June 2021

Agriculture Background Paper

Climate Bonds Standard & Certification Scheme

Revision	Date	Summary of changes
2	15 June 2021	Text supporting the addition of criteria for livestock
1	20 August 2020	Publication of first criteria for crops

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Definitions

Agriculture: Agriculture is the management of plants and domesticated animals to produce food, feed, fibre, fuel and other products.

Agricultural production unit: The collection of assets and activities associated with the management of plants and domesticated animals to produce food, feed, fibre, fuel and other products. The most likely production unit is a farm.

Certified Climate Bond: A Climate Bond that is certified by the Climate Bonds Standard Board as meeting the requirements of the Climate Bonds Standard, as attested through independent verification.

Climate Bond Certification: allows the issuer to use the Climate Bond Certification Mark in relation to that bond. Climate Bond Certification is provided once the independent Climate Bonds Standard Board is satisfied the bond conforms with the Climate Bonds Standard.

Climate Bond: A climate bond is a bond used to finance – or refinance - projects needed to address climate change. They range from wind farms to hydropower plants, to rail transport and building sea walls in cities threatened by rising sea levels.

Climate Bonds Initiative (CBI): An investor-focused not-for-profit organisation, promoting large-scale investments that will deliver a global low carbon and climate resilient economy. The Initiative seeks to develop mechanisms to better align the interests of investors, industry, and government to catalyse investments at a speed and scale sufficient to avoid dangerous climate change.

Climate Bonds Standard (CBS): A screening tool for investors and governments that allows them to identify green bonds where they can be confident that the funds are being used to deliver climate change solutions. This may be through climate mitigation impact and/or climate adaptation or resilience. The CBS is made up of two parts: the parent standard (Climate Bonds Standard V3.0) and a suite of sector specific eligibility Criteria. The parent standard covers the certification process and pre- and post-issuance requirements for all certified bonds, regardless of the nature of the capital projects. The Sector Criteria detail specific requirements for assets identified as falling under that specific sector. The latest version of the CBS is published on the Climate Bonds Initiative website.

Climate Bonds Standard Board (CBSB): A board of independent members that collectively represents $34 trillion of assets under management. The CBSB is responsible for approving i) Revisions to the Climate Bonds Standard, including the adoption of additional sector Criteria, ii) Approved verifiers, and iii) Applications for certification of a bond under the Climate Bonds Standard. The CBSB is constituted, appointed, and supported in line with the governance arrangements and processes as published on the Climate Bonds Initiative website.

Critical interdependencies: The asset or activity's boundaries and interdependencies with surrounding infrastructure systems. Interdependencies are specific to local context but are often connected to wider systems through complex relationships that depend on factors 'outside the asset fence' that could cause cascading failures or contribute to collateral system benefits.

Green Bond: A Green Bond is a bond whose proceeds are allocated to environmental projects. The term generally refers to bonds that have been marketed as "Green". In theory, Green Bonds proceeds could be used for a wide variety of environmental projects, but in practice they have mostly been the same as Climate Bonds, with proceeds going to climate change projects.

Industry Working Group (IWG): A group of key organisations that are potential issuers, verifiers and investors convened by the Climate Bonds Initiative. The IWG provides feedback on the draft sector Criteria developed by the TWG before they are released for public consultation.

Investment period: The interval between the bond's issuance and its maturity date. Otherwise known as the bond tenor.

Technical Working Group (TWG): A group of key experts from academia, international agencies, industry, and NGOs convened by the Climate Bonds Initiative. The TWG develops the Sector Criteria - detailed technical criteria for the eligibility of projects and assets as well as guidance on the tracking of eligibility status during the term of the bond.

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1 Introduction

1.1 Funding needs of a low-carbon and climate resilient economy

The current trajectory of climate change, expected to lead to a global warming of 3.1-3.7°C by 2100[1], poses an enormous threat to the future of the world's nations and economies. The aim of the Paris Agreement is to limit warming to a global average of no more than 2°C higher than pre-industrial levels by the end of the century, and ideally no more than 1.5°C. The effects of climate change and the risks associated even with a 2ºC rise are significant: rising sea levels, increased frequency and severity of hurricanes, droughts, wildfires and typhoons, and changes in agricultural patterns and yields. Meeting the 2ºC goal requires a dramatic reduction in global greenhouse gas emissions.

At the same time, the world is entering an age of unprecedented urbanisation and related infrastructure development. Global infrastructure investment is expected to amount to USD 90 trillion over the next 15 years, more than the entire current infrastructure stock[2].

To ensure sustainable development and avoid dangerous climate change, this infrastructure needs to be low-carbon and resilient to physical climate impacts, without compromising the economic growth needed to improve the livelihoods and wellbeing of the world's poorer citizens. Ensuring that the infrastructure built is low-carbon raises the annual investment needs by 3–4%[3]. Climate adaptation needs add another significant amount of investment, which is estimated at USD 280–500 billion per annum by 2050 for a 2ºC scenario[4].

1.2 Role of bonds

Traditional sources of capital for infrastructure investment (governments and commercial banks) are insufficient to meet these capital needs; institutional investors, particularly pension and sovereign wealth funds, are increasingly looked to as viable actors to fill these financing gaps.

Capital markets enable issuers to tap into large pools of private capital from institutional investors. Bonds are appropriate investment vehicles for these investors as they are low-risk investments with long-term maturities, making them a good fit with institutional investors' liabilities (e.g. pensions to be paid out in several decades).

Bond financing works well for low-carbon and climate-resilient infrastructure projects post-construction, as bonds are often used as re-financing instruments. Labelled green bonds are bonds with proceeds used for green projects, mostly climate change mitigation and/or adaptation projects, and labelled accordingly. The rapid growth of the labelled green bond market has shown in practice that the bond markets can provide a promising channel to finance climate investments.

The green bond market can reward bond issuers and investors for sustainable investments that accelerate progress toward a low carbon and climate resilient economy. Commonly used as long-term debt instruments, green bonds are issued by governments, companies, municipalities, commercial and development banks to finance or re-finance assets or activities with environmental benefits. Green bonds are in high demand and can help issuers attract new types of investors.

Green bonds are regular bonds with one distinguishing feature: proceeds are earmarked for projects with environmental benefits, primarily climate change mitigation and adaptation. A green label is a discovery mechanism for investors. It enables the identification of climate-aligned investments even with limited resources for due diligence. By doing so, a green bond label reduces friction in the markets and facilitates growth in climate-aligned investments.

Currently green bonds only account for less than 0.2% of a global bond market of USD 100 trillion. The potential for scaling up is tremendous. The market now needs to grow much bigger, and quickly.

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[1] According to Climate Tracker, under current policies we could expect 3.1-3.7ºC: http://climateactiontracker.org/global.html

2 The Global Comission on the Economy and Climate (2016), 'The Sustainable Infrastructure Imperative: Financing for Better Growth and Development': http://newclimateeconomy.report/2016/wp-content/uploads/sites/4/2014/08/NCE_2016Report.pdf

3 The Global Comission on the Economy and Climate (2016), 'Better Growth, Better Climate': http://newclimateeconomy.report/2016/wp-content/uploads/sites/2/2014/08/BetterGrowth-BetterClimate_NCE_Synthesis-Report_web.pdf
4 UNEP (2016), 'The Adaptation Finance Gap Report': http://www.unepdtu.org/newsbase/2016/05/uneps-adaptation-finance-gap-report-released?id=377aa3d4-32c1-4100-8bee-ae65390b60ba

1.3 Introduction to Climate Bonds Initiative and the Climate Bonds Standard

The Climate Bonds Initiative (CBI) is an investor-focused not-for-profit organisation whose goal is to promote large-scale investments through green bonds and other debt instruments to accelerate a global transition to a low-carbon and climate-resilient economy.

Activating the mainstream debt capital markets to finance and refinance climate-aligned projects and assets is critical to achieving international climate goals, and robust labelling of green bonds is a key requirement for that mainstream participation. Confidence in the climate objectives and the use of funds intended to address climate change is fundamental to the credibility of the role that green bonds play in a low carbon and climate-resilient economy. Trust in the green label and transparency to the underlying assets are essential for this market to reach scale but investor capacity to assess green credentials is limited, especially in the fast-paced bond market. Therefore, CBI created Climate Bonds Standard & Certification Scheme, which aims to provide the green bond market with the trust and assurance that it needs to achieve scale.

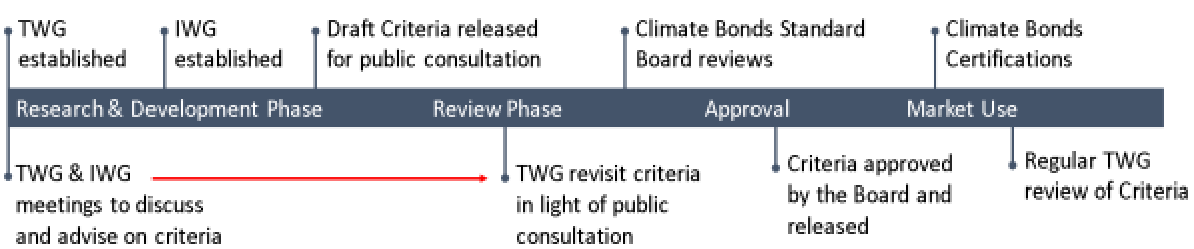
The Climate Bonds Standard & Certification Scheme is an easy-to-use tool for investors and issuers to assist them in prioritising investments that truly contribute to addressing climate change, both from a resilience and a mitigation point of view. It is made up of the overarching Climate Bonds Standard detailing management and reporting processes, and a set of Sector Criteria detailing the requirements assets must meet to be eligible for certification.

The Sector Criteria cover a range of sectors including solar energy, wind energy, marine renewable energy, geothermal power, low carbon buildings, low carbon transport, forestry, bioenergy, waste management and water. The Certification Scheme requires issuers to obtain independent verification, pre- and post-issuance, to ensure the bond meets the requirements of the Climate Bonds Standard.

1.4 Process for Sector Criteria Development

The Climate Bonds Standard has been developed based on public consultation, road testing, review by the assurance roundtable and expert support from experienced green bond market actors. The Standard is revisited and amended on an annual basis in response to the growing green bond market. Sector-specific Criteria, or definitions of green, are developed by Technical Working Groups (TWGs), made up of scientists, engineers, and technical specialists. Draft Criteria are presented to Industry Working Groups (IWGs) before being released for public comment. Finally, Criteria are presented to the Climate Bonds Standard Board for approval.

Figure 1 Criteria development timeline



1.5 Revisions to the Criteria

As part of CBI's goal to accelerate a global transition to a low-emissions, climate resilient economy, the Agriculture Criteria seek to maximise viable bond issuances with verifiable climate outcomes. All groups and individuals involved recognise the unique nature of this sector as both a source and sink of GHG emissions. As the sector is still developing mitigation, adaptation and resilience options, the Criteria are a foundation and starting point from which to encourage high performance and increased transparency and consistency in application of scientific best practices and data in the context of bond issuances but should be reviewed as needed to keep pace with developments in the sector.

The Criteria will be reviewed regularly, at which point the TWG will take stock of issuances that arise in the early stages and any developments in improved methods and data that can increase the climate integrity of future bond issuances. After the first review, the Criteria will be reviewed periodically on a needs basis as technologies and the market evolve. As a result, the Criteria are likely to be refined over time, as more information becomes available. Certification will not be withdrawn retroactively from bonds certified under earlier versions of the Criteria.

1.6 Summary of information and supporting documentation

This document supports the Agriculture Criteria. It captures the issues raised and discussed by the TWG, as well as the arguments and evidence in support of the proposed Criteria. It is structured as follows:

Section 2 provides a brief overview of the sector: its status, trends and role in mitigating and adapting to climate change.

Section 3 outlines the principles and boundaries of the Criteria. It states that an agriculture asset must pass three sets of requirements to be eligible for certification: (i) minimum standards for animal welfare, (ii)mitigation requirements and (iii) adaptation, resilience and other environmental and social requirements.

Supplementary information is available in addition to this document including:

1. Agriculture Criteria Brochure: a 2-page summary of the Agriculture Criteria
2. Agriculture Criteria
3. Climate Bonds Standard V3: the umbrella document laying out the common requirements that all Certified Climate Bonds need to meet, in addition to the sector-specific Criteria (V3 is the most recent version).
4. Climate Bonds Standard & Certification Scheme Brochure: an overview of the purpose, context and requirements of the Climate Bonds Standard & Certification Scheme.

For the documents listed above, see https://www.climatebonds.net/agriculture. For more information on the Climate Bonds Initiative and the Climate Bond Standard & Certification Scheme, see https://www.climatebonds.net/standard.

2 Sector Overview

2.1 What is Agriculture?

Agriculture is the management of plants and domesticated animals to produce food, feed, fibre, fuel and other products.

Defining agriculture is challenging due to the high variability within the sector and the nature of agricultural production systems. Significant variability exists in crop and animal production, farm size, farmer assets, income, environmental conditions, mitigation potential and climate risks. Agriculture's role in supply chains, food systems, household economy and landscapes require defining sectoral boundaries with respect to:

- Other land uses, including forests, peatlands, grasslands and coastal areas
- Agricultural production, including inputs, capital and transformation processes, such as land, labour, crop seeds, animal breeds, fertilizer, feed, water and irrigation, machinery, pesticides, herbicides and climate and other advisory services
- Supply chain processing, transportation, markets, consumption, waste use and recycling
- Energy use and production, including renewable energy
- Rural livelihoods, food security and nutrition

2.2 The future of food and agriculture[5]

By 2050, it is projected that the global population will increase to 10 billion resulting in a 50% increase in food demand, with global grain demand projected to double. Income growth in low- and middle-income countries is driving changes in diets towards more emissions-intensive animal-based products, much of it grain fed. While the need to increase crop yields is clear, how this will be achieved is less obvious given the likely negative impacts of climate change and the evidence that yields of major crops have been levelling off in large parts of the major producing countries (Ray et al., 2012; Grassini et al., 2013). Furthermore, this levelling off in yields has been observed for both potential (Duvick et al., 1999; Peng et al., 1999) and actual (Grassini et al., 2013) yields.

