
Landscape of Climate Finance for Agrifood Systems

Report Annexes

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CONTENTS

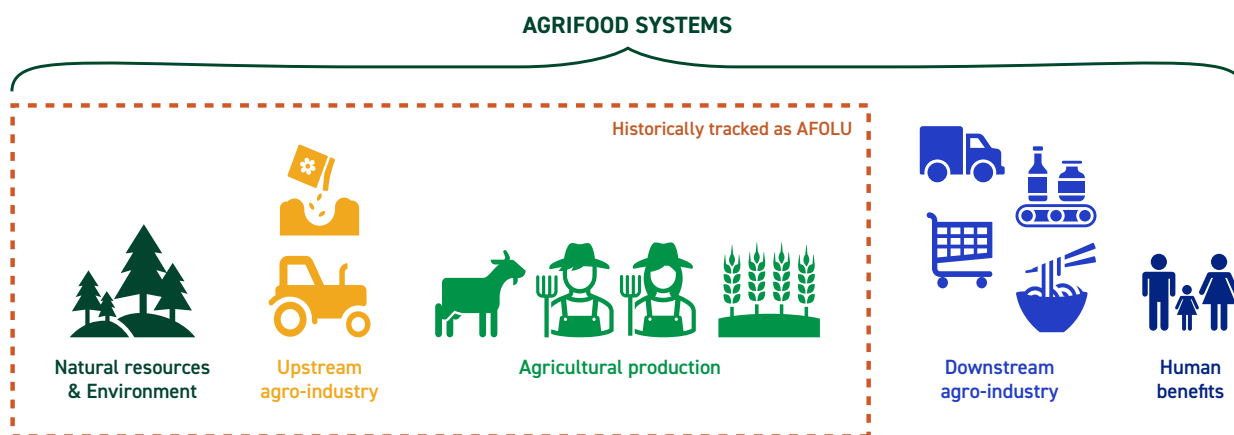
Annex 1: Definition and tracking framework	1
Annex 2: CPI classification of AFOLU sectors	6
Annex 3: Approach used to determine climate relevance of company-level data	11
Annex 4: Sources of data	12
Annex 5: Approach used to identify agrifood systems investments in non-AFOLU sectors	13
Annex 6: Methodology used to estimate needed levels of climate finance	15
Annex 7: Climate finance activity of agrifood corporates	22
Annex 8: Overview of tracked data	23
References	27
List of acronyms	30

ANNEX 1: DEFINITION AND TRACKING FRAMEWORK

DEFINITION

The concept of “agrifood systems” (Campanhola and Pandey, 2019; FAO, 2021c; HLPE, 2020) encompasses the processes and actors that convert natural resources and the environment into benefits and costs for humans through agricultural production and agro-industries (Campanhola and Pandey, 2019), as shown in Figure A.1.

Figure A.1. Agrifood systems concept: segments & interactions



Source: Campanhola and Pandey, 2019, adapted

Agricultural production is placed at the center of agrifood systems, with the other components revolving around it. According to this definition and throughout our analysis, agricultural production covers both food and non-food products (i.e., biofuel, fibres, or timber) (Campanhola and Pandey, 2019). Both food and non-food production and relevant industries are included based on the recognition that both types of value chain compete for fertile land within themselves, between each other and with natural ecosystems (FOLU, 2019). They are also driven and rely on the same farmers, especially in developing and emerging markets (FAO, 2022c). Reflecting this, many projects tracked in our data combine aspects of crop, livestock, fisheries, and forestry. From this perspective, excluding non-food value chains from agrifood systems would be an artificial operation and reduce the value of the systemic approach adopted.

In terms of **natural resources**, agrifood systems encompass land-based systems with the sub-sectors of crop cultivation, livestock raising, hunting, gathering of products from and harvesting of forests as well as water-based systems including fisheries and aquaculture.

Upstream agro-industry includes provision of agricultural inputs like seeds, breeding stocks, fertilizers, pesticides, farm machinery, feed processing, as well as the wider enabling environment providing extension and financial services, the governmental administrations and regulatory bodies, and agricultural research (Campanhola and Pandey, 2019).

Downstream agro-industry entails “handling, processing, preserving, transporting, and marketing agricultural products” (Campanhola and Pandey, 2019), as well as disposal through loss or waste (von Braun, 2020).

Of particular interest for this study are the agrifood **benefits and costs to humankind** that have an impact on climate or are impacted by it. Those include consumption patterns and low-carbon diets, rural livelihoods, and bio-energy. Our analysis does not cover financial flows directed towards general social protection, security, culture, or healthcare systems, which are not currently covered by climate finance data.¹

These actors and segments of agrifood systems are in constant movement, creating complex interactions and feedback loops (FAO, 2018). For example, changes to downstream consumption patterns affect the benefits and costs for humans, and influence production at farm level through downstream industries. Agricultural production in turn influences demand for agricultural inputs, such as seeds and fertilizers, provided by upstream industries. Furthermore, agricultural practices, technologies, and inputs affect the natural environment such as land, water, vegetation. In return, water availability and soil quality have direct impacts on agricultural yields and livestock health.

TRACKING FRAMEWORK

To apply this definition to climate finance data, the analysis of climate financial flows in this report is based on a sectoral classification. This maps out for each sector and solution the activities and sub-activities that are deemed to contribute to climate change mitigation and adaptation in agrifood systems. Data analyzed are for projects with activities that fit this classification. The same classification was used to identify new data relevant for the analysis, even when the respective data was not labelled as climate finance by reporting entities. The structure of this framework, at sector and solution levels, is based on the sectoral framework used for CPI’s flagship Global Landscape of Climate Finance (GLCF) report (CPI, 2021b), allowing us to ensure consistency in data management and comparability across periods.

We built the agrifood system universe using three main categories of sectors:

1. **Agriculture, Forestry, Other Land Uses and Fisheries (AFOLU)**, as derived from the IPCC emissions categories. The identification of eligible activities and sub-activities for the sectors that are part of AFOLU builds on CPI’s 2020 publication on climate finance to small-scale agriculture (CPI, 2020) and is based on the review of taxonomies used by some of the main climate finance reporting bodies (MDBs & IDFC 2021; EIB, 2022a; CBI, 2018a, 2018b, 2021a, 2021b). Financial flows channeled to these sectors are composed of projects that primarily target upstream agro-industries, agricultural production, and its relationship with the natural environment. The complete classification of AFOLU sectors and activities is included in Annex 2. As such, these interventions have been historically reported by funders and investors and included in CPI’s climate finance tracking research in the past 10 years as AFOLU.

