SBTi-criteria.pdf
- Science Based Targets initiative. Sector specific guidance available at https://sciencebasedtargets.org/sectors

Now that I have a corporate target, what should I do to meet it?

- Accountability Framework (2019). 'Operational Guidance on Supply Chain Management'. Accessible at: https://accountability-framework.org/operational-guidance/supply-chain-management/
- IPCC (2019). 'Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems' – Chapter 6 on response options. Accessible at: https://www.ipcc.ch/srccl/chapter/chapter-6/
- Gold Standard (2018). 'Value Chain Scope 3 Interventions – Greenhouse Gas Accounting & Reporting Guidance. Accessible at: https://www.goldstandard.org/sites/default/files/documents/2018_09_scope_3_guidance_testing_draft_v1pdf.pdf

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Huppmann, D., Kriegler, E., Krey, V., Riahi, K., Rogelj, J., Rose, S.K., Weyant, J., Bauer, N., et al. (2018). IAMC 1.5 °C Scenario Explorer and Data hosted by IIASA. https://doi.org/10.22022/SR15/08-2018.15429 (IIASA, 2018).

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Penman, Gytarsky, M., Hiraishi, T., Krug, T., Kruger, D., Pipatti R., Buendia, L., Miwa, K., Ngara, T., Tanabe, K., Wagner, F. (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry. Intergovernmental Panel on Climate Change, National Greenhouse Gas Inventories Programme (IPCC-NGGIP).

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Rogelj, J., Popp, A., Calvin, K.V., Luderer, G., Emmerling, J., Gernaat, D., Fujimori, S., Strefler, J., et al. (2018). Scenarios towards limiting global mean temperature increase below 1.5 °C. Nat. Clim. Change (8), 325-332.

Schurer, A. P., Hawkins, E., Mann, M. E., Scott, V., Tett, S. F. B. (2018). Interpretations of the Paris climate target. Nat. Geosci. 11, 220–221.

Science Based Targets Initiative. (2021). Science Based Targets Criteria and Recommendations. https://sciencebasedtargets.org/resources/files/SBTi-criteria.pdf

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