Given agriculture's central role in climate change, sustainable development, and food security, achievement of major international policy targets will be impossible without meaningful action in the sector. The United Nations Sustainable Development Goals call for transformation of our economic, financial, energy, and land use systems. Frontrunner companies have committed to zero deforestation supply chains. Climate change mitigation in the land sector, which is

[5] FAO, (2017). The future of food and agriculture: Trends and challenges.

strongly linked to commodity markets (e.g., beef, soy, paper and pulp, biofuels), can build on experience gained through sustainability roundtables and certification schemes.

The transition to a climate resilient and sustainable, low emission agricultural sector may be facilitated by technological innovations. Examples include:

- Yield-enhancing technologies that can increase crop productivity and resistance to extreme changes in weather while also reducing water usage
- Improving crop nutrient levels through fortification/biofortification processes that can reduce hunger and malnutrition
- Low emission rice varieties
- Vaccinations to reduce methane emissions from cattle
- Hydroponic and vertical farming provide the opportunity to optimize land use and reduce stress on resources.

2.3 Agriculture and Climate Change

The land use sector, and agriculture in particular, differ from other sectors for climate bond issuance in several key ways:

- Agriculture can act as a source and sink for GHG emissions.
- Agriculture activities and assets are vulnerable to climate change, but also support adaptation and resilience due to their role in rural livelihoods and ecosystem services.
- The mitigation potential of soil and biomass carbon pool improvements is complex and their attribution to management actions can be challenging. Equilibrium levels and saturation of carbon storage vary due to management practices and over time. Stored carbon is always vulnerable to future release to the atmosphere.
- GHG emissions and sequestration vary spatially and are highly heterogeneous. Data based on measurements do not exist for many places. Hence uncertainty around emissions estimates is high.

Agriculture plays a crucial role in achieving global decarbonisation targets. In 2014, the IPCC[6] estimated that the sector accounted for approximately 10-12% of anthropogenic GHG emissions or 5 to 5.8 $GtCO_2e$/yr in 2000-2010. Then in the period 2007-2016[7], agriculture contributed 6.2 $GtCO_2e$/yr and with a range of 2.6. This is 12% of anthropogenic GHG emissions, showing that agriculture's contribution is growing year on year. Agriculture is also a major driver of deforestation, contributing at least an additional 2.3 $GtCO_2$ in annual emissions in 2010-2014[8] due to the expansion of cropland and pastureland in forest areas.[9] The implementation of sustainable agricultural practices is necessary for the industry to successfully reduce emissions, adapt to changes in weather patterns, and withstand the pressures placed on food security by population growth. Simultaneously, limiting deforestation and forest degradation is imperative to ensure that forests act as a net carbon sink rather than a GHG emitter. Estimates suggest that between USD 7 billion and 7.6 billion are required per year for adaptation measures in the Agriculture, Food and Forestry sectors.[10] Despite the need for more finance flows directed towards addressing climate impacts on these sectors, investment remains small, accounting for USD 37.3 billion or just over 3% of the climate-aligned bond universe.[11]

2.4 Inclusion of livestock production

Demand for animal protein products is increasing[12] as populations grow and income levels rise in developing countries. There is also huge support for agriculture from policy mechanisms for food security, employment, and GDP. Set against this is the enormous contribution, particularly from ruminant animals to GHG emissions.

Whilst it is recognised that collectively we need to eat less meat,[13] the exclusion of certain production systems or commodities from the criteria at this stage is a blunt tool to achieve this. Whilst it may send a clear signal about the end goal, it may not have the desired effect of encouraging the transition towards that, especially amidst strong consumer support. In addition, it is recognised that some animal production systems may positively contribute to climate action though the scope and scale is not yet well understood.

Instead, the approach is to effectively engage with the sector to create a premium product platform for livestock and to realise the mitigation potential within the sector. It is estimated that this could be around 30% just from practices and technologies widely available today by setting ambitious criteria, so that halving emissions by 2030 becomes possible.

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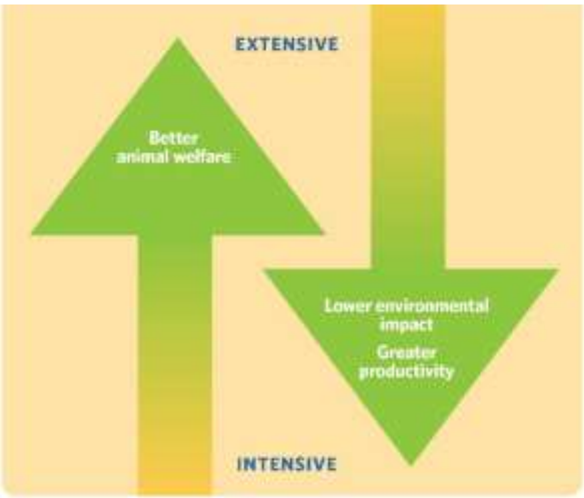
[6] https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_summary-for-policymakers.pdf
[7] https://www.ipcc.ch/site/assets/uploads/2019/08/4.-SPM_Approved_Microsite_FINAL.pdf
[8] These were low deforestation years in Brazil. https://rainforests.mongabay.com/amazon/deforestation_calculations.html
[9] Pendrill et al. 2019. https://www.sciencedirect.com/science/article/pii/S0959378018314365#sec0080. Pendrill et al. indicate that 2.6 $GtCO_2e$ of deforestation emissions were due to agriculture and forest plantations. Based on their data for cropland and pastureland, we derived that 2.3$GtCO_2e$ can be attributed to agriculture only.
[10] See http://siteresources.worldbank.org/INTCC/Resources/EACCReport0928Final.pdf
[11] Climate Bonds Initiative, (2018). Bonds and Climate Change - The State of the Market 2018. Available: https://www.climatebonds.net/files/reports/cbi_sotm_2018_final_01k-web.pdf. Also Buchner 2017. https://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2017/. Climate-aligned bonds are defined as either labelled green bonds or bonds from issuers that derive more than 75% of revenue from 'green' business lines.
[12] http://www.fao.org/livestock-environment/en
[13] Ibid

This develops an engagement platform to reshape the sector more fundamentally over time and move on to a more robust pathway to reduce emissions.

Animal welfare requirements

There is a direct link between GHG emission intensities and animal efficiency: the more productive or efficient an animal is (at producing milk, meat or eggs), the lower its environmental impact. However, efficient production typically takes place in intensive systems (largely indoor) and is often associated with concerns around animal welfare issues – as shown in the figure below. Extensive animal production systems (largely outdoor) are generally seen as better from an animal welfare perspective but have higher GHG emissions rates. Generally,[15]animal production systems that have the lowest climate impact tend to be intensive systems.

Figure 2 Inverse relationship between climate impact and animal welfare



With this inverse relationship between animal welfare and GHG emission mitigation, there is a tension that can be managed with careful management of animal welfare.

Examples of the animal welfare issues include:

Meat chickens: fast growth, heart failure, walking impairment, footpad injuries, mortality.

Laying hens: Caged confinement, weak bones leading to bone breakage, adverse behaviours such as feather pecking, invasive painful procedures, such as beak trimming.

Pigs: Permanent hunger for pregnant sows, caged confinement, adverse behaviours such as ear-and tail-biting, invasive painful procedures such as tail-docking.

Cattle: Permanent indoor housing as milk production requires almost constant feed intake; 'unnatural' diets consisting of grain, rather than herbage; no access to grazing or outdoors; housing on hard floors leading to lameness; invasive painful procedures, such as dehorning. Diets that have high levels of grain can cause digestive and other health problems for cattle. Acidosis is very common in cattle fed high levels of grain.

The ethical framework that provides a broad generic principle to safeguard animal welfare is often referred to as the Five Freedoms:

1. Freedom from hunger or thirst by ready access to fresh water and a diet to maintain full health and vigour
2. Freedom from discomfort by providing an appropriate environment including shelter and a comfortable resting area
3. Freedom from pain, injury or disease by prevention or rapid diagnosis and treatment
4. Freedom to express (most) normal behaviour by providing sufficient space, proper facilities and company of the animal's own kind
5. Freedom from fear and distress by ensuring conditions and treatment which avoid mental suffering

There is the potential for animal welfare concerns to be a materially significant component of an investment. A complete understanding of the risks and trade-offs is required where they may significantly alter the investment rationale. There may also be an obligation for investors to require those corporations and entities in which they invest to meet a high standard of conduct and strive towards sustainability.

There are no specific animal welfare requirements to be met for extensive agricultural systems. Intensive production systems, however, should meet good practice expectations to safeguard animal welfare. Overall guidance is provided in the IFC Good practice note[14].

Issuers are required to obtain certification to schemes that require high standards. The following schemes have been selected as suitable for this purpose:

- Humane Farm Animal Care Certified Humane https://certifiedhumane.org/
- RSPCA Assured https://www.rspcaassured.org.uk/farm-animal-welfare/rspca-welfare-standards/
- Animal Welfare Approved by A Greener World https://agreenerworld.org/certifications/animal-welfare-approved/
- Beter Leven levels 2&3 https://beterleven.dierenbescherming.nl/
- G.A.P levels 4&5 https://globalanimalpartnership.org/

If the issuer demonstrates that none of these schemes certify in the country where the operations are located, then assessment should be undertaken using the requirements (principles and the relevant species-specific mitigation criteria) detailed in the FARMS Initiative RMS (except those criteria relating to transportation and slaughter as these are out of the scope of this Agriculture criteria). These are available at https://farms-initiative.com.

There is no burden of proof required for extensive agricultural systems to *demonstrate* animal welfare standards as this is not the area where animal welfare issues are typically seen. However, it is expected that welfare standards would still apply e.g., no dehorning.

Sourcing of feed requirements

While animal feed is an essential input to the animal protein industry, it also has a significant impact on the environment, including air, land, soil, water, and biodiversity. For instance, life cycle assessment (LCA) studies have estimated that feed production accounts for 70% of the carbon footprint of animal products.[15] Thus, meeting future demand for protein products in a sustainable way will require a wide range of strategies to tackle the environmental impact of feed production. While there are several organisations looking at the sustainability of feed, it is important that schemes that certify feeds do not undertake a mass balance approach where the overall feed meets certain criteria but that the criteria can be met by mixing feeds from different, some of which will fall short but which will, overall, meet the criteria. The requirements for certification schemes must include an assessment of the chain of custody for all feed. Feed must not be sourced from land that has been converted from high carbon stock (HCS) lands.

2.5 Investment need

Adaptation costs can vary widely. Between the World Bank, Stern, Oxfam, UNDP and UNFCCC, the costs of climate change adaptation in all sectors ranges from as little as USD 4 billion to as much as 109 billion per year.[16] The land use sector receives only 2.5% of public mitigation finance yet is responsible for up about 25% of global emissions (CBI, 2015). Eighty-six percent of private investment in climate action from green bond issuances is invested in energy and transport, and only 0.9% in land use (CBI, 2016). Estimates suggest that between USD 7 billion and 7.6 billion are required per year for adaptation measures in the Agriculture, Food and Forestry sectors.[17]

To mobilize investment in a sustainable land use sector from large pools of global capital, issuers of land use climate bonds will need to repay bond debt by generating revenues in more traditional ways such as through sale of agricultural products or revenue streams related to production (e.g., inputs, trade finance).

2.6 Bonds in the sector

In 2017, agriculture and forestry made up a small proportion of the overall climate-aligned bond universe, accounting for just 1% of climate bond value[18] with the majority coming from certified paper and packaging. By 2018, despite the need for more finance to address climate change in these sectors, investment remained small: USD 37.3 bn or just over 3% of the climate-aligned bond universe.[19]

This is partly because bonds are not frequently issued in these sectors and partly because it is challenging to identify companies that focus on a particular product or activity ("pure-plays") in this sector. By 2018 when the work to develop this criteria was started, there were still no 'green' agriculture issuers identified.[20] The role that bonds will play in

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[14] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_gpn_animalwelfare_2014

[15] Alessandra Nardina Trícia Rigo Monteiro, and Jean-Yves Dourmad. "Life cycle assessment of feed ingredients." SUMINAPP – Sustainable Usage of trace Minerals for Animal Production Programs (2018). DOI: 10.13140/RG.2.2.26695.75682
[16] IIED, (2009). Assessing the costs of adaptation to climate change. Available online.
[17] See http://siteresources.worldbank.org/INTCC/Resources/EACCReport0928Final.pdf
[18] Climate Bonds Initiative, (2017). Bonds and Climate Change: The State of the Market 2018. Available online.
[19] Climate Bonds Initiative, (2018). Bonds and Climate Change: The State of the Market 2018. Available online.
[20] Climate Bonds Initiative, (2017). Bonds and Climate Change: The State of the Market 2017. Available online.

financing a transition in this sector therefore remains unclear. Guidance, such as Climate Bonds' Agriculture Criteria, about which assets and projects align with green financing in the agriculture sector, is likely to catalyse investment and can be utilised by governments in setting regulation or recommendations for decarbonising the sector.

Numerous opportunities exist for investment. For example, hydroponic and vertical farming provide the opportunity to optimise land use and reduce stress on resources. Yield-enhancing technologies can increase crop productivity and resilience to extreme changes in weather while also reducing water usage, thus ensuring steadier revenue streams for farmers. Low-emission breeds and crops could reduce emissions significantly. Augmenting crop nutrient levels through fortification or biofortification can help tackle hunger and malnutrition. The availability of such innovations presents significant investment opportunities to help create an efficient and potentially low-carbon agriculture system.