¹ We note that a wider range of human benefits and costs are encompassed by the FAO definition, which includes stability, security, culture, and heritage, in addition to food, nutrition, health, employment, livelihoods, energy, materials, and economic growth. Costs include diseases related to unhealthy diets and overconsumption, zoonotic diseases, antimicrobial resistance, and hazards to which agricultural workers are exposed.

2. **Food loss/waste and diets** is a newly added sector to CPI's classification, introduced for the 2021 edition of the GLCF (CPI, 2021a). The creation of a stand-alone category for food loss/waste and diets was a first step towards a more systemic framework and aims to reflect the importance of downstream agro-industries as well as the benefits and costs to humans. Data for this sector has been bundled historically under AFOLU, and scarcely reported by institutions tracked by CPI. In this report, we reinforce the importance of this stand-alone sector as a part of the agrifood systems to help draw attention to its importance in contrast to the financing and data gaps. To this end, we made efforts to collect company-level data to complement the existing project-level data traditionally collected by CPI.

Table A.1. Sectors and activities historically referred to as AFOLU with their corresponding agrifood systems segments

Sectors	Solutions and examples	Most relevant agrifood systems segment
Agriculture	Production and conservation <i>Agricultural soil restoration</i> <i>Resilient crops</i> <i>Animal husbandry and manure management</i> <i>Farm-level irrigation efficiency</i>	Agricultural production Natural Resources & Environment Upstream agro-industry
	Supply chain management (commercialization, primary processing, and storage) <i>Improving carbon footprint of agro- industries</i> <i>Promoting local and resilient commercialization routes</i>	Downstream agro-industry
	Financial services for production, commercialization, storage, and processing <i>Crop insurance to protect farmers against financial risks posed by adverse weather events</i> <i>On-lending programs providing credit lines to local commercial banks for disbursement to agri-SMEs</i>	Upstream agro-industry Downstream agro-industry
Forestry & other natural habitats	Production and conservation <i>Re/afforestation projects</i> <i>Forest, mangrove, or peatland conservation</i> <i>Sustainable forestry (selective logging)</i>	Agricultural production Natural Resources & Environment
	Supply chain management (commercialization, primary processing & storage) <i>Improving carbon footprint of forestry-related businesses and industries</i> <i>Promoting local and resilient commercialization routes</i>	Downstream agro-industry
Fisheries	Fishing and aquaculture <i>Sustainable management of fisheries (quotas, etc.)</i> <i>Energy efficiency and fuel switches in fishing boats</i>	Agricultural production Natural Resources & Environment Upstream agro-industry
	Supply chain management (commercialization, primary processing & storage) <i>Energy-efficient refrigeration technologies to improve fish storage and transportation</i> <i>Implementing digital technologies like blockchain for better traceability, efficiency, and sustainability</i>	Downstream agro-industry
Food loss/waste & diets (Historically bundled with one of the above sectors or the Other/ Multiple category)	Reduced food loss/waste <i>Changes in consumption habits</i> <i>City-level composting projects</i> <i>Food waste diversion</i>	Downstream agro-industry Human costs and benefits
	Low-carbon diets <i>Production of alternative proteins</i> <i>Promotion of low-meat diets</i> <i>Consumption of local food</i>	Human costs and benefits

3. **Other non-AFOLU economic sectors intersect with AFOLU to create the dynamics of agrifood systems and service their various segments.** These sectors help shape agrifood systems and are analyzed in this study for the first time (these are shown in Table A.2). They are typically interventions that take place in upstream and downstream agro-industries, support agricultural production activities, or are complementary to them. Historically, these have been analyzed in CPI's GLCF as uniquely contributing to their primary sector (e. g., energy systems, or solid waste sectors). Connecting them to agrifood systems creates a more complete picture of the dynamics between the different components, especially as pre- and post-production processes, including energy, transport, and waste which account for over one third of the GHG emissions from agrifood systems (Tubiello et al., 2021). For ease of identification, we tagged each multi-sectoral project with the AFOLU, or the "Food loss/waste and low-carbon diets" sector it benefits. For example, a project on solar panels for irrigation comes under Agriculture – Production.

Table A.2. Sectors and activities historically tracked under sectors other than AFOLU

Non-AFOLU sectors	Measures that support or interact with agrifood systems, and examples	Possible intersections with:
Energy systems	Utility-scale bioenergy <i>Biofuel plants that use agricultural residues or energy crops</i> <i>Biogas/Biomethane plants that use agricultural or forestry residues, energy crops, or food waste</i>	Agriculture Forestry Fisheries Food & Diet
	Farm-level renewable energy generation <i>Farm-level biodigesters</i> <i>On-site solar power (hangar roofs, fish farms, etc...)</i>	Agriculture Forestry Fisheries
Water and wastewater	Water supply & planning <i>Water supply & watershed management programs that support AFOLU uses</i>	Agriculture Forestry Fisheries
	Treatment of agricultural wastewater <i>Dedicated treatment of agricultural wastewater and manure lagoons</i>	Agriculture Forestry Fisheries
Solid waste	Food and organic waste treatment <i>Landfill gas plants</i> <i>Solid waste plants with food waste diversion units</i>	Food and Diet
Industry	Reduced carbon footprint of agri-related industries <i>Energy efficiency gain and fuel switch</i>	Agriculture Forestry Fisheries
Transport	Resilient transport infrastructure <i>Development projects to maintain and enhance agriculture and forestry commercialization routes</i>	Agriculture Forestry

ANNEX 2: CPI CLASSIFICATION OF AFOLU SECTORS

Table A.3. CPI classification of AFOLU sectors

Solution	Activity	Sub-activity
Sector: Agriculture		
Sustainable Crops, Agro-forestry, Livestock production	Management of soil for net carbon sequestration	Increase in above-ground biomass (cover crops, agroforestry) and residue retention
	Improve existing carbon pools	Sowing of cover/catch crops using a locally appropriate species mixture with at least 1 legume and reducing bare soil to the point of having a living plant coverage index of at least 75% at farm level per year
		Reduced tillage techniques that increase carbon content of soil
		Undertake a GHG assessment of sources of emissions and sinks on the farm
		For non-perennial crops, apply crop rotation, including at least one legume
		Increase in above-ground biomass (grassland/pasture productivity, cover crops, agroforestry) by at least 20%
		Prevent soil compaction by avoiding traffic on wet soil; avoiding or strongly reducing tillage operation on wet soils; reducing stock density
	Management of biomass for net carbon sequestration	Management of crop residues like collection and use of bagasse, rice husks or other agricultural waste
	Biofuels	Production of biofuels, including biodiesel and bioethanol
	Rehabilitation of degraded lands	Peatland restoration
	Soil health and erosion management	Mulching with cover crops (green manure), such as forage grass and leguminous forage, in tea and tea-oil plantations to conserve soil moisture and control soil erosion
		Enhancement of soil water retention (e. g., through use of cover crops, organic fertilizers, minimum tillage)
		Organic matter amendments to the soil (compost)
	Reduction in energy use in agricultural processes	Energy efficient traction (e.g., efficient tillage)
		Energy efficient irrigation
	Use of renewable energy	Solar energy use for irrigation
Solar energy use for groundwater pumping		
Renewable energy use in greenhouses		
Solar panels or wind turbines on agricultural land/buildings to power the farm or sell to the grid		

Solution	Activity	Sub-activity
		Energy-efficient traction, irrigation, and storage (i.e., within top 25% of energy efficiency rates for equipment available in country) OR uses of only renewable energy
	Reduction of non-CO2 emissions from agricultural practices and technologies	Paddy rice management – shallow flooding, mid-season drying event, off-season straw
		Reduction in fertilizer use; identify right source of fertilizer, right timing, and right placement. Biological N-fixation as the source of nitrogen inputs
		Nutrient management to reduce N2O emissions, including recording of nutrient applications and use of low emission N-application technology
	Crop diversification and resilience	Provision of information on crop diversification options to farmers
		Use of improved strains and varieties of crops, which are adapted to the local soil and climate conditions (particularly to droughts and floods)
		Controlled agriculture (vertical farming, hydroponics)
	Nutrient and pest control management	Integrated pest control measures (chemical and biological)
	Water management	Promotion of adoption of climate resilience technologies to save water (e.g., water recycling)
		Significant on-farm water-storage capacity as a buffer against the effects of seasonal drought
		Use of water efficient irrigation technologies, including sprinkle and drip irrigation Lining of canals, changes to flow velocity, new building codes for dams and canals
	Weather forecasting	Forecasting tools and systems
	Supporting Infrastructure	Machinery and equipment to manage and cultivate eligible land or livestock
		Rehabilitation and protection of climate-exposed roads and buildings
		Associated management, information systems and other technologies
		Farm facilities: Modified designs, siting and construction materials, deeper foundations, protective walls, vegetated contour bunding
	Livestock practices that reduce methane or other GHG emissions	Improved feeding practices: use of feed additives that reduce enteric methane emission of ruminants; precision and multi-phase feeding techniques to reduce N2O emissions from manure; use feed sourced responsibly and not produced in deforested areas
		Development of sheep and cattle feed that contains dried seaweed or other ingredients which in turn cut methane emissions significantly
		Agroforestry, silvo pastoralism or grassland/pasture management that offsets CH4 emissions by at least 20%
		Better health planning and management – breed selection for improving methane and ammonia emission efficiency
Resilient livestock breeds	Using species and breeds adapted to changes in CO2 and climate	

Solution	Activity	Sub-activity
	Manure management	Manure management with biodigesters producing biogas for heating or cooking
		Practices that reduce or offset CH ₄ and N ₂ O by 20%: cooling of liquid manure, sealing manure storage, composting
	Permanent grassland management	Pasture renovation Reducing compaction by removing animals from very wet fields Maintain permanent grassland No ploughing of permanent grassland
Supply chain management (commercialisation, primary processing and storage)	Alternative meat and dairy products	On-site storage at facilities or projects 100% dedicated to production of selected alternative meat and dairy products
	Supply chain	Input supply systems for seed production, distribution, and access
		Energy efficient primary processing and storage facilities for agricultural produce
		Minimization of post-harvest loss (i.e., through cold chains)
Measures in existing supply chains dedicated to improving in energy/resource efficiency upstream or downstream, leading to an overall reduction in GHG emissions		
Financial services for sustainable production, commercialisation, storage, and processing	Climate risk-based insurance	
	Financial services targeting climate vulnerable beneficiaries	
Research and Development	Climate focused R&D in crops & livestock	
	Testing climate-friendly practices, inputs, adaptive crop varieties or technologies Research relating to climatic trends	
Extension Services	Improving agronomic practices and access to technology and infrastructure	
Training, and monitoring	Advisory services on transitioning a farm to climate friendly practices	
	Capacity-building, e.g., for improved climate risk management Training in locally appropriate climate-smart/-friendly agricultural practices	