One example of the potential for agricultural bond growth is Brazil.[21] Brazil is a top agricultural producer and various financing programmes for agriculture and agribusiness have been introduced, including for low-carbon agriculture. However, the use of green bonds has been limited to sustainable forestry and paper. Opportunities exist, but a more concerted effort in promoting and supporting green financing is required. Aggregation of small loans and receivables can help the market scale up.

Capital market financing may not be economically feasible for small- to medium-size producers. However, the scale and composition of current lending to this sector suggest there is an opportunity for sustainable investment to be scaled up via aggregation. Certificate of Agribusiness Receivables Asset-Backed Securities (ABS), a tried and tested structure, can be used to bundle smaller revenue streams (agricultural credit rights) and use them as collateral for green ABS sold to domestic or international investors.

In addition, tackling the obstacles that make it difficult or prevent producers, especially small producers in rural areas in developing countries, from receiving financing is crucial. Streamlining the credit application, approval and disbursement process, ensuring credit terms for sustainable agriculture are either the same or even better than for traditional practices, improving capacity for producers to obtain technical assistance, and adequately training staff at rural banks and public and private agencies appear of particular importance.

Through collaboration between global and local stakeholders to develop robust but flexible standards, increase technical knowledge of sustainable practices, and improve lending processes, the international green bond market could no doubt be a powerful vehicle to address the barriers discussed and boost funding for sustainable agriculture worldwide.

3 Principles and Boundaries of the Criteria

This section sets out the key principles governing the Criteria for qualifying agricultural assets and activities under the Climate Bonds Standard and describes the assets and activities covered by those Criteria.

3.1 Guiding Principles

The Climate Bonds Standard needs to ensure that the agriculture assets and projects included in Certified Climate Bonds deliver GHG mitigation potential and climate resilience benefits in line with best available scientific knowledge and compatible with the goals of the Paris Agreement. At the same time, the Agriculture Criteria need to be pragmatic and readily usable by stakeholders in the market to maximise engagement and use. High transaction costs run the risk of reducing uptake of a standard in the green bond market. Keeping the costs of assessment down while maintaining robust implementation of the criteria is important. Table 1 sets out the principles guiding the development of the Agriculture Criteria to meet and balance these two goals.

Table 1 Key principles for the design of the Agriculture Criteria

Principle	Requirement for the Criteria
Level of ambition	Compatible with meeting the objective of 2ºC or less temperature rise above pre-industrial levels set by the Paris Agreement, and with a rapid transition to a low carbon and climate resilient economy

[21] Climate Bonds Initiative, (2018). Can green bonds finance Brazil's agriculture? Available online.

Robust system	Scientifically robust to maintain the credibility of the Climate Bonds Standard
"Do not reinvent the wheel"	Harness existing robust, credible tools, methodologies, standards and data to assess the low carbon and climate resilient credentials of any technology, endorsed by multiple stakeholders where possible.
Level playing field	No discrimination against certain groups of producers (such as smallholders) or geographies or technologies
Multi-stakeholder support	Supported by key stakeholders; those within the relevant industry, the financial community and broader civil society
Continuous improvement	Subject to an evolving development process with the aim of driving continuous improvement and credibility in the green bond market
Animal welfare	Production systems should be mindful of animals as sentient beings and should follow good practice guidance on animal welfare.

The additional overarching principles for the Agriculture Criteria are proposed:

1. All issuances shall contribute to both climate change mitigation and resilience of the asset.
2. All issuances shall reduce absolute emissions or increase carbon sequestration to contribute definitively to global climate change mitigation.
3. Resilience shall be determined as the sustained value of the asset in the face of climate change over the period of the investment.
4. Issuances involving livestock should meet a minimum standard of animal welfare.

The TWG recommended a prescriptive approach to be used for animal welfare and for the mitigation component, whilst for the more complicated assessment of climate change adaptation eligibility it was recommended that a set of guiding principles should be adopted. This is the approach adopted here.

All issuances shall employ good agricultural practice as recommended for the location.

Regarding assumptions for designing criteria:

- Criteria shall be designed to have quantitative thresholds or targets, where possible.
- Thresholds or targets should reflect the uncertainty of estimates.
- Assessment shall focus on the assets of the investment during the bond period.
- Evaluation of criteria shall lead to a decision of "eligible" or "not eligible" for certification. No intermediate status is possible.
- For verification, CBI encourages bond issuers to make use of existing recognized tools, standards and methodologies where possible, such as verified GHG calculators.
- Aligning criteria with existing standards will facilitate efficiency in this regard.
- Methods should follow IPCC guidance on methods for estimating GHG emissions.

To grow the market meaningfully, bonds in the agriculture sector should fit the needs of both investors and issuers.

The role of the Climate Bonds Standard and Agriculture Criteria is to develop technology-agnostic climate mitigation and resilience thresholds for the sector. These metrics and thresholds help asset owners, issuers, and investors determine the most climate compatible types of activities to finance.

By determining the types of activities to finance through bonds, issuers will be key drivers for growth in the agriculture climate/green bond market. However, potential bond investors can also drive the market's growth by signalling the types of investments they are eager to make.

For bond investors, this means eligibility criteria should promote bond issuances that are:

- Relatively straightforward, predictable, and easy to understand (e.g., in terms of the source and credibility of expected cash flows)

- Transparent regarding use of bond proceeds and intended impacts, facilitating independent third-party scrutiny
- Sizeable, liquid and preferably rated
- A comparable investment opportunity relative to non-green-labelled bonds. This may mean, for example, involving concessional funding or government incentives to improve the risk/return profile, particularly at this nascent stage.

For bond issuers, this means eligibility Criteria should:

- Allow a relatively wide scope for eligible activities
- Indicate scientifically robust references and approaches for calculating climate benefits (e.g., guidelines for selecting among existing methodologies and tools)
- Cater to a range of potential issuers (and users of the guidance), including: (a) relatively large companies, including banks, who aggregate across sectors and industries, (b) smaller companies and organisations, where there may need to be some aggregation and, or, concessional support, and (c) government agencies
- Leave room for issuances that are short-term inter alia trade/input finance, insurance, uptake of relevant, proven technology
- Be supportive of best practice in animal welfare.

3.2 Assets and Activities Covered by these Criteria

3.2.1. Scope of use of proceeds

The scope of the sector and eligibility criteria needs be broad enough to capture diverse systems and their mitigation and adaptation impacts, while also having clear boundaries with other sectors, especially those covered by CBI's other sector criteria. Following earlier discussions and criteria development on Agriculture, Forestry and Other Land Use (AFOLU), CBI (2016) recommended that the AFOLU Criteria be divided into sub-sectors to develop separate eligibility criteria for agriculture, forestry, fisheries and aquaculture. A similar principle may need to be applied within agriculture itself to capture differences among production systems, income level or other sources of variation. The scope and criteria should be consistent with other major accounting systems to enable comparison and avoid redundant accounting.

The TWG considered whether to apply land use categories or production system types to further define the scope of agriculture. While land use corresponds well with IPCC methods for emissions estimates, investments are usually tied to agricultural production systems. The decision therefore was made to align the scope with production systems. Note that scope is different than eligibility, which is assessed using specific criteria (see Criteria section).

The following agricultural production systems are within scope:

- Perennial & non-perennial crop production - including alfalfa, fruit trees, oil palm, coffee, tea, cocoa, rubber, oil seeds, cereals, paddy rice, sugarcane, soy and cotton.[22] This includes crops grown for bioenergy.
- Livestock production both extensive and intensive production systems for cattle, buffalo, sheep, goats, dairy, pigs and poultry and their waste (manure) and related grassland or pasture. There are specific additional requirements for intensive production systems with respect to animal welfare and feed sourcing.
- Agroforestry,[23] where more than 50% of the land is for crops, is within the scope of the Criteria and will be assessed as combinations of crop production plus the impacts of any synergistic interactions (e.g., nitrogen-fixing trees).

3.2.2. Scope of farmgate

The boundary of the eligible crop production system is in essence "farm gate to farm gate".

For mixed farms, unless the crops are just for fodder, the crop production elements should follow criteria for crop production and the livestock elements follow the criteria for livestock. The boundary of the eligible crop and livestock production system is, in essence, "farmgate to farmgate".

For clarification, these "farmgate to farmgate" boundaries can include non-contiguous lands and production systems. The farm is treated as the production unit, so it includes areas such as any forest holdings linked to the agricultural production system by ownership or ecosystem function. Non-contiguous production activities are eligible if they are related to farm production prior to the sale of the product, such as storage, manure management, or composting, and managed by the farm production unit. The Criteria are neutral regarding the future use of crops once they have left the agricultural production unit and do not have provisions for tracking the use of crops by the agricultural production unit.

[23] Agroforestry is defined by the FAO as land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. See www.fao.org/forestry/agroforestry/80338/en/.

Eligible activities and associated assets and projects include those integral to the whole production unit (such as land purchase costs for an entire farm) or only a part of the production unit (such as equipment or infrastructure for particular components of land management or the purchase of additional land for expansion of the farm). The Criteria will vary according to whether the use-of-proceeds cover the whole production system or a component of it.

Livestock spend most of their life on a farm and conditions during this phase have the biggest impact on welfare, However, it is acknowledged that transport and slaughter have the potential for animal welfare issues, this phase is relatively short and when done humanely and professionally, the killing of an animal is not regarded as a welfare issue.

Examples and further information are given in Table 2.

3.2.3 Agricultural production systems not in scope

Controlled environment agriculture such as greenhouse or hydroponic production are out of scope for the Criteria due to the special considerations associated with their infrastructure and energy use, however CBI has produced the Criteria for Protected Agriculture in Mexico[24]. There will not be further differentiated Agriculture Criteria for different regions.

For the avoidance of doubt, aquaculture and the farming of fish is not covered under these Criteria.[25]

3.2.4 Supporting activities in scope

The Criteria also cover activities carried out outside of specific agricultural production units but that generate or provide products and services which enable agricultural production units to reduce emissions and/or increase climate adaptation and resilience. These are limited to certain activities that are detailed in Table 2.

3.3 Eligible types of expenditure

According to the overarching Climate Bonds Standard V3.0, which sets out the framework for all certified bonds, eligible expenditure includes:

- Related and supporting expenditures for projects or physical assets, where the projects or physical assets meet the relevant Sector Eligibility Criteria (such as the Criteria in this document;
- Capital expenditure undertaken to increase the value and/or lifetime of the assets or projects;
- Related and supporting expenditure including relevant installation and routine maintenance expenditure and upgrades undertaken to maintain the value and/or lifetime of the asset.

In line with this, in broad terms eligible use-of-proceeds relating to agriculture production systems might include capital and operating expenditure relating to (1) inputs (e.g., land, seeds, fertilizer,[26] energy, information), (2) capital goods (e.g., land, equipment, housing), (3) crop-based transformation processes (e.g., crop cultivation and planted trees), (4) agricultural outputs (e.g., grains, vegetables, fibre, meat, dairy products[27]) (5) waste management on the production unit (composting, manure, crop residue processing, recycling), and (6) primary processing and storage before point of sale.

And in broad terms, eligible use-of-proceeds relating to supporting activities generated outside of the production system that enable mitigation or climate adaptation and resilience on production systems can include a variety of capital and operating expenditure associated with the provision of the qualifying product or service.

For the avoidance of doubt, what will not be considered eligible are activities, assets or projects where the climate benefits are unclear or have an unclear time horizon. For example:

- Research & development programs where climate benefits are unclear;
- Biodiversity projects with unclear climate benefits;
- General behaviour change training;
- Any project with unclear time horizon for climate benefits;
- Expenditure relating to general corporate purposes.

3.4 Defining scope in relation to supply chains

The food supply chain contributes 19-29% of global GHG emissions (Vermeulen et al., 2012) and up to a third of food is lost and wasted (FAO 2011). Yet the majority of food system emissions, for most supply chains, occurs at the farm level (80%–86%); the remainder comes from pre-farmgate production and post-farmgate activities such as processing,

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[24] https://www.climatebonds.net/standard/protected-agriculture
[25] A separate TWG has considered potential criteria for fisheries but were not able to propose criteria at this time. See CBI's discussion paper for further information. https://climatebonds.net/fisheries
[26] Future iterations of the Criteria will preferably include (subject to developments in labelling by fertilizer producers) requirements for fertiliser to be only from domestic sources and produced in line with International Fertiliser Association's guidelines.
[27] This includes the raw milk provided by the farmers and also the processing.

packaging, refrigeration, transport, retail, catering, domestic food management and waste disposal (Vermeulen et al., 2012).

Pre-farmgate production of nitrogen fertilizer is a significant source of emissions[28] accounting for about 50% of total supply chain GHG emissions. In China, for example, because of the predominance of coal-based fertilizer plants, the carbon footprint of urea is estimated to be three times higher than in the EU where natural gas-based plants are mainly used. China consumes and produces about one third of global nitrogen fertilizer, suggesting substantial emissions reductions are possible. Including assessment of the GHG footprint of nitrogen fertilizer could incentivize investment and sourcing towards cleaner technologies and state-of-the art fertilizer products. Nitrogen fertilizer inputs therefore will be in scope, but industrial fertilizer production as an asset class will not be.

Similarly, the emissions from direct energy use on farm, for example fuel and electricity use, can be comparable to farm methane or nitrous oxide emissions,[29] for example on a dairy farm in the Netherlands[30] and therefore are considered in scope.

This GHG accounting scope corresponds to the GHG Protocol Corporate Standard's Scope 1 and Scope 2 emissions, and further includes fertilizer input emissions. The GHG Protocol provides three levels of accounting for a company's GHG emissions: "Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions not included in scope 2 that occur in the value chain of the reporting company, including both upstream and downstream emissions."[31]

Because of the complexity of agricultural supply chains after the farmgate and overlaps with the energy, manufacturing and transport sectors, the Agriculture Criteria does not address the supply chain post farmgate. Primary processing and other supply chain processes, unless for storage, are also out of scope, even if they are "on-farm" or undertaken by the producer.

One exception is plant-based alternative-meat and dairy products, which are expected to have an overall substitution effect on meat and dairy consumption and emit only about half the GHG emissions of these products per kilogram (see Mitigation section).The scope of an agricultural production system therefore will be based on all agriculture-related assets and activities in the selected production system up to and including the farmgate.

The general principle that is applied is that use of proceeds are eligible for Climate Bonds Certification if it can be demonstrated that the mitigation and resilience requirements are met in a way that links directly to the use of proceeds. Broadly, use of proceeds can be categorised in two ways; capital expenditure and linked operational expenditure. We may see direct financing of these types of use of proceeds (e.g., by the asset owner) or indirect financing through subsidies or credit lines (e.g., by a bank or sovereign).

Assets and projects do not need to be physically located on the land in question.

Where several projects are bundled under one bond, proof of compliance with other sector criteria may be required. For example, if the bond was financing sustainable cropland agriculture projects that included irrigation and solar energy projects then the issuer would have to prove compliance not only with the Agriculture Criteria but also under the Water and Solar Criteria.

[28] https://academic.oup.com/bioscience/article/63/4/263/253267
[29] https://academic.oup.com/bioscience/article/63/4/263/253267
[30] https://www.sciencedirect.com/science/article/pii/S1573521413000705
[31] Ibid

4 Setting Mitigation Thresholds in Agriculture

Agricultural systems for climate change mitigation are typically defined at the level of the (1) production unit, (2) commodity (kilogram of product or other relevant unit), or (3) the company or farmer owning or operationally controlling emissions sources (controlling unit) (GHG Protocol – Agriculture guidance). Sometimes boundaries are extended to include sources of emissions from inputs or in the supply chain, especially where they are significant sources. See, for example, the Cool Farm Tool or the EX-ACT Supply Chain tool.

For the Agriculture Criteria, the TWG determined that the scope of accounting of emissions will include:

- Emissions embedded in fertilizer inputs and transportation of farm inputs as significant sources
- Emissions resulting from on-farm production, use of capital goods, or outputs on the farm
- Emissions from the processes required for storing outputs, such as washing or simple packaging

Emissions from agricultural buildings or machinery are not in scope due to a lack of readily available information for these sources. Indirect emissions, for example from nitrogen-related emissions from downstream water, are out of scope due to the difficulty of accounting. The Agriculture Criteria does not address the supply chain after the farmgate, for example emissions associated with food loss and waste or consumption, given the difficulties of traceability, mixing of products, and overlaps with other Criteria. One exception is for plant-based alternative meat and dairy products due to the assumption that these will reduce meat and dairy consumption.

The TWG and IWG recommended that the mitigation criteria should recognize a range of producer scenarios and incentives, including (1) producers who expand production or increase productivity, but also improve GHG efficiency, and (2) producers who already use best practices at start of or prior to the investment period. It was also recommended that accounting should allow for flexibility in the specification of best practices, to allow for novel or unanticipated practices that achieve equivalent mitigation.

Determination of mitigation: Mitigation in the agriculture sector is defined here as a net reduction in GHG emissions or increase in carbon sequestration relative to the starting year of the investment (known as the base year) and measured as tCO_2-e. Use of best practices for low emissions agriculture may be used as a proxy.

Mitigation criteria: Issuances must meet a mitigation threshold for eligibility. Thresholds should reflect ambitious mitigation activities suitable to the production system, but also what is practical to implement in the near-term to attract finance and what is fair given regional differences. Ambition should be aligned with UNFCCC targets; such as net zero emissions by 2050.

Mitigation in agriculture needs to consider opportunities for reducing emissions from land use change (e.g., forest cut for pasture or crops), farm-level production and consumption.

4.1 Land use change

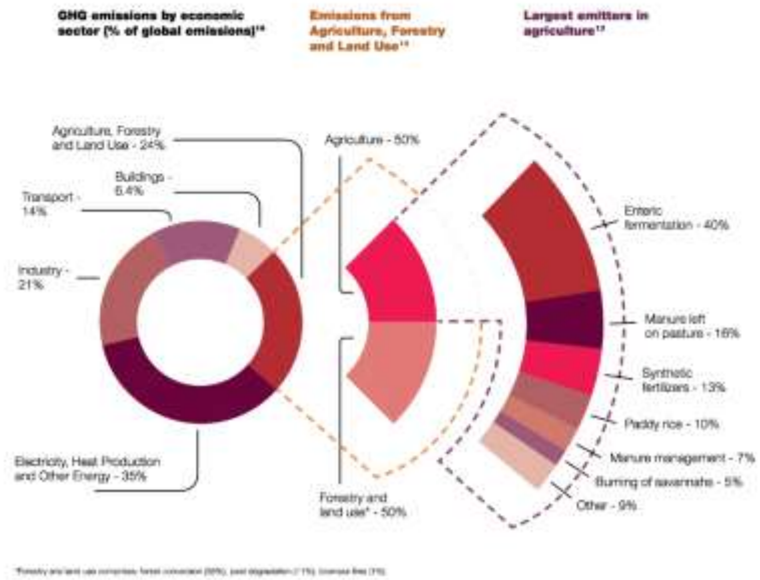
Agriculture is a major driver of land use change, including deforestation and conversion of peatlands and other wetlands that store large amounts of carbon in the biomass and soil. Avoiding future land use conversion is a highly cost-effective way of reducing climate change. As projections for meeting future agricultural demands indicate that expansion of agricultural land will be needed, measures that reduce demand for agricultural land use and expansion in sensitive areas, support more productivity in existing lands and create incentives to avoid conversion of high-carbon land are the major mitigation options.

4.2 Farm-level production

The major agricultural GHG are methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). For accounting purposes, the IPCC defines agriculture emissions in terms of methane and nitrous oxide only. Under this definition, agriculture contributed 10-12% of GHG emissions/year between 2000 and 2010. The major sources of methane and nitrous oxide emissions are shown in **Error! Reference source not found.**[32]. Soil carbon, biomass (trees, shrubs, grasslands) and fossil fuels are also relevant as major pools of CO_2. Avoiding conversion of these pools to additional CO_2 will be critical to meet climate policy targets.

Figure 3 Agriculture emissions (carbon sinks not reflected).

[32] Carbon Disclosure Project, 2015.



Mitigation in agriculture includes practices that reduce absolute emissions or emission intensity defined as emission/unit yield, or GHG efficiency, relative to a base year or business-as-usual baseline projection into the future. Mitigation also includes practices that store carbon in the soil or biomass (trees, shrubs, crops, grass), which in some cases can offset emissions. To achieve global climate change mitigation targets, a net reduction of GHG emissions relative to the past (a base year) is required.

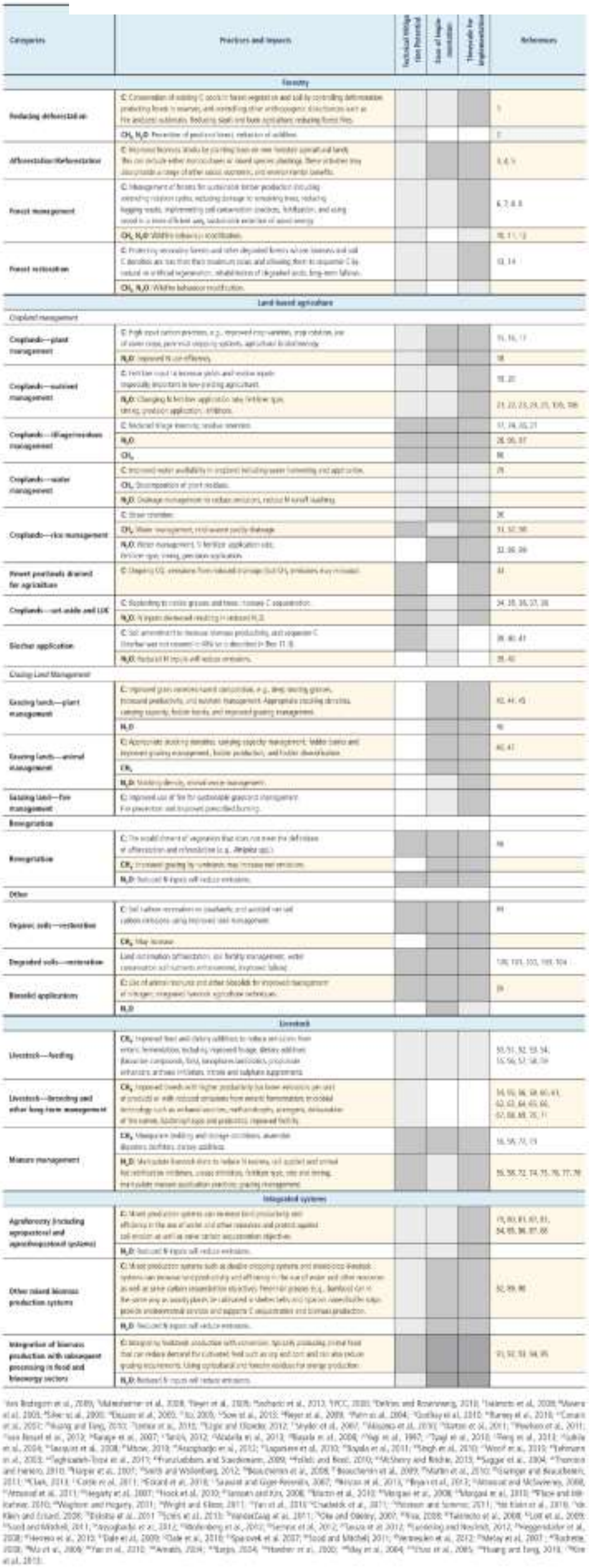
As general principles, use of zero or low GHG inputs, more efficient use of inputs, production systems that slow or inhibit GHG generation, storage of carbon, use of waste and integration of crop systems can help increase the GHG efficiency of agriculture.[33]

Many existing agricultural activities have the potential to reduce net GHG emissions (Table 4[34]) and are already considered best practice for their other impacts on farm productivity, efficiency, soil health or biodiversity.

[33] Rabobank, 2016. Integrated crop-livestock-forest systems (ICLF): environmental and agricultural benefits.

[34] Technical Mitigation Potential: Area = (tCO2eq/ha)/yr; Animal = percent reduction of enteric emissions. Low = < 1; < 5 % (white), Medium = 1–10; 5–15 % (light grey), High = > 10, > 15 % (grey); Ease of Implementation (acceptance or adoption by land manager): Difficult (white), Medium (light grey), Easy, i. e., universal applicability (grey); Timescale for Implementation: Long-term (at research and development stage; white), Mid-term (trials in place, within 5–10 years; light grey), Immediate (technology available now, grey). IPCC AR 5, 2014.

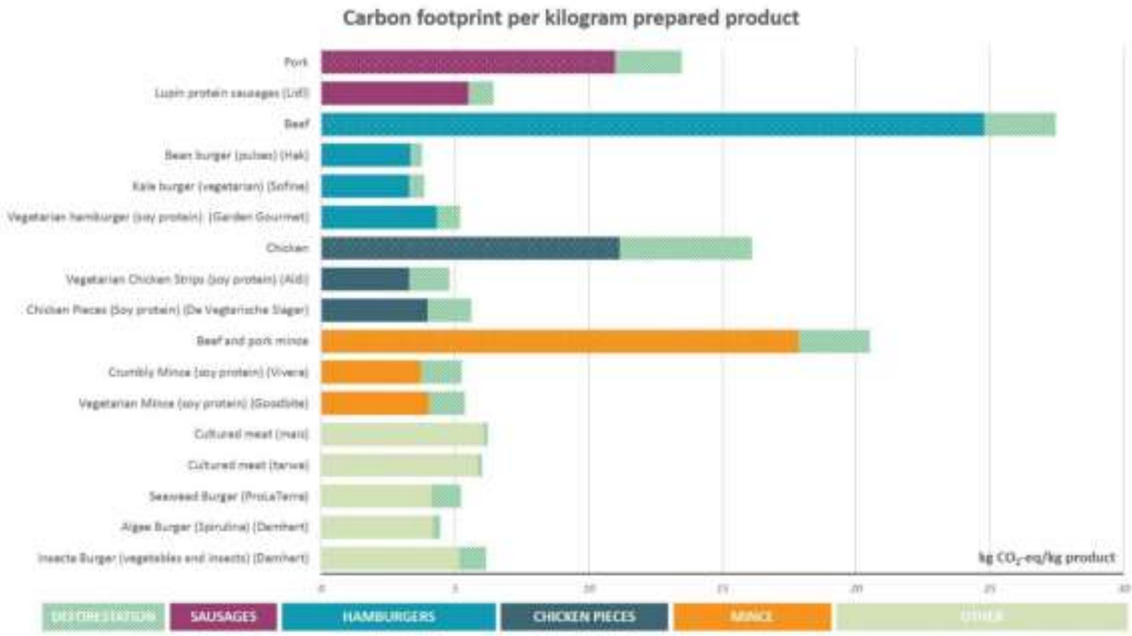
Figure 4 Comprehensive list of mitigation measures relevant to agriculture



4.3 Food consumption

Since livestock are a primary source of emissions in agriculture, consumption of products that substitute for meat and dairy reduces emissions of food. A study conducted for the Dutch Consumers' Association[35] to inform consumers about the sustainability of meat substitutes showed that the GHG emissions of meat substitutes are about half those of meat products (see Figure 5. Carbon footprint per kilogram prepared product). The study is based on a 'cradle-to-grave' life-cycle analysis, which included all the key production processes, from the raw materials to the treatment of the final wastes, such as the packaging.