Solution	Activity	Sub-activity	
Sector: Forestry			
Afforestation, Reforestation, Forest Conservation, Sustainable management of existing forest, including extraction of non-timber products	Afforestation on non-forested land	Conversion of low productivity land (e.g., along field edges) into woodland to increase C sequestration and protect against soil erosion	
	Reforestation on previously forested land		
	Sustainable forest management and conservation of forests to reduce emissions from deforestation and degradation	Sustainable forest management activities to increase carbon stocks or reduce the impact of forestry activities on soil quality, soil carbon and biodiversity (e.g., harvesting methods, continuous cover, maintaining adequate deadwood) Non-intervention forest management approaches (e.g., reduced harvest)	
		Ecological diversification, including shifting land use from monoculture to polyculture or other diversified production	
		Management of seedling stand and timely thinning (to reduce damage from increased wind)	
		Use of early warning systems or wildfire control measures (in case of heatwaves)	
	Production of non-timber forest products	Commercial cultivation/extraction of goods derived from forests that are of biological origin other than wood (e.g., timber, bamboo, resin, nuts, mushrooms, fruits, herbs, game, fibres, medicinal, cosmetic, or cultural produce). Practised in plantations or sustainably managed forests.	
	Forest conservation	Non-commercial forestry activities designed to maintain the area and quality of existing forest habitat. Activities range from minimal interventions to active management (e.g., protection from deforestation, voluntary and mandatory set-aside and active conservation efforts, geographic information system (GIS) analysis, satellite data collection and analysis).	
	Forest restoration and rehabilitation	Non-commercial forestry activities designed to increase the area or improve the quality of existing forest habitat or to establish new forest stands. Activities range from minimal interventions to active restoration including facilitating regeneration and restoration via natural or artificial means.	
	Conservation of non-forested land	Conservation of non-commercially productive land to maintain existing habitat area and quality (e.g., establishment of protected land or national parks, voluntary or mandatory set aside)	
Restoration or rehabilitation of non-forested land	Restoration/rehabilitation of non-commercially productive land to improve quality or increase the area of existing habitats, or to establish new habitats		
Reduction of emissions from deforestation or ecosystem degradation	Payments for ecosystem services		
Supporting and supply chain infrastructure	Infrastructure associated with the forestry sector (e.g., storage, manufacture of monitoring and assessing equipment and plant nurseries)and initial processing of timber (e.g., into wood products, paper or pulp)		
Supply chain management (commercialisation, primary processing and storage)	Supply chain	Associated management, information systems and other technologies	

Solution	Activity	Sub-activity
Sector: Fisheries		
Sustainable fish production	Supporting Infrastructure	Energy efficient machinery and equipment to manage and harvest in fisheries and fish farms (e.g., fishing vessels)
		On- and off-shore fish processing and storage facilities connected to eligible fisheries and fish farms
		Associated management, information systems and other technologies
	Aquaculture	Adoption of sustainable aquaculture techniques to address changes in fish stocks resulting from climate change and supplement local fish supplies, etc.
	Energy	Reduction in energy use or resource efficiency
Supply chain	Energy efficient primary processing facilities and storage for eligible fisheries and aquaculture activities	
	Measures in existing supply chains to improve energy efficiency or resource efficiency upstream or downstream, leading to an overall reduction in GHG emissions	
Supply chain management (commercialisation, primary processing & storage)		
Sector: Food Loss/Waste & Diets		
Food waste and low-carbon diets	Sustainable consumption patterns	Healthy diets (diversified protein sources, plant-based diets)
		Reducing food loss/waste
		Local loops/links between urban consumers and farmers
Sub-sector: Policy & National Budget Support & Capacity Building		
Policy & National Budget Support & Capacity Building		

ANNEX 3: APPROACH USED TO DETERMINE CLIMATE RELEVANCE OF COMPANY-LEVEL DATA

The climate relevance of the data provided by AgFunder on company-level VC investments was determined based on each company's target market, technology or services provided, and alignment of those with the sectoral classification presented in Annex 2. The analysis is based on data representing the full amount of the investment deal in the respective companies announced in 2019 and 2020. This is based on the assumption that since these companies are startups, they offer a clear and narrow range of services and solutions. This limits (but does not eliminate completely) the risk of attributing climate relevance to companies that provide both climate and non-climate solutions.

ANNEX 4: SOURCES OF DATA

Table A.4. Breakdown of the data types and sources used

Data Type	Scope	Granularity	%	Sources historically used in CPI's GLCF	Sources used for the current study only
Project-level data	AFOLU only	High	93%	OECD-DAC, BNEF, CBI, Climate Funds CFU, IATI, and biannual surveys of DFIs, conducted by CPI	The USDA's Natural Resource Conservation Service (NRCS, 2022) and Conservation Reserve Program (CRP, 2020 & 2022); California Department for Agriculture programs (CDFA, 2022); the US Environmental Protection Agency's AgSTAR (AgSTAR, 2022); Environment and Climate Change Canada funding programs (ECCC, 2022); the EU's European Structural Investment Funds (European Commission, 2022a); China's National Forestry and Grassland Administration (NFGA, 2019 & 2020)
	Agrifood systems	High			
Company-level data	Agrifood systems	Medium - Low	7%	-	AgFunder

ANNEX 5: APPROACH USED TO IDENTIFY AGRIFOOD SYSTEMS INVESTMENTS IN NON-AFOLU SECTORS

Table A.5 presents the list of keywords used to identify investments outside of AFOLU sectors that support agrifood systems. A manual review covering 95% of the volume of finance extracted with this technique was conducted. An additional review of the largest non-AFOLU financial flows which were not picked up through this keyword search was also conducted. All of the projects that ended up being included from non-AFOLU projects in this study dataset were manually reviewed.

In addition to this approach, bioenergy projects, categorized by feedstock and use (biogas, biofuel, etc.), were extracted from a previous CPI research (CPI, 2022b) and added to this dataset.

Table A.5. Keywords used to identify agrifood-relevant investments in data tagged as non-AFOLU sectors

Matched AFOLU sector	Keyword
Agriculture	agriculture/farmer/agricultural
	agro-forestry/agroforestry
	soil/crop + cover
	no/zero/minimum/low till/tilling/tillage/overturn/overturning
	regenerative agriculture/practice
	crop rotation
	crop/agri/agricultural/rice/wheat residue/waste
	rice/cereal/wheat + husk/hull/straw
	energy crop
	crop-to-energy
	crop to energy
	biofuel/biodiesel/bioethanol
	peatland
	cover crop
	mulch/mulching
	forage + grass/legume/leguminous
	soil/land + health/sequestration/erosion/moisture/conserve/conservation
	soil + water
	organic + fertilizer/input
	compost
	energy efficiency + irrigation/irrigate/irrigating
energy efficient + irrigation/irrigate/irrigating	
energy use + irrigation/irrigate/irrigating	
energy demand + irrigation/irrigate/irrigating	