Figure 5. Carbon footprint per kilogram prepared product



In 2019, UK mycoprotein producer Quorn unveiled footprint labelling of its products showing its products' emissions to be around 5% of beef, 25% of chicken and lower even than tomatoes.[36]

Comparison of plant-based and livestock-based dairy products show a similar pattern (see

and **Error! Reference source not found.**

[35] blonk consultants, (2017). Milieueffecten van vlees en vleesvervangers. Available online. https://www.blonkconsultants.nl/2017/12/07/environmental-impact-of-meat-substitutes/?lang=en; See also Our Meatless Future: How The $1.8T Market Gets Disrupted. Available online. https://www.cbinsights.com/research/future-of-meat-industrial-farming/
[36] Climate Action, (2019). Quorn unveils carbon footprint labelling of its products. Available online: http://www.climateaction.org/news/quorn-unveils-carbon-footprint-labelling-of-its-products?utm_source=ActiveCampaign&utm_medium=email&utm_content=Air+Pollution+could+kill+160,000+in+the+UK+over+next+decade+-+Climate+Action+News&utm_campaign=CA+Newsletter+14th+January+2020

[37]

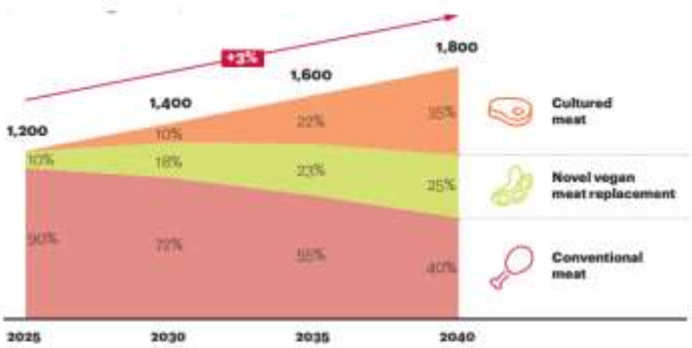


Figure 6 Global meat market forecast (in $bn, global)

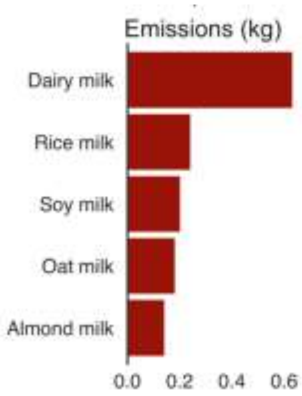


Figure 7 GHG emissions impact of different types of milk (one 200 ml glass).

Research into selected meat alternative products is eligible in the Criteria not only for helping to produce lower GHG emissions profile products compared to the conventional versions of the product, but also because there is an observed meat displacement effect. The GHG savings from displacing meat consumption is also substantial.

According to analysis done by Faunalytics, "Associations Between Consumption of Meats And Animal Product Alternatives,"[38] a substitution effect was observed with meat alternative products. Although most of the omnivores who ate meat alternatives did it relatively rarely, they still ate significantly less meat in comparison to omnivores who never ate alternatives. Over half (57%) of conventional omnivores ate red meat and poultry almost daily – but of omnivores who eat meat alternatives, only 40% ate red meat and poultry so often. It appears that for at least some omnivores, meat alternatives have successfully substituted meat.

Then again in a study by AT Kearney, "How Will Cultured Meat and Meat Alternatives Disrupt the Agricultural and Food Industry?" it was found that there was a predicted meat displacement effect in the market caused by novel vegan meat replacements[39] and cultured meats.[40]

[37] Poore and Nemecek (2018). Available online. https://science.sciencemag.org/content/360/6392/987
[38] https://faunalytics.org/associations-between-consumption-of-meats-and-animal-product-alternatives/
[39] Novel vegan meat replacements - No animal ingredients are required as these products are completely made of plant-based inputs. Nevertheless, their sensory profile gets a lot closer to meat than classic vegan meat replacements. The main reason for the improved sensory profile is a sophisticated production process with the use of hemoglobin and binders, extracted via fermentation from plants, which imitates the sensory profile of meat and even blood to complete the meat-like experience. Start-ups in this field, such as Impossible Foods, Just, and Beyond Meat, evolved around 2010.
[40] This type of meat, also referred to as clean meat, cell-based meat, or slaughter-free meat, has evolved in recent years and represents meat that is created through exponential cell growth in bioreactors. The result is meat which is identical to conventionally produced meat.

4.4 Guidance for low-emission agricultural best practice criteria

Best practices are indicated by a set or bundle of agricultural practices identified by the TWG as the best available low-emission farming methods or technologies in that subsector. Low-emission agriculture is an initial step toward net zero carbon agriculture. The approach assumes that a variety of farming methods and associated emission impacts exist and aims to shift farming norms to more climate-friendly practices, for example in the top 25% of the range. Regular updates of the criteria will acknowledge new practices that emerge as well as increase the ambition of the criteria to meet net zero emissions standards by 2050.

The threshold for low emission best practices is determined by whether sufficient key practices, or combinations of practices, have been used to ensure highly likely mitigation, while also reflecting good practice in agriculture, as defined by national policies or other relevant standards. For example, the amount and quality of organic amendment applied to the soil should be consistent with recommendations for achieving net carbon sequestration and productivity improvements, while also not harming the environment.

Assumptions for assessing best practices include that:

- Requirements should be met for all key categories of emissions sources and sinks farm-wide for the farm where the investment is located. A comprehensive approach is taken to encourage ambition and reduce leakage.
- All core requirements for best practices need to be met.
- Both GHG emissions reductions and no loss of sequestered carbon occur.

Key categories of emissions sources and sinks are those sources and sinks that add up to 95% of farm emissions, determined using IPCC Tier 1 methods.[41] Recommended categories follow the IPCC:

- CH_4 and N_2O Emissions from Savanna Burning
- CH_4 and N_2O Emissions from Agricultural Residue Burning
- Direct N_2O Emissions from Agricultural Soils
- Indirect N_2O Emissions from Nitrogen Used in Agriculture
- CH_4 Emissions from Rice Production
- Carbon sequestration in the soil or biomass

Criteria for selection of practices were based on EU TEG recommendations and CBI TWG discussions. Criteria include:

1) Sufficient existing scientific knowledge and agreement exist on mitigation effects of practices across a range of biophysical and farming conditions (see Smith et al. 2018).
2) Mitigation effects of practices are highly likely, taking into consideration their uncertainty and the consistency of mitigation effects under varying conditions.
3) Where mitigation effects are small, uncertainty of mitigation is high, or simple estimation methods do not provide reliable estimates, practices should not be excluded, as these practices' effects and their monitoring may improve in the future. More specific or robust thresholds should be required to compensate.
4) Practices do not risk leakage or other negative effects.
5) Core requirements should be easily monitored or documented and not require field measurement or other costly measures.
6) Practices that consistently and predictably lead to increased emissions are excluded, e.g., conversion of high carbon landscapes.
7) Core required practices reflect practices that can achieve significant mitigation and are broadly relevant across agroecological contexts. Additional options are indicated to provide options appropriate to diverse agroecological contexts, as well as to support increased use of novel practices and practices that increase ambition.

It must be demonstrated that the production system is following the best practice requirements described in the Criteria for the full investment period. The core practices must be met.

[41] See Section 5.4.2.1 in https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp5/Chp5_4_KeyCategory.pdf. The Tier 1 method requires summing the absolute value of all sources and sinks in the system.

4.5 Issues related to criteria for mitigation

Issue 1: Baselines

Mitigation can be accounted for relative to a base year or a projected business-as-usual baseline. Base year accounting is necessary to track emissions budgets toward the global policy 2°C target. However, business-as-usual (BAU) baselines are useful where food security and economic development goals require actions that increase emissions, and interventions can reduce emissions below what they would have been otherwise. While the IPCC provides a methodology for calculating baselines, modelled projections can be subject to debate, depending significantly on assumptions and model quality.

For Climate Bonds, in line with the principle of contributing "definitively to global climate change mitigation," mitigation is calculated using a base year rather than BAU baseline. The base year should be set by the start date of the bond investment period.

Issue 2: Emission intensity

Ambitious mitigation requirements should not compromise achieving food security, particularly in low-income countries. Raising yields inevitably means increasing inputs such as fertiliser and a concomitant increase in GHG emissions. Low-income countries that need to increase agricultural production can do so with maximum efficiency of inputs and should seek to minimize negative impacts on the climate. Organizations seeking joint agriculture and mitigation objectives often use emissions intensity (EI) as a measure of mitigation instead of reducing absolute emissions.

As the CBI Agricultural Criteria are intended to focus on climate outcomes, an emission intensity measure is not used. In addition, smallholder farmers starting with zero emissions will produce higher emissions intensities, as they cannot decrease EI from a baseline of zero unless they produce negative emissions. Similarly, producers already using best practices will not decrease their emission intensity.

Ambiguous results are also possible. Producers could reduce N, but if their food yields also go down, there will be no decrease in emission intensity. Two producers might increase their emissions by the same amount, but the producer who produces more food would get a better "mitigation" score, which is not a fair or transparent method for the purpose of CBI. "Best practice" criteria will accommodate productivity increases needed in these contexts. A practice–based threshold achieves many of the same goals of an emission intensity indicator and has wider applicability to a range of conditions, is independent of food production, and is more transparent.

For the CBI Standard, emissions (tCO_2e/year), not emissions intensity (tCO_2e/unit of production) is used as the metric for mitigation.

Issue 3: Confidence in emissions estimates

Emissions can be estimated with varying levels of certainty and are often described in tiers. Tier 1 is the lowest level of certainty where estimates are made; tier 2 often includes emission factors and tier 3 certainty signifies that higher order methods often incorporating models and real data have been used. Tier 1 estimates of GHG emissions have levels of error that are typically 30%-50%, and up to 300% for nitrous oxide. If verification relies on Tier 1 calculators, confidence intervals will be large. Tier 2 estimates are therefore preferred though these may require more technical knowledge to identify or calculate.

Table 2 Uncertainty of mitigation based on mitigation potential and relative uncertainty

		Relative uncertainty		
		Low	Medium	High
Mitigation potential	Low		Livestock: improved feeding, animal management	• Grasslands: grazing management; reduced burning • N fertilizer management
	Medium	Rice: Alternate Wetting and Drying	• Crops: SOC-enhancing practices • Manure management	Grasslands: improved grasses
	High			Agroforestry

Key

Green = typically tier 3 Low uncertainty
Yellow = typically tier 2 Medium uncertainty
Red = typically tier 1 High uncertainty

For the CBI standard, more stringent criteria are required for practices with high uncertainty.

Issue 4: Global Warming Potential

Given the different global warming potentials (GWP) of methane (25) and nitrous oxide (298) relative to carbon dioxide (1) over 100 years (IPCC 2019), the TWG discussed whether separate accounting should be conducted for each gas. Treating gases separately would allow for better understanding of their relative effects. For example, the affect that methane has on the climate is high, but as it is broken down in the atmosphere within about 12 years, its affects are short-lived. It should be treated differently from carbon dioxide which has a lower impact but survives in the atmosphere for a much longer time (1000 years). Disaggregation would allow for future corrections in GWP as science improves. The convention of aggregating across gases allows for a simpler evaluation however and is more practical.

For the CBI Standard, net GHG emissions for CH_4, N_2O, CO_2 and C sources and sinks will be expressed as tCO_2e.

Issue 5: Need for additional eligibility criteria for a carbon sequestration component?

Whilst the potential carbon sink of soils is large, massive carbon losses from soils have taken place mainly due to agriculture and land use change, particularly during the past 200 years (Sanderman et al., 2017). The largest losses have been associated with croplands and grasslands and especially in arid and semi-arid regions. There is no question that soil carbon restoration can have a positive impact on climate change adaptation and resilience. There is less certainty, however, as to the extent to which soil carbon restoration can contribute to climate change mitigation with arguments that the carbon sequestration potential of certain practices including no-till agriculture (Powlson et al., 2014) and improved grazing land management (Henderson et al., 2015) have been overestimated, and especially if emissions of non-CO_2 GHGs are considered (e.g., Gao et al., 2018).

In addition to GHG removals due to soil carbon sequestration, carbon may also be stored in above-ground biomass and in the context of the Agriculture Criteria the assets in scope here are mainly agroforestry and improved fallows (Feliciano et al., 2018).

The debate around the potential of above- and below-ground carbon sequestration focuses on three issues: (i) the process is reversible with any gains in carbon lost if, for example, no-till systems are ploughed to plant new crops; (ii) land management practices associated with carbon sequestration can result in an increase in non-CO_2 emissions (e.g., associated with fertiliser use) which can offset gains due to above- and below-ground carbon sequestration; and (iii) the amount of carbon that can be locked up in soils is finite, such that the rate of sequestration levels off once a new soil carbon equilibrium value is approached. Equilibrium is usually reached within 20 years. Soil organic carbon increases are hard to detect in periods of less than five years. In addition, robust estimates can be expensive. For example, see Australia's Emissions Reduction Fund methods.[42]

Carbon markets deal with the risks of carbon losses using uncertainty discounts or by requiring evidence that the land will be managed in a particular way for a period of time.