Matched AFOLU sector	Keyword
	renewable energy + greenhouse (gas)
	solar + greenhouse (gas)
	passive + greenhouse (gas)
	thermal + greenhouse (gas)
	renewable/solar/wind/panel/turbine + agricultural/agriculture
	rice
	nitrous oxide
	n2o
	crop diversification/rotation
	intercrop/intercropping/intercropped
	polyculture
	agriculture/crop + resilience/flood/flooding/drought/drought-resistant/drought-resilient/flood-resistant
	drought-resistant/resistant/resilience/resilient + seed
	agriculture/crop/farm/agricultural + water
	pest control
	hydroponic
	water storage + agriculture/crop/farm/agricultural
	sprinkle/drip/micro-jet + irrigation
	weather forecasting/monitoring/services
	soil + analysis
	satellite + farm/farming/agriculture/agricultural
	remote sensing + farm/farming/agriculture/agricultural
	road + rehabilitation/maintenance/work/refurbishment + farm/farming/agriculture/agricultural
	silvopasture/silvopastoralism
	grassland/pasture + restoration/conservation/restore/conserv
	harvest + loss
	afforestation/forestry/forest/reforestation/tree/reforestation/deforestation
	carbon + sequestration
	forest + management
	selective felling/cutting/logging
	wildfire
	thinning + forest
	forest/fire/wildfire/deforestation + satellite
	forest/ecosystem/biosphere + restoration/rehabilitation/conservation/regeneration
	ecosystem service
	forest + road
	fishery/aquaculture/fishing/fish/fisher/fishes

To make keyword listing more compact and efficient, we use a simple syntax in this table. A “/” means that the words on both sides of the separator were used interchangeably. A “+” means that the two words, or combination of words had to be found in the same text for the tagging to operate. Finally, a simple space (“ ”) means the two terms had to be next to each other in order to be picked up. The plural form of each word was systematically used interchangeably.

ANNEX 6: METHODOLOGY USED TO ESTIMATE NEEDED LEVELS OF CLIMATE FINANCE

In this section, we present the methodology used to calculate the level of climate finance needed for agrifood systems globally. Our calculation draws on three distinct studies: FOLU, 2019; UNEP, 2022; Thornton et al., 2023, each of which employs a unique approach to calculate the necessary finance estimates. In an effort to ensure consistency with our conceptual understanding of climate finance and agrifood systems, we have selected subsets of investment figures from these studies to include in our analysis. These investments best align with the definitions of climate finance used by CPI in the Global Landscape of Climate Finance (CPI, 2022a), on which this study draws, as well as with the definition of agrifood systems and the tracking framework used in this study.

The figures presented are estimates of the annual investment required up to 2030 to bridge the financial gap between current and desired outcomes for agrifood systems globally, based on information currently available. Data and knowledge on climate finance needs are constantly evolving and their assessment will change with the course of actions taken by public and private actors and with more data becoming available.

For a more in-depth understanding of the methodology and assumptions used in each of these studies, we recommend exploring the referenced publications, which are summarized below.

FOOD AND LAND USE COALITION (FOLU), 2019. GROWING BETTER: TEN CRITICAL TRANSITIONS TO TRANSFORM FOOD AND LAND USE.

Total figure included in the current study: USD 212bn

This study presents an extensive blueprint for transitioning our current food and land use systems to ones that are more sustainable, equitable, and resilient. Central to this report is the “Better Futures” scenario, a forward-looking projection which relies on the successful implementation of ten critical transitions. This scenario envisions a future of net carbon neutrality, biodiversity conservation, improved health outcomes, enhanced rural income growth, increased job creation, and heightened food security.

To achieve this by 2050, the study presents a comprehensive breakdown of annual investment requirements (in 2018 prices) for the period 2018 to 2030, across each of the ten critical transitions. These estimates are based on additional capital investment expenditure (CAPEX) and long-term operating expenses (OPEX) and include both public and private investments. The estimates provided cover the key transformation areas and critical transitions.

For the purpose of the current analysis, we excluded the estimates for activities that are not aligned with our definition of climate finance or agrifood systems. In some cases, the alignment between the activities covered by the FOLU estimates and our definition and

framework is partial, so by eliminating those solutions, we obtained the low-end of the total estimates for agrifood systems. When including both the fully and the partially aligned estimates, we obtained the high-end of the total needs estimates for agrifood systems. To limit overcounting and/or undercounting, we used the average of these two figures.

Table A.6 outlines the specific investment figures incorporated into our aggregated USD 212 billion estimation, which is the midpoint between the low-end average (USD 149 billion) and high-end average (USD 275 billion), as well as those intentionally excluded.

Table A.6. Estimated annual investment required (USDbn) between 2018 and 2030 under the 'Better Futures' Scenario (2018 prices) (FOLU, 2019) and categories included in the current study

Critical Transition	Relevant tracking sector	Activities	Climate relevant	Annual investment (low)	Annual investment (high)	Annual investment (average)
Healthy Diets	-	Product Reformulation	No	17.0	17.0	17.0
	-	Global Nutrition Targets	No	7.0	7.0	7.0
	-	Targeted School Feeding Programmes	No	5.2	5.2	5.2
	-	R&D	No	1.6	1.6	1.6
Productive & Regenerative Agriculture	Agriculture	Implementation of Regenerative Farming Practices	Yes	4.5	5.5	5.0
	Multiple	Closing the Productivity Gap	Partial	13.5	15.5	14.5
	Agriculture	Irrigation Efficiency	Yes	4.3	4.3	4.3
	Agriculture	Organic and Biofertiliser Production	Yes	6.7	6.7	6.7
	Agriculture	Organic and Biopesticide Production	Yes	3.1	3.1	3.1
	Agriculture	R&D	Yes	3.3	3.3	3.3
Protecting & Restoring Nature	Forestry	Forest Restoration (incl. Peatlands)	Yes	29.0	49.0	39.0
	Forestry	REDD+ Programme for Forest Conservation	Yes	14.0	14.0	14.0
	Forestry	Forest Management	Yes	0.9	1.3	1.1