For the CBI Standard, to ensure detectable levels of carbon, only projects of five years or more are eligible to account for above-ground biomass and soil organic carbon. To address permanence, criteria need to show evidence of conditions for permanence or sequester an additional 50% of carbon as a buffer.

[42] https://www.legislation.gov.au/Details/F2018L00089

Issue 6: Applying the principle of common but differentiated responsibility in practice

If the principle of common but differentiated responsibilities (CBDR) is used, low-income farmers would be expected to meet only some proportion of the threshold value. A lower threshold also serves as an incentive to invest among low-income farms. The CBDR principle would require a standard for defining low-income farmers and setting a threshold. Common standards are the World Bank international poverty line of $1.90/day (2011 prices) for extreme poverty and national poverty lines. Assessing farmer income using either standard is a challenge, however, due to a lack of information and subjective self-reporting. A more practical but coarser threshold could be based on countries' income status, i.e., low-income countries (<995 GNI/capita in 2018-19), using the World Bank standard[43] or countries' development status, using the United Nations' least developed country classification.[44] Both classifications are updated regularly, so producer's status would need to be verified annually. No classification system will perfectly capture poor farmers, leaving some poor farmers without the benefit of the lower threshold. Also, given income disparities among farmers, farmers on the margins of the classification may feel the system is unfair.

Setting a threshold for low-income farmers will be somewhat arbitrary. It could be set based on an arbitrary percentage or based on some indicator like the food deficit, e.g., global food production needs to roughly double by 2050, so the mitigation threshold could be half of the threshold for better off farmers.

For the CBI Standard, given the practical difficulties of classifying farmers and setting a defensible threshold, the Standard does not use the principle of common but differentiated responsibilities.

Issue 7: recognition of livestock production emissions

Livestock is the largest source of agricultural emissions and, to date, reducing absolute emissions has only been possible by reducing numbers of animals, reducing higher emitting animals (e.g., changing herd composition or using low emission breeds), using dietary supplements such as 3NOP, which can be expensive, managing manure, or carbon sequestration in grassland management, Silvopastoralism or agroforestry. Improved feed quality usually increases emissions, resulting only in a reduction in emissions intensity. Since numbers of livestock and the productivity of livestock are expected to increase in the future, in many systems, absolute emissions are expected to also increase.

At this time, while livestock production, and in particular ruminant livestock production (beef, lamb and dairy), is a significant source of emissions in the agriculture sector, it is included in the Criteria due to the significant short-term mitigation potential associated with reducing emissions intensity in livestock management, and because it is not yet clear what appropriate transition pathways are for livestock production. In the interim, it is appropriate to maximise the significant mitigation potential here, noting that the best practices for livestock production must not prevent or close down further opportunities that might deliver greater mitigation opportunities in the sector. However, it is noted that for absolute emissions from agriculture to continue decreasing beyond a certain point and to move towards net-zero targets by mid-century, reduced emissions intensity will need to be coupled as soon as possible with commensurate changes in consumption patterns and overall reduced per-capita consumption of livestock products, especially certain beef, lamb and dairy products.[45]

4.6 Criteria are set to reduce absolute emissions

For the CBI Standard, criteria are set to ensure reductions of absolute emissions, not just emission intensity.

Equivalent net emissions to best practices threshold

To allow for unanticipated or novel practices, issuances may also meet the best practice threshold by demonstrating "equivalent net emissions" for any core requirement that is not documented by best practices. Equivalent net emissions is defined as emissions that are less than or equal to the total sum of emissions reductions from the required low-emission best practices. Best practice emission equivalents will be based on IPCC-published Tier 2 emission factors appropriate for the production system, location and environmental conditions. Where no geographically specific Tier 2 emission factors exist, emission factors for the practice and geographic region most similar to the investment shall be selected. If these also are not available, the Tier 1 global average default value can be used. This approach is potentially sensitive to the relevance and accuracy of emission factors and activity data available for a given system, so well-justified figures are required and uncertainty ranges should be provided. For carbon sequestration, the criteria of a project length of at least five years and evidence that carbon sequestration is likely to be maintained (see Tables in the Agriculture Criteria) are still required.

Farm management records, including maps and georeferenced photographs, detailing agricultural practices for the year

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[43] See https://blogs.worldbank.org/opendata/new-country-classifications-income-level-2018-2019
[44] See https://www.un.org/development/desa/dpad/least-developed-country-category/ldcs-at-a-glance.html
[45] There is consensus in the scientific community that climate neutrality requires dietary shifts, which will also have significant public health benefits. For example, in the EU, energy and protein intake levels are higher than recommended – for protein by as high as 70% per capita compared to WHO guidelines.

and estimates of emissions and mitigation based on carbon accounting calculators will be the method for determining compliance. Acceptable calculators for estimating emissions are the Carbon Benefits Tool, Ex-Act Tool, and the Cool Farm Tool, based on their consistency with IPCC guidelines, levels of verification, and wide application, which can provide comparative examples. Standard accounting methodologies such as the Sustainable Agriculture and Land Management methodology of Verra may also be used.

Mitigation of emissions by a net of 20% per year over ten years' threshold

In some cases, meeting best practices may not be practical. However, a reduction in emissions is still possible, especially over time. For this reason, a 20% mitigation threshold is also offered. The 20% threshold is relevant to issuances where the investment addresses only incremental improvements, not all best practices can be met, delays in implementation of best practices are expected; or where emissions are higher than the best practice equivalent, but reductions are still possible. Similar to the best practice equivalent, this threshold enables flexibility in choice of practice and use of novel practices.

A ten-year period is used to allow sufficient time to achieve and demonstrate average mitigation impacts. The threshold can be adjusted for investments of less than ten years, by increasing the threshold proportionally, e.g. mitigation of emissions by a net of 40% for investments of less than five years or a net of 80% for investments of less than two-and-one-half years. Investments of longer than ten years will be assessed according to the 20% threshold.

The 20% threshold reflects UNFCCC policy targets as it is the mitigation of CH_4 and N_2O needed to meet the 2°C goal of the Paris Agreement. Based on scenario models, the agriculture sector needs to deliver a global mitigation saving of 1 gigaton of carbon dioxide equivalents per year ($GtCO_2e$ yr-1) for methane and nitrous oxide by 2030 to meet the 2°C goal (Wollenberg et al., 2016).[46] This mitigation saving is 17% of projected 2030 agricultural emissions of 5.8 $GtCO_2e$ (FAOSTAT 2019) (1 $GtCO_2e$/5.8 $GtCO_2e$). The number is rounded to 20% for convenience. The target should be revised for investments starting after 2030 to reflect the best available science about expected carbon budget requirements, emissions scenarios, and carbon sequestration targets. For carbon sequestration, the criteria of a project length of at least five years and evidence that carbon sequestration is likely to be maintained (see Tables in the Agriculture Criteria) are still required.

Table 3 Considerations for selecting a threshold method provides guidance on the decisions underlying selection of the threshold.

Table 3 Considerations for selecting a threshold method

Considerations	Best practices	Equivalent to best practices	20% net mitigation per year over 10 years
All best practices can be met	✓		
Emissions can be quantified		✓	✓
Use of novel practices not on best practice list		✓	✓
Emissions are higher than best practices, but reductions possible			✓
Delayed implementation or incremental improvement			✓

[46] The figure does not address soil carbon, biomass or CO_2 targets.

5 Setting Adaptation and resilience requirements in Agriculture

Agriculture will need to adapt and be resilient to climate change to ensure stable production into the future. Climate is a major determinant of agricultural productivity, with climate variability accounting for one-third of yield variability on average globally, but in some areas of global breadbaskets, can reach more than 60% of yield variability (Ray et al. 2015).[47] The vulnerability of agricultural systems to climate change is determined by their level of exposure to climate risks, sensitivity to those risks and adaptive capacity.[48]

CBI focuses on resilience to physical climate risks. Climate-related risks[49] can be expressed as the probability of a climate hazard occurring, i.e., the variability or uncertainty of an expected outcome. Climate hazards vary in terms of severity and frequency and include both chronic hazards (associated with long-term shifts in climate patterns, such as rising sea levels from higher temperatures) and acute (event-driven, such as extreme weather events).[50]

Investments particularly susceptible to climate risk are those with[51]

- long-lived, fixed assets;
- locations or operations in climate-sensitive regions (e.g., coastal and flood zones);
- reliance on availability of water; and
- value chains exposed to the above.

5.1 Climate Resilience Principles

CBI's Climate Resilience Principles[52] provide the definitive minimum list of physical climate hazards to be considered and were the basis for the development of Adaptation and Resilience criteria within the Agriculture Criteria. See Table 4 Classification of climate-related hazards.

Classification of climate-related hazards				
Changes in climate patterns and in the frequency/severity of climate-related events that are:				
	Temperature-related	Wind-related	Water-related	Solid mass- related
CHRONIC	Changing temperature (air, fresh water, marine water)	Changing wind patterns	Changing precipitation	Coastal erosion
	Heat stress		Coastal erosion patterns and types	Soil degradation
	Temperature variability		Precipitation and/or hydrological variability	Soil erosion
	Permafrost thawing		Ocean acidification	Solifluction
			Saline intrusion	
			Sea level rise	
			Water stress	
ACUTE	Heat wave	Cyclone, hurricane, typhoon	Drought	Avalanche
	Cold wave/frost	Storm (including blizzards, dust and sandstorms)	Heavy precipitation (rain, hail, snow/ice)	Landslide
	Wildfire	Tornado	Flood (coastal, fluvial,	Subsidence

Table 4 Classification of climate-related hazards

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[47] Ray, D., Gerber, J., MacDonald, G. et al. Climate variation explains a third of global crop yield variability. Nat Commun 6, 5989 (2015) doi:10.1038/ncomms6989. https://www.nature.com/articles/ncomms6989

[48] See https://www.iso.org/standard/68507.html. See also IFC risk standards: https://www.ifc.org/wps/wcm/connect/8804e6fb-bd51-4822-92cf-3dfd8221be28/PS1_English_2012.pdf?MOD=AJPERES&CVID=jiVQIfe See especially 8, 9 and 10

[49] See also the general classification of climate risks by European Bank for Reconstruction & Development (EBRD) and Global Centre on Adaptation (GCA). "Advancing TCFD Guidance on Physical Climate Risk and Opportunities". 2018. https://s3.eu-west-2.amazonaws.com/ebrd-gceca/EBRD-GCECA_draft_final_report_full_2.pdf

[50] Climate Resilience Principles: A framework for assessing climate resilience investments. Climate Bonds Initiative. https://www.climatebonds.net/files/files/climate-resilience-principles-climate-bonds-initiative-20190917.pdf

[51] https://www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-2017-TCFD-Report-11052018.pdf

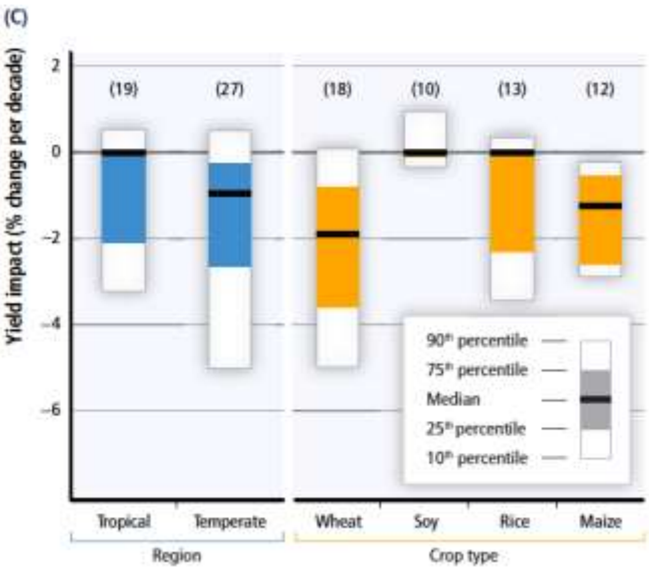
[52] Climatebonds.net/climate-resilience-principles

Extreme weather or climate events can be defined according to a threshold value; a probability of occurrence; a frequency, sequence or accumulation of impacts in a time period; or the cost or length of the recovery to prior productivity or income levels. Extreme events' impacts can vary by place or time, making standardized thresholds problematic.

The IPCC (2012) report defines an extreme climate or weather event as "the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable."[53] Considerations include "values with less than 10, 5, 1%, or even lower chance of occurrence for a given time of the year (day, month, season, whole year) during a specified reference period (generally 1961-1990)."

Analysis of the impacts of climate change on crop yield changes show that climate has led to stable or declining yields per decade for the major cereal crops, especially wheat. (Figure 9 Summary of estimated impacts of observed climate changes on yields over 1960 – 2013 for four major crops in temperate and tropical regions, with the number of data points analysed given within parentheses for each category[54]). The figure indicates that yield impacts can vary significantly by crop and region, and are not always negative, so risks must be assessed specific to the farming system and region of interest.

Figure 8 Summary of estimated impacts of observed climate changes on yields over 1960 – 2013 for four major crops in temperate and tropical regions, with the number of data points analysed given within parentheses for each category



Principle 1. Clear boundaries and critical interdependencies identified

Assets and activities being invested in must have clearly defined boundaries and identify interdependencies for assessing climate risks and resilience impacts[55]

Issuers must define the boundaries of the climate resilient investment and associated assets and activities. Boundaries should be consistent with the scope of agriculture defined in this Standard. The time period to be assessed for resilience should be the project lifetime.

Issuers should also identify as critical interdependencies between the assets or activities and the broader social and environmental system (See Principle 4). Some interdependent risks may be costly to evaluate and address, with implications that are beyond the sphere of influence for the asset or activity owner or manager. Nonetheless, issuers must assess, document, and allow for interdependencies to the extent possible.