Critical Transition	Relevant tracking sector	Activities	Climate relevant	Annual investment (low)	Annual investment (high)	Annual investment (average)
A Healthy & Productive Ocean	Fisheries	Sustainable Fisheries	Yes	4.2	4.2	4.2
	Fisheries	Bivalve Production	Yes	0.8	0.8	0.8
	Fisheries	Finfish Aquaculture Expansion	Yes	2.5	2.5	2.5
	Fisheries	Aquaculture Sustainable Intensification Training	Yes	0.4	0.4	0.4
	Forestry	Mangrove Restoration	Yes	1.2	1.2	1.2
	Fisheries	R&D	Yes	3.3	3.3	3.3
Diversifying Protein Supply	Food loss & diets	Plant-Based Meat	Yes	1.8	7.5	4.7
	Food loss & diets	Plant-Based Dairy	Yes	11.5	14.5	13.0
	Food loss & diets	Edible Insect Protein	Yes	0.3	0.3	0.3
	Food loss & diets	R&D	Yes	3.3	3.3	3.3
Reducing Food Loss	Food loss & diets	Demand Management in Developed Countries	Yes	0.7	0.7	0.7
	Food loss & diets	Postharvest Waste in Developing Countries	Yes	8.5	8.5	8.5
	Food loss & diets	Supply Chain Waste	Yes	19.6	19.6	19.6
Local loops & Linkages	Agriculture	Urban Farming	Yes	5.6	5.6	5.6
	Multiple	Composting of Inedible Foods	Yes	2.9	2.9	2.9
	Agriculture	R&D	Yes	1.7	1.7	1.7
Digital Revolution	Agriculture	Precision Agricultural Machinery	Partial	1.4	2.4	1.9
	Agriculture	AgTech Investment	Partial	9.2	9.2	9.2
	Agriculture	R&D	Partial	3.3	3.3	3.3

Critical Transition	Relevant tracking sector	Activities	Climate relevant	Annual investment (low)	Annual investment (high)	Annual investment (average)
Stronger Rural Livelihoods	Multiple	Rural Infrastructure	Partial	32.0	38.0	35.0
	Multiple	Access to Clean Cooking	Partial	3.7	3.7	3.7
	Agriculture	Irrigation Expansion	Partial	6.5	6.5	6.5
	-	Connectivity	No	5.5	5.5	5.5
	Multiple	Training of Entrepreneurs	Partial	8.3	17.0	12.7
	Agriculture	Financing Needs of Smallholder Farmers	Partial	16.5	18.3	17.4
	Multiple	Safety Nets for Rural Resilience	Partial	21.6	21.6	21.6
Gender & Demography	-	Family Planning	No	3.0	3.0	3.0
	-	Girls' Education	No	14.0	14.0	14.0

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP), 2022. STATE OF FINANCE FOR NATURE 2022 - TIME TO ACT

Total figure included in the current study: USD 381 billion

The UNEP 2022 State of Finance for Nature publication analyzes financial flows to nature-based solutions (NbS) capable of addressing climate change, as well as biodiversity loss and land degradation. As part of this study, UNEP estimates the cumulative additional NbS investment required between 2022 and 2050 to align with the 1.5 °C target.

For the purpose of the current analysis, we have divided these cumulative figures equally across the relevant years to estimate annual investment requirements up to 2030. In some cases, the alignment of the NBS solution with the agrifood systems definition is not straightforward, so by eliminating those solutions we obtained the low end of the total estimates for agrifood systems. When including all categories, we obtained the high end of the estimates. To limit overcounting and/or undercounting, we used the average of these two figures.

Table A.7 outlines the specific investment figures incorporated into our aggregated USD 381 billion estimation, which is the average of the low-end estimate (USD 365 billion) and high-end estimate (USD 396 billion).

Table A.7. Estimated annual investment required (USDbn) between 2022 and 2050 under a 1.5°C scenario (2022 prices) (UNEP, 2022) and categories included in the current study.

Activities	Relevant tracking sector	Climate relevant	Cumulative investment	Annual investment (low)	Annual investment (high)	Annual investment (average)
Agroforestry	Agriculture	Yes	3600	128.6	128.6	128.6
Cover crops	Agriculture	Yes	320	11.4	11.4	11.4
Grazing-optimal intensity	Agriculture	Yes	180	6.4	6.4	6.4
Re/afforestation	Forestry	Yes	3400	121.4	121.4	121.4
Protected areas	Forestry	Yes	1300	46.4	46.4	46.4
Restoration of peatlands	Forestry	Yes	750	26.8	26.8	26.8
Avoided deforestation	Forestry	Yes	290	10.4	10.4	10.4
Restoration of saltmarshes	Forestry	Yes	250	8.9	8.9	8.9
Avoided grassland conversion	Forestry	Yes	79	2.8	2.8	2.8
Avoided peatland impact	Forestry	Yes	38	1.4	1.4	1.4
Restoration of mangroves	Forestry	Yes	16	0.6	0.6	0.6
Avoided mangrove impact	Forestry	Yes	6	0.2	0.2	0.2
Restoration of seagrass	Multiple	Partial	840	0.0	30.0	15.0
Avoided seagrass impact	Multiple	Partial	6	0.0	0.2	0.1
Total	-		11,075	365.3	395.5	380.5

Note: Investment figures do not add up to totals due to rounding.

THORNTON, P., CHANG, Y., LOBOGUERRERO, A.M., CAMPBELL, B., 2023. PERSPECTIVE: WHAT MIGHT IT COST TO RECONFIGURE FOOD SYSTEMS?

Total figure included in the current study: USD 1,267 bn

This study builds on the foundation laid by Steiner et al. (2020), who identified four action areas and eleven actions required for food system transformation in light of climate change. These four action areas are:

1. Reroute farming and rural livelihoods to new trajectories
2. De-risk livelihoods, farms, and value chains
3. Reduce emissions from diets and value chains
4. Realign policies, finance, support to social movements and innovation

Thornton et al. (2022) expands on these by conducting a review of more than 2,000 sources, including peer-reviewed articles, governmental documents, private sector reports, and others, to estimate the annual cost of implementation for each action.

As with the aforementioned studies, where there was partial alignment between the activities covered by Thornton et al. (2023) and our definition and framework, we eliminated these to obtain the low-end of the total estimates for agrifood systems. When including both the fully and the partially aligned estimates, we obtained the high-end of the total needs estimates for agrifood systems. To limit overcounting and/or undercounting, we used the average of these two figures.

Table A.8 outlines the specific investment figures incorporated into our aggregated USD 1,267 billion estimation, which is the average of the low-end estimate (USD 1,196 bn) and high-end estimate (USD 1,338bn).