Boundaries may extend across multiple farms. Examples of bonds with implications for different types of boundaries include the following:

- Sovereign issuance: reservoir development, coastal defences;
- Sub-sovereign issuance: programs to fund organic (in India called net-zero budget farming) subsides, district level water management schemes, tree planting grants to restore water table, conserve soil;

[53] https://www.ipcc.ch/site/assets/uploads/2018/03/SREX_Full_Report-1.pdf, p. 117.
[54] IPCC, 2014a.
[55] Text in blue boxes indicate principle drawn from AREG document, Sept 2019.

- Agricultural bank issuance: backed by loans to farmers or others in the supply chain to induce farm-level behaviour change e.g., drought-resistance crops, efficient N fertilizer use;
- Soft infrastructure investment like capacity building of farmers to shift to resilient practices.

Critical interdependencies in agriculture with adverse effects can be categorized as (1) the effects of water use or pollution on other water users or erosion in the watershed; (2) relationships of the asset/project to nearby flood zones; (3) introduction of pests and diseases; (4) reduction in pollinating insects and birds; (5) reduction of biodiversity or habitat, (6) damage or reduction in value of neighbours' property due to boundary trees, other structures at risk of falling during storm events, agricultural pests and disease; (7) fire and other practices that affect air quality, (8) market influences, such as flooding supplies which drives down prices; (9) appropriation of land or economic assets from nearby vulnerable groups; (10) overuse of farm inputs; (11) reduction in productivity of an asset; and (12) decline in condition below a policy standard.

An example of an indirect adverse impact is that drought over multiple years can lead to the failure of multiple farms and forests in a landscape, reducing additions to soil carbon, reducing pollinators, and increasing fire risk. When a large fire occurs where most of the community is affected, there is no community buffer to help those in need and emergency resources are stretched more thinly.

Principle 2. Physical climate risk assessed

Physical climate risk assessments for assets and activities being invested in

Issuers must assess the physical climate hazards to which the subject asset or activity will be exposed over its operating life. Issuers should use scenario-based risk assessments based on the RCP 4.5 and 8.5 emissions scenarios and a range of models where possible. This should be complemented by analysis of observed risks in the local context. The impacts of climate hazards should be assessed for: annual probability of failure, annual costs of loss or damage, and indirect transfer of risk to or from the project, such as insurability thresholds.

CGIAR reviews tools for assessing climate risk in agriculture and notes that assessments most often focus on productivity and yield increases rather than reducing the variability of yields or minimizing losses, which would seem critical for vulnerable farmers.[56] The tools also do not indicate how to deal with uncertainty or lack of climate information. Brown suggests using no regrets strategies in these instances, especially strategies that enable readiness for extreme weather conditions. Another challenge is that the tools help to identify risks but do little to support decisions about actions. These gaps point to areas where further work is needed.

Principle 3. Climate risk reduction measures identified (resilience at asset level)

Risk reduction measures for the identified climate resilience risks

It must be demonstrated that the risks identified through the risk assessment will be mitigated such that the asset or activity is sufficiently resilient to function adequately, and does no significant harm to the resilience of the system of which it is a part, taking into account the asset or activity's boundaries and interdependencies.

Issuers are encouraged to select risk reduction options that offer flexible solutions suitable to a variety of scenarios. Given climate change uncertainty, options will likely need to go beyond current insurability thresholds, sustainability best practices, and codes or regulations.

Resilience practices in agriculture might/often include:

- Improved or more stable productivity (economic buffering of climate impacts): increasing yields or yield stability, or reducing costs to produce net gains in product or revenue; diversified production; enhancing savings and value of assets; increasing efficiency of water, energy, fertilizer and other inputs; improving product storage capacities; using the agronomic practice best suited to changing climatic conditions; reducing the percentage of area planted to vulnerable crops; increasing the percentage of production under controlled environment agriculture;
- Adapted stock: using species and breeds adapted to changes in CO_2 and climate, e.g., temperature, water regimes, extreme events, or seasonality;

[56] Brown, D.R. 2017. Review of climate screening approaches and tools for agricultural investment: Areas for action and opportunities to add value. CCAFS Working Paper no. 214. Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: https://ccafs.cgiar.org/publications/review-climate-screening-approaches-and-tools-agricultural-investment-areas-action-and#.XX7g7i2ZPEY

- Ecological buffering of climate impacts: water or microclimate management, e.g., irrigation, water storage, increased soil water holding capacity; agroforestry to buffer extreme temperatures or enhanced soil organic carbon; ecological diversification; riparian buffer strips; soil and water conservation; mangrove management; habitat restoration;
- Risk management: hard assets (weather stations, satellites, computing and communication infrastructure) used for climate information services and early warning systems, crop insurance, monitoring and evaluation of farm performance, identification and addressing of risks beyond design standards (e.g., of levees/embankments or other physical infrastructure), emergency preparedness, and other services that help avoid or compensate for climate risk at the farm level;
- Physical relocation of vulnerable assets or activities: avoided use of locations vulnerable to climate risks such as flooding, salinization, or heat stress.

Simple metrics for resilience at the farm level are (1) maintenance of productivity above a threshold, (2) minimized loss, (3) minimized failure of assets and their performance, (4) the variation in yields across years/seasons during periods of climate risk relative to the variation in yields across years/seasons with no climate risk. Resilience should be assessed for a range of climate scenarios over the duration of the project's lifetime.

Examples of resilience interventions widely suitable for bond issuance include:

- Improved or new irrigation and agricultural water management systems;[57]
- Technical practices that enhance land value or productivity under climate change (e.g., climate-adapted stock; improved agronomy; more efficient use of nutrient, energy or water inputs);
- Installing and upgrading enhanced hardware for observation and early warning (e.g., weather information systems).

Improving on-farm productivity is one way of improving resilience under future climates that is consistent with investment and economic development priorities. In developing countries in particular, surplus enables farm households to pursue education or employment off-farm, diversifying livelihoods and further reducing vulnerability to climate shocks. Beyond the farm level, adaptation can include enhanced access to finance and other production resources, strengthening institutions and social networks, including famine relief, and climate risk management (IPCC, 2014).

Principle 4. Assessment of climate resilience benefits (resilience at system level)

Expected climate resilience benefits assessment undertaken for system-focused assets and activities being invested in

According to the CBI AREG report,[58] the climate resilience benefits of system-focused investments should be demonstrated. Benefits should offer flexible solutions that are robust under a variety of scenarios. Types of relevant resilience benefits include:

- Resilience for beneficiaries beyond the project boundary;
- Public goods that provide benefits beyond the project;
- Transformative change (e.g., reduces market and policy barriers for other resilience investments to enter the market).

Issuances in agriculture can improve resilience to the larger system through, for example, the use of water saving techniques that make more water available to others; building of soil organic carbon for long-term soil health; using pest- and disease-resistant varieties and breeds; attracting new pollinators; agroforestry or boundary plantings that act as windbreaks or buffer temperatures for others; and the introduction of more diverse varieties, breeds and economic production systems.

Assets or projects can reduce the climate resilience of the larger social and biophysical system in which they operate, for example: diverting scarce water resources from other users; clearing land, compacting land, creating structures or using practices that exacerbate flooding or erosion; planting trees or creating structures that could become hazards during wind events; changing the market for climate-adapted varieties or breeds, such as driving up the prices for seeds and inputs; inefficient use of scarce energy, nutrient, land or labour resources; or not being able to employ resident workers in the event of a catastrophic weather event.

While enhancing resilience to the larger system is desirable, the TWG and IWG deemed that using a "do no harm" principle regarding system resilience is a sufficient minimum threshold for the agriculture sector. Both direct adverse impacts and indirect adverse impacts should be considered. System impacts can be identified by focusing on critical interdependencies and where adverse impacts are possible.

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[57] Note that rapid technology depreciation should be considered in determining bond tenure in these cases.
[58] Climate Resilience Principles: A framework for assessing climate resilience investments, September 2019, Climate Bonds Initiative

Assets and activities that function primarily to provide resilience to the larger system beyond the boundaries of the agricultural production system need to demonstrate the resilience they expect to achieve. For example, a nursery of climate-adapted agroforestry seedlings should demonstrate the resilience that the new seedlings will provide to the larger landscape where they will be used. Climate information systems should demonstrate the resilience they will provide to the farmers they will serve. Improved water efficiency to make water available to downstream users should demonstrate the resilience benefits it confers to these users.

Principle 5. Climate change mitigation trade-offs identified

Mitigation trade-offs assessed

Mitigation requirements may be lowered or considered inconsequential for climate resilience-focused assets or activities where resilience benefits considerably outweigh associated emissions. Issuers should demonstrate at a minimum that the investment causes “no harm” to the climate (net GHG emissions do not increase), that mitigation options were examined and the reasons they were ruled out, and that the investment does not lock-in practices that will prevent mitigation in the future.

Efforts to quantify the net benefits of mitigation and adaptation, for example using ISO 14044 and consequential life-cycle analysis, were examined by AREG and deemed not robust, hence qualitative measures are recommended. Also, carbon offsets, on principle, based on CBI objectives, shall not be permitted.

Given needs for food security and economic development in low-income countries, the TWG recommends that exceptions for the mitigation requirement should be made for low-income countries with high climate risks and low responsibility for climate change.

Principle 6. Monitoring and evaluation

Ongoing monitoring and evaluation

Issuers should have a viable plan to monitor climate risks and benefits linked to the assets and activities to determine whether they continue be climate resilient as climate hazards, exposure and vulnerability evolve. The issuer must have a plan to annually verify climate resilience performance through monitoring and evaluation. This should include allowance for new or evolving climate risks.

The plan for monitoring and evaluation is required to cover only the lifespan of the Certified Climate Bond.

5. Issues related to criteria for adaptation and resilience

Issues related to resilience criteria include: (1) whether to assess resilience of the asset/project’s environment, (2) how to ensure manageable and consistent assessments of the environment of the asset/project, (3) how often to assess climate risk, (4) the uncertainty of climate change risk, (5) attribution of harm to the asset to climate, (6) the multi-scale nature of vulnerability and resilience, (7) the use of outcome versus process criteria, (8) the lack of standards, (9) the need for resilience in the places most vulnerable to climate change, and (10) the potential biases and unanticipated impacts that the criteria create.

Some are particularly pertinent to agriculture and these are addressed below:

1. Issue: Whether to assess resilience of the asset/project's physical and social environment?

Assets or projects may have adverse, beneficial or neutral impacts on the climate resilience of the larger social and biophysical system or environment in which they operate. Resilience to climate risks is needed at multiple scales (e.g., farm, household, landscape, global markets) and mechanisms for handling risk exist at multiple scales (single farmer, household, extended family, community, government services, global finance agreements). Interactions can happen across scales. For example, strong coping mechanisms at one scale can often compensate for weak mechanisms at another scale, e.g., famine relief services can reduce losses of crops that were not drought-tolerant. Interventions can also affect risks at different scales. A new silvopastoral cattle system in a forest landscape may reduce the resilience of the nearby forest due to grazing, burning, forest fragmentation, nutrient concentration in waterways, or pesticide use. This in turn could affect the watershed and water storage capacity of the landscape, and reduce the pasture quality, ultimately affecting the cattle operation.

As a result, climate change risks and resilience need to be seen as a system and resilience ideally measured at multiple scales to correspond to these different risks and coping mechanisms. Yet a simple set of criteria is needed and the larger environment is often beyond the control of the investment.

For the CBI Standard, to enable consistent and manageable assessments, the TWG and IWG recommended that the criteria under Principles 3 (asset focus) and 4 (system focus) focus on climate risks and resilience at the farm scale and critical interdependencies with adverse effects with the larger environment. See also Issue 2 below.

2. Issue: Manageable and consistent assessment of the impacts of the asset or activity on the environment?

The larger environment of an agricultural production system can extend widely to hundreds of kilometres from the asset/project and involve thousands of complex interactions, depending on the types of resilience relationships examined. In addition, characterizing resilience benefits for larger complex systems is not straightforward or simple. To fairly, consistently and manageably define the environment of assets/projects, it is necessary to limit the environment and assessment of resilience of that environment in a clear and generalizable way.

The CBI Standard (1) considers only direct, rather than indirect, impacts of the asset or activity; (2) account for "no harm" rather than all resilience benefits; and (3) focuses on critical interdependencies as the indicators of where any risk of harm due to the climate may occur to the larger environment. Separating climate risks from climate change risks is not easily done in an objective manner.

3. Issue: When and how often to assess climate risk?

Climate change risks occur at short- and long-term scales. In the short-term, changes in the pattern of the next season or phase of the season (e.g., onset of rain, maximum night temperatures, drought or flood risk, storm events) can be identified. Some climate risk analysts prefer to work with current climate and their known climate risks as future projections can be highly uncertain. At the same time, long-term changes in climate are highly likely in most places based on different scenarios of CO_2e concentrations. While climate models can predict climate change over the next several decades, they cannot do so with high confidence, especially for specific locations. The nature and extent of future climate change are highly uncertain due to complex systems processes, multiple potential tipping points, and a lack of certainty about likely policy interventions. Projections of long-term change are more reliable to the extent they reflect the average climate expected based on multiple climate models and concentration scenarios. Resilience will require anticipation of a range of possible changes, recognizing that even the best projections are inherently uncertain. Perennials in current agroforestry systems may be maladapted to the temperature expected 20 years from now, but planting species adapted to those future conditions may also fail if the projections turn out to be wrong.

To account for both near- and long-term climate risks, annual seasonal forecasts provide significant near-term information, while decadal projections provide information about the range of long-term climate changes possible and their associated risks.

The CBI Standard includes the time scale for assessment as optional guidance only to enable issuers to determine the time horizons most relevant to their investments and risks.