Table A.8. Estimated annual investment required (USDbn) to transform food systems by 2030 (Thornton et al., 2023) and categories included in the current study

Action Area	Relevant tracking sector	Action	Climate relevant	Annual investment (low)	Annual investment (high)	Annual investment (average)
Reroute	Forestry	Ensure zero agricultural land expansion in high-carbon landscapes (forests and peatlands)	Yes	753.0	753.0	753.0
	Agriculture	Enable markets and public-sector actions to incentivise climate-resilient, low emission farming practices	Yes	181.0	181.0	181.0
	Multiple	Support prosperity through mobility and rural reinvigoration (rural livelihoods and jobs)	Partial	0.0	116.0	58.0
De-risk	Multiple	Secure resilient rural livelihoods through early warning systems and adaptive safety nets	Partial	0.0	5.6	2.8
	Agriculture	Help farmers make better choices: Climate services to farmers and agribusinesses	Yes	2.4	2.4	2.4
Reduce	Low-carbon Diets	Shift to healthy, sustainable, climate-friendly diets: Substantial reduction in beef and dairy consumption in high-income countries	Yes	35.0	35.0	35.0
	Food Loss & Diets	Reduce food loss and waste	Yes	12.6	12.6	12.6

Action Area	Relevant tracking sector	Action	Climate relevant	Annual investment (low)	Annual investment (high)	Annual investment (average)
Realign	Policy & National Budget Support	Implement policy and institutional changes that enable transformation by aligning subsidies to a climate change agenda	Yes	177.0	177.0	177.0
	Agriculture	Unlock billions in sustainable finance	Yes	20.0	20.0	20.0
	Multiple	Drive social change for more sustainable decisions: Youth movements for climate action in food systems	Partial	0.0	20.0	10.0
	Agriculture	Transform innovation systems to deliver impacts at scale: agricultural research to achieve SDGs related to food	Partial	15.0	15.0	15.0
Total	-	-		1,196	1,338	1,267

ANNEX 7: CLIMATE FINANCE ACTIVITY OF AGRIFOOD CORPORATES

Table A.9. Examples of financing models used by multinational corporates (MNCs) in agrifood systems

Model	Example	Climate investment (USDm)	Estimated annual average (USDm) (a)	2022 annual net income (USDm) (b)	% climate investment of net income (a/b)
Corporate – farmer association partnerships	PepsiCo: Multi-year partnerships with Practical Farmers of Iowa, Soil and Water Outcomes Fund, and the IL Corn Growers Association (FoodBev Media, 2023).	216 (2023–30)	27	8,910 (Macrotrends, 2023a)	0.30%
Direct work with suppliers	Nestle: more than 500,000 farmers and 150,000 suppliers (Nestle, 2021; FoodDive, 2021)	~1,320 (2021–25) ³	264	9,714 (Macrotrends, 2023b)	2.7%
Partnerships with farmers, research institution and NGOs for payment by results mechanisms	Kellogg Company: five-year program that will partner with Lower Mississippi River Basin rice farmers, GHG measurement firm Regrow, Kellogg supplier Kennedy Rice Mill LLC, and agribusiness firm Syngenta (PR Newswire, 2022). Part of Kellogg's Origins Program.	2 (2022–26)	0.4	960 (Macrotrends, 2023c)	0.042%
Public-private partnership & matching investment for research	Danone North America: initial investment in research + public funding from U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) (The Organic & Non-GMO Report, 2018; SustainableBrands, 2018).	6 (2018–22; 3 in public funding)	1.2	1,010 (Macrotrends, 2023d)	0.12%
Corporate – public bank partnership	Cargill Brazil ESG Time Deposit: Time deposit that will be used to fund Environment, Social and Governance (ESG) projects in the South American food powerhouse (NASDAQ, 2023).	240 (over 5 years)	48	6,680 (2021–22; (Washington Post, 2022)	0.72%
Dedicated climate funds	Unilever Climate & Nature Fund: Supports projects to help progress Unilever's net zero goal by 2039, and increase resilience. Aims to create an impact-led investment platform to drive collaboration with partners and co-financers to scale solutions beyond Unilever's value chain (Unilever, n.d.).	~1,100 ⁴ (2020–30)	100	8,052 (Macrotrends, 2023e)	1.2%
	Paulig Unique Climate Fund: Aims to accelerate climate emission reductions in its wheat and coffee value chains, logistics and own operations (i.e. carbon neutrality of factories) (Paulig, 2023a).	~2.9 ⁵ (2023)	2.9	-21.4 (Paulig, 2023b)	-
Total⁶	-	2,784	440.6	35,326	1.25%

3 CHF 1.2 billion

4 EUR 1 billion

5 EUR 2.7 million

6 Excluding Paulig, due to outlier negative net income in 2022

ANNEX 8: OVERVIEW OF TRACKED DATA

This annex presents an overview of our tracked data in tabular form.

Table A.10. Breakdown of 2019/20 project-level investments to AFOLU sub-sectors and activities

AFOLU sub-sector	Activities	2019/2020 average (USDbn)	%
Agriculture	Sustainable Crops, Agro-forestry, Livestock production	8.24	35%
	Supply chain management (commercialization, primary processing & storage)	0.80	3%
	Financial services for sustainable production, commercialization, storage, and processing	0.22	1%
	Unspecified	0.66	3%
Forestry	Afforestation, Reforestation, Forest Conservation, sustainable management of existing forest, including extraction of non-timber products	8.64	37%
	Supply chain management (commercialization, primary processing & storage)	0.05	0%
	Unspecified	0.07	0%
Fisheries	Sustainable fish production	0.08	0%
	Supply chain management (commercialization, primary processing & storage)	0.00	0%
	Unspecified	0.02	0%
Food loss/waste & diets	Food waste and low-carbon diets	0.13	1%
Policy & National Budget Support & Capacity Building	Unspecified	0.70	3%
Unspecified/Multiple	Unspecified	3.62	16%
Total	-	23.2	100%

Table A.11. Breakdown of 2019/20 project-level investments in non-AFOLU sectors

non-AFOLU sector	Relevance for AFOLU sector	2019/2020 average (USDbn)	%
Energy Systems	Forestry	2.4	45%
	Agriculture	0.8	15%
	Fisheries	0.02	0%
Water & Wastewater	Agriculture	0.4	8%
	Fisheries	0.002	0%
	Food Loss/Waste & Diets	0.001	0%
	Policy & National Budget Support & Capacity Building	0.001	0%
	Forestry	0.0001	0%
Transport	Agriculture	0.03	1%
	Policy & National Budget Support & Capacity Building	0.001	0%

non-AFOLU sector	Relevance for AFOLU sector	2019/2020 average (USDbn)	%
Industry	Agriculture	0.002	0%
Waste	Food Loss/Waste & Diets	0.001	0%
	Agriculture	0.0	0%
Information and Communications Technology	Agriculture	0.02	0%
	Policy & National Budget Support & Capacity Building	0.001	0%
Unspecified/Multiple	Unspecified	1.6	30%
Total	-	5.2	100%

Table A.12. Breakdown of 2019/20 company-level investments to AFOLU sub-sectors

AFOLU sector	2019/2020 average (USDbn)	%
Food Loss/Waste & Diets	1.1	50%
Agriculture	1.0	44%
Fisheries	0.1	2%
Forestry	0.03	1%
Unspecified / Multiple	0.04	2%
Total	2.3	100%

Table A.13. Breakdown of 2019/20 project-level investments, by climate objective

AFOLU sector	2019/2020 average (USDbn)	%
Mitigation	14.4	100%
Forestry	8.5	59%
Agriculture	3.8	26%
Food Loss/Waste & Diets	0.1	1%
Policy & National Budget Support & Capacity Building	0.1	1%
Fisheries	0.0	0%
Unspecified/Multiple	1.8	13%
Adaptation	7.3	100%
Agriculture	5.0	68%
Policy & National Budget Support & Capacity Building	0.5	6%
Forestry	0.1	2%
Fisheries	0.1	1%
Food Loss/Waste & Diets	0.0	0%
Unspecified/Multiple	1.7	23%
Dual climate objectives	6.7	100%
Agriculture	3.1	46%
Forestry	3.0	45%
Policy & National Budget Support & Capacity Building	0.2	3%
Fisheries	0.0	0%
Food Loss/Waste & Diets	0.0	0%
Unspecified/Multiple	0.4	5%
Total	28.5	-

Table A.14. Breakdown of 2019/20 company-level investments, by climate objective

AFOLU sector	2019/2020 average (USDbn)	%
Mitigation	1.5	100%
Food Loss/Waste & Diets	1.0	65%
Agriculture	0.4	25%
Fisheries	0.04	3%
Forestry	0.01	1%
Unspecified/Multiple	0.04	3%
Adaptation	0.5	100%
Agriculture	0.4	81%
Food Loss/Waste & Diets	0.1	16%
Fisheries	0.01	3%
Unspecified	0.0	0%
Dual climate objectives	0.5	100%
Agriculture	0.2	87%
Food Loss/Waste & Diets	0.02	8%
Forestry	0.01	5%
Fisheries	0.001	0%
Total	2.3	100%

Table A.15. Breakdown of 2019/20 project-level investments, by public and private actors

Actor	2019/2020 average (USDbn)	%
Public	24.2	100%
Government	9.5	39%
National DFI	5.3	22%
Multilateral DFI	5.7	24%
Multilateral Climate Funds	1.7	7%
Bilateral DFI	1.5	6%
Public Fund	0.3	1%
State-owned FI	0.2	1%
SOE	0.04	0%
Unknown	0.001	0%
Export Credit Agency (ECA)	0.0	0%
Private	3.3	100%
Commercial FI	1.6	48%
Corporation	0.9	29%
Institutional Investors	0.5	15%
Unknown	0.2	7%
Funds	0.03	1%
Unknown	1.0	100%
Unknown	1.0	100%
Total	28.5	-

Table A.16. Breakdown of 2019/20 project-level investments, by instruments

Instrument	2019/2020 average (USDbn)	%
Grant	10.8	38%
Project-level market rate debt	8.9	31%
Low-cost project debt	3.8	13%
Unknown	3.1	11%
Project-level equity	0.9	3%
Balance sheet financing (debt portion)	0.8	3%
Balance sheet financing (equity portion)	0.3	1%
Total	28.5	100%

Table A.17. Breakdown of 2019/20 project-level investments, by OECD membership and region of destination

OECD membership / Region of destination	2019/2020 average (USDbn)	%
Non-OECD	18.3	100%
East Asia and Pacific	8.6	47%
Sub-Saharan Africa	4.4	24%
Latin America & Caribbean	1.8	10%
Central Asia and Eastern Europe	1.6	8%
South Asia	1.5	8%
Middle East and North Africa	0.4	2%
OECD	7.6	100%
US & Canada	2.9	38%
Western Europe	2.4	32%
East Asia and Pacific	1.6	22%
Latin America & Caribbean	0.3	4%
Central Asia and Eastern Europe	0.3	4%
Middle East and North Africa	0.0	0%
Transregional/Unknown	2.6	100%
Total	28.5	-

Table A.18. Breakdown of 2019/20 international and domestic project-level investments, by OECD membership

OECD membership / Region of destination	2019/2020 average (USDbn)	%
Domestic	13.3	100%
non-OECD	7.9	59%
OECD	5.5	41%
International	14.2	100%
non-OECD	12.1	85%
OECD	2.1	15%
Transregional/Unknown	0.9	100%
Total	28.5	-

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LIST OF ACRONYMS

AFOLU	Agriculture, Forestry, Other Land Uses, and Fisheries
FOLU	Food and Land Use Coalition
BNEF	BloombergNEF
CBI	Climate Bonds Initiative
CDFA	California Department of Food and Agriculture
CFU	Climate Funds Update
CRP	Conservation Reserve Program
OCED DAC	OECD Development Assistance Committee
DFI	Development Finance Institution
FAO	Food and Agriculture Organization
GHG	Greenhouse gas
IATI	International Aid Transparency Initiative
IDFC	International Development Finance Club
IPCC	Intergovernmental Panel on Climate Change
MDB	Multilateral Development Bank
NRCS	Natural Resource Conservation Service
OECD	Organisation for Economic Co-operation and Development
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDG	Sustainable Development Goal
USDA	United States Department of Agriculture
VC	Venture Capital
WWF	World Wildlife Fund

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