4. Issue: Lack of standards for quantifying adaptation

Measuring climate change adaptation is a relatively new field. Multiple guidelines and frameworks have been developed and compilations of indicators exist (Quinney et al. 2016), yet indicators are often not generalizable and there is no agreement about a standard. The high-level framework developed by FAO[59] provides the best available reference for

[59] FAO (2018) Tracking adaptation in Agriculture sectors

standardizing assessments. It is still necessary to develop indicators relevant to specific places, however this also allows for flexibility in the selection of indicators and their ranking and scores based on objectives and data availability.

The TAAS framework is comprised of four categories of indicators (Table 5 Tracking adaptation in Agriculture sectors Indicators): 1) agricultural production systems, 2) natural resources and ecosystems, 3) socio-economics and institutional, and 4) policy systems. TAAS (2018) propose an indicative list of 16 process- and outcome-based indicators. Process-based indicators are generally qualitative and outcome-based indicators quantitative. Indicators are given a score from 0 to 10 to reflect the level of adaptation progress: very low (0 to <3), low (3 to <5), moderate (5 to <7), high (7 to <9) and very high (9 to 10).

TABLE 2

MAIN AND SUBCATEGORIES OF INDICATORS TO TRACK ADAPTATION IN AGRICULTURE

Main categories	Subcategories	
Natural resources and ecosystems	1	Availability of, and access to, quality water resources for agriculture
	2	Availability of, and access to, quality agricultural land and forests
	3	Status of ecosystems and their functioning
	4	Status of the diversity of genetic resources in agriculture
Agricultural production systems	1	Agricultural production and productivity
	2	Sustainable management of agricultural production systems
	3	Impact of extreme weather and climate events on agricultural production and livelihoods
	4	Projected impact of climate change on crops, livestock, fisheries, aquaculture and forestry
Socio-economics	1	Food security and nutrition (vulnerability)
	2	Access to basic services
	3	Access to credit, insurance, social protection in rural areas
	4	Agricultural value addition, incomes and livelihood diversification
Institutions and policy making	1	Institutional and technical support services
	2	Institutional capacity and stakeholder awareness
	3	Mainstreaming of climate change adaptation priorities in agricultural policies, and vice versa
	4	Financing for adaptation and risk management

Table 5 Tracking adaptation in Agriculture sectors Indicators

The CBI Standard treats TAAS indicators as an optional framework only given their highly general nature.

5. Issue: Resilience in the places most vulnerable to climate change and incentives created by CBI criteria

The CBI Agriculture Criteria are intended to catalyse investment in low carbon and climate resilient assets and projects. The types of farms and locations that are most vulnerable to climate change are where the resilience of agriculture to climate change is most needed. Yet these are also the contexts where financial investment is riskiest and adaptation the costliest. Criteria could require demonstration of high vulnerability to climate change to target investment. In practice, however, this would make application of the criteria very limited and discourage overall update. If in the future CBI uses a multi-level certification system, resilience measures in a highly vulnerable system could receive a commensurate certification status recognizing this achievement.

A standardised definition of risk and risk assessment may exacerbate the bias toward already resilient targets. Location-specific thresholds for acceptable risk in high-risk climate zones like West Africa could help mitigate these issues. In practice, this would mean allowing higher levels of risk for different regions. Making this allowance, though, also means the investment is at higher risk of failure, which only puts vulnerable populations at more of a disadvantage. Another option is to provide additional incentives to issuers taking on high-risk or vulnerable assets through partnerships with public finance entities, thereby sharing the risk.

The CBI Standard provides the GHG mitigation exemption (Principle 5) as one measure to promote investment in places or farms vulnerable to climate change risk.

Criteria may create other incentives and disincentives that lead to potential lock-ins, lock-outs, maladaptation or limits in access to finance during the climate change adaptation transition period (e.g., up to 2050), especially given the uncertainty and fluid nature of climate change. For this reason, the CBI Standard requires annual monitoring and evaluation and a grievance redress mechanism by stakeholders.

6 Appendices

6.1 Appendix: Sectoral scope and common methodologies for assessing mitigation

Table 6-1. Sectoral scope and common methodologies for assessing mitigation.

IPCC 2006 Good practice guidance accounting guidelines	Verra Verified Carbon Standards	Australia Emission Reduction Fund	Gold Standard	Other CAR - Climate Action Reserve ACR - American Carbon Registry CDM – Clean Development Mechanism
Cropland	Adoption of Sustainable Agricultural Land Management (SALM) (fertilizer use, N-fixing species, crop residue management, biomass burning, woody perennials, soil organic carbon, cover crops, improved tillage practices and agroforestry)			
Biomass	See SALM			
Soil carbon	-Soil Carbon Quantification -See SALM	-Estimating sequestration of carbon in soil using default values -Measurement of soil carbon sequestration in agricultural systems	The Gold Standard "Low Tillage Methodology" accounts for GHG emissions from agriculture by changing soil tillage practices within agricultural systems.	
Non-CO_2 GHG emissions from biomass burning	See SALM			
N_20 emissions from managed soils and CO_2 emissions from lime and urea application	Quantifying N_2O Emissions Reductions in Agricultural Crops through Nitrogen Fertilizer Rate Reduction	Fertiliser use efficiency in irrigated cotton		Reduced Use of Nitrogen Fertilizer on Agricultural Crops (ACR) Changes in fertilizer management (ACR)
Rice cultivation				- Rice management systems (ACR) - Dry seeding with delayed flooding: the adoption of a dry seeding method that

IPCC 2006 Good practice guidance accounting guidelines	Verra Verified Carbon Standards	Australia Emission Reduction Fund	Gold Standard	Other CAR - Climate Action Reserve ACR - American Carbon Registry CDM – Clean Development Mechanism
				involves sowing of dry seeds into dry or moist soil with field flooding delayed until rice stand is established. (CAR) - Post-harvest rice straw removal and baling (CAR) -Methane emission reduction by adjusted water management (CDM).
Grassland	-Methodology for Sustainable Grassland Management -Methodology for the Adoption of Sustainable Grasslands through Adjustment of Fire and Grazing			
Soil carbon		Sequestering carbon in soils in grazing systems		Compost Additions to Grazed Grasslands (ACR)
Non-CO_2 GHG emissions from biomass burning		-Savanna fire management (emissions avoidance) -Savanna fire management (sequestration and emissions avoidance)		
Livestock		Beef cattle herd management	The use and cultivation of N-fixing plant species as organic fertiliser and livestock fodder should be enhanced.	Grazing land and livestock management (enteric methane, manure methane, nitrous oxide from fertilizer use, fossil fuel emissions, and biotic sequestration in above- and below-ground biomass and soils) (ACR).
CH_4 from Enteric Fermentation		Reducing GHG emissions in beef cattle through		

IPCC 2006 Good practice guidance accounting guidelines	Verra Verified Carbon Standards	Australia Emission Reduction Fund	Gold Standard	Other CAR - Climate Action Reserve ACR - American Carbon Registry CDM – Clean Development Mechanism
		feeding nitrate containing supplements Reducing GHG emissions in milking cows through feeding dietary additives		
CH_4 from manure management N_20 from manure management		- Destruction of methane from piggeries using engineered biodigesters - Destruction of methane generated from dairy manure in covered anaerobic ponds - Destruction of methane generated from manure in piggeries		Biogas control system (BCS) that captures and destroys methane (CH_4) gas from manure treatment and/or storage facilities on livestock operations (CAR) -Methane Recovery in animal manure management systems (ACR) -Methane recovery in animal manure management systems (CDM)
Land use change	Methodology for Avoided Ecosystem Conversion			
Land converted to grassland				Avoided Conversion of Grasslands and Shrublands to Crop Production (ACR)

6.2 Appendix: Compilation of indicators for resilience

Table 6-1. CSA Programming and Indicator Tool: 3 Steps for increasing programming effectiveness and outcome tracking of CSA interventions[60]

Productivity-focused indicators
Smallholder producers apply suitable management schemes to raise the profitability of their agricultural production
Number of households receiving homestead gardening inputs and advice
Number of farmers and others who have applied improved technologies or management practices as a result of assistance
Number of hectares under improved technologies or management practices as a result of assistance
Number of people with new on-farm/off-farm income streams
Number of people with increased number of farm enterprises (non-financial)
Number of people with diversified income
Number of households receiving productive assets
Number of MSMEs, including farmers, receiving business development services from assisted sources
Prevalence of Poverty: Percent of people living on less than $1.25/day
Depth of Poverty: Mean percent shortfall relative to the $1.25 poverty line
Number of Infrastructure Employment Project (IEP) person days during the lean season
Percentage of female participants in assisted programs designed to increase access to productive economic resources (assets, credit, income or employment)
Number of new businesses established based on a new technology or innovation
Number of stakeholders implementing risk-reducing practices/actions to improve resilience to climate change as a result of assistance
Value of new private sector investment in the agriculture sector or food chain leveraged by FTF implementation
Number of public-private partnerships formed as a result of FTF assistance
Number of people accessing market services
Number of people accessing financial services
Number of social assistance beneficiaries participating in productive safety nets
Value of Agricultural and Rural Loans
Number of MSMEs, including farmers, receiving assistance to access loans
Number of people with access to higher value soil formation services
Number of people with access to higher value nutrient cycling services
Increase in institutional training of farmers group, cooperatives, extension services and stakeholders to improve agricultural production and marketing
Increased access to relevant financial services for households investing in animal health, productivity and production quality
Adaptation and resilience focused indicators
Natural assets protected or rehabilitated
Number of people implementing risk-reducing practices/actions to improve resilience to climate change as a result of assistance
Number of livestock units subject to CSA practices
Uptake of soil conservation measures
Proportion of forest managers taking action on adaptation
Land area where CSA practices have been adopted
Number of agricultural actors who adopted CSA practices (Gender disaggregated)

[60] https://cgspace.cgiar.org/handle/10568/75646

Number of surface water areas subject to declining water quality due to extreme temperatures
Households carry out climate change adaptation measures.
Number of food security private enterprises (for profit), producers' organizations, water users associations, women's groups, trade and business associations, and community-based organizations (CBOs) receiving assistance
Number of members of producer organizations and community-based organizations receiving assistance
Percentage of climate resilient trees planted (in areas likely to be climatically suitable in the long term)
$ value of new or existing rural infrastructure made climate-resilient
Number of hectares under improved or new soil conservation practices
Number of farmers applying improved or new energy efficient practices as a result of assistance.
Number of farmers implementing agroforestry
Number of farmers implementing reduced tillage
Number of stakeholders implementing risk-reducing practices/actions to improve resilience to climate change as a result of assistance
Number of farmers and others who have applied improved technologies or management practices as a result of assistance
Number of private enterprises (for profit), producers' organizations, water users' associations, women's groups, trade and business associations, and community-based organizations (CBOs) that applied new technologies or management practices as a result of assistance
Number of hectares under improved technologies or management practices as a result of assistance
Increase in the percentage of climate resilient crops being used
Percentage of cultivated surface cultivated with drought resistant varieties
Percentage of climate resilient trees
Capacities exist to support access of farmers to seed banks and make adapted seeds available for CSA
A certain ratio of the target group applies the proposed improved technologies and confirm their usefulness.
Number of farmers using improved or new stress-tolerant seed varieties as a result of assistance
Number of climate resilient crops being used that are less than 20 years old
Number of stakeholders implementing risk-reducing practices/actions to improve resilience to climate change as a result of assistance
Finance-related indicators
Number of financial mechanisms identified to support climate change adaptation
Funding strategies are developed and resources are secured for CCA programs.
Green credit products and other climate finance options available for CCA practices
Number of hectares under CSA certification schemes
Number of new impact investment/financial mechanisms implemented to support uptake of CSA practices, technologies and policies along the value chain
Number of CSA practices and technologies promoted by voluntary certification schemes
Number of farmers accessing certification schemes aimed to promote adoption of CSA practices and technologies that increase resilience
Number of farmers accessing financial services or impact investment mechanisms aimed to promote adoption of CSA practices and technologies that increase resilience
Perceived access to affordable credit and capital that increase the promotion of CSA technologies and practices
Amount of investment mobilized (in USD) for climate change as supported by assistance
Number of businesses with risk management plans considering climate change aspects or adaptation options
Percentage of companies assessing risks and opportunities from extreme weather and reduced water availability to their supply chains
Capacity-building indicators
Training courses for local multipliers to disseminate and respond to early warnings are carried out by local disaster risk management platforms
No. and type of targeted institutions with increased capacity to minimize exposure to climate variability risks
Number of individuals who have received supported long-term agricultural sector productivity or food security training

Number of individuals who have received supported short-term agricultural sector productivity or food security training
Number of people supported by PPCR to cope with climate change
Number of vulnerable stakeholders using climate responsive tools to respond to climate variability or climate change
Agency in charge has sufficient knowledge base, resources and decision-making authority to operate effectively
No. of farmers trained to respond to, and mitigate impacts of, climate-related events
Number of people receiving training in global climate change as a result of assistance
Number of days of funded technical assistance in climate change provided to counterparts or stakeholders
Clean energy generation capacity installed or rehabilitated as a result of assistance
Number of vulnerable stakeholders using climate responsive tools to respond to climate variability or climate change
Number of agricultural actors who use information and communication technology (ICT) services for obtaining information on i) weather and climate (gender disaggregated), ii) CSA practices, and (iii) market (price) information
Number of communication tools that incorporate climate change adaptation
Number of people with increased awareness and knowledge of sustainable practices
Private sector and rural farmers' organizations, including women and youth groups, support access to information and opportunities for innovation, learning and implementation
Information is easily accessible to all national agencies, jurisdictions, and civil society.
Public or private groups use good quality information to design CSA infrastructure or programs

6.3 Appendix: Further Reading

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