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Concept note

Exploration of methodological options for developing ‘agriculture CDM’

Version 01.0

United Nations
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TABLE OF CONTENTS **Page**

1. Procedural background

1. The Executive Board of the clean development mechanism (CDM) (hereinafter referred to as the Board), at its eighty-second meeting, requested the secretariat to elaborate concept notes on methodological issues related to cities, transport, biofuels and **agriculture**.

2. The Board requested that the concept note on agriculture should cover integrated mitigation actions in agriculture combining efficient water pumps, more efficient use of fertilizers and efficient animal husbandry, and it should be presented at its eighty-seventh meeting including inputs from the Methodologies Panel (MP) and the Small-Scale Working Group (SSC WG).

3. This concept note is prepared in response to the above request from the Board and is based on a review of the existing climate initiatives pertaining to agriculture and takes into account inputs from the MP and the SSC WG. It discusses technologies/measures that would be desirable to include in ‘agriculture CDM’, as well as possible areas of focus for project/programme development.

2. Purpose

4. The purpose of this concept note is to explore new methodological options for developing ‘agriculture CDM’ to complement the existing ones. It reviews the existing CDM methodologies and nationally appropriate mitigation actions (NAMAs) in the agriculture sector, and takes into account a number of national/international initiatives. It identifies gaps in existing CDM methodologies and proposes potential options to address them.

3. Key issues and proposed solutions

5. According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5), the agriculture, forestry, and other land use (AFOLU) sector is responsible for just under a quarter (10–12 $GtCO_2eq$/year) of anthropogenic greenhouse gas (GHG) emissions mainly from deforestation and emissions from livestock, soil and nutrient management. Agriculture accounted for 10–12 per cent of total global anthropogenic emissions of GHGs in 2005, about 60 per cent of anthropogenic nitrous oxide emissions and about 50 per cent of anthropogenic methane emissions (IPCC AR4, 2007). Further, it is estimated that an increase in food production by about 70 per cent will be needed to feed a projected population of 9.1 billion by 2050 (Food and Agriculture Organization of the United Nations (FAO), 2009).

6. Agricultural practices and measures discussed in this note can have multiple benefits for climate change mitigation, adaptation, sustainable development and food security. Studies have recommended that climate financing mechanisms need to target agriculture, reward synergistic action and leverage investment for upscaling in order to accelerate mitigation and adaptation action (FAO, 2009).

7. In spite of the large potential, the contribution of mitigation activities in the agriculture sector under the CDM is negligibly small for several reasons including the following:

(a) In agriculture, the factors causing emissions (i.e. sources) are typically multiple (e.g. fertilizers, irrigation, energy use, enteric fermentation, biomass burning, etc.) and are spread across large geographical areas and large numbers of land holders;

(b) Agricultural GHG mitigation options often have higher abatement and transaction costs than mitigation options in other sectors where GHG emissions, on a relative basis, may be more easily identified, quantified, measured and monitored;

(c) There are only limited mitigation options currently eligible under the CDM. The number of CDM methodologies available in the agriculture sector is also limited (see sections 3.1 and 3.2 below);

(d) There are difficulties in the measurement of emissions in agricultural settings and in addition the measurement is subject to high uncertainties. There are fewer existing local/regional studies about GHG emissions levels in the agricultural field which prevents further simplification and standardization of emission factors;

(e) Stringent measurement/monitoring requirements in CDM methodologies have also been cited in the literature as a main reason for limited development of agricultural carbon finance projects in developing countries (Larson et al., 2011 from World Bank’s policy research working paper). Other stakeholders have also pointed out restrictive CDM monitoring requirements against farmers’ monitoring capabilities (e.g. Horka, P., 2012[1]);

(f) Project development is also hampered by the false perception that mitigation projects will affect or cap agriculture production. Stakeholders in the agricultural sector are generally unaware of opportunities to develop projects related to reductions in GHG intensity (tCO_2eq/unit of product) under the CDM not necessarily affecting growth in agriculture production;

(g) Agriculture is a substantial portion of gross domestic product in many developing countries and tends to have a large share of country emissions and high technical mitigation potential, but those countries tend to have low capacity for participation in the CDM.

8. As part of the solutions to the above issues, the development of new methodologies and measures for the reduction of transaction costs and further scale-up with the use of programmes of activities (PoAs) has been proposed in the literature (e.g. Horka, P., 2012). Additional proposed solutions are discussed below.

3.1. Mitigation potential and eligible activities under the CDM

9. The IPCC AR4 notes that the management of cropland and grazing land and the restoration of degraded and cultivated organic soils present the greatest potential for carbon dioxide (CO_2) emission reduction, while livestock and rice field management

[1] Horka, P. (2012). Agriculture and the carbon market [Powerpoint slides]. Retrieved on 06 November 2015 from: <https://www.fibl.org/fileadmin/documents/de/news/2012/calas/8_CaLas2011_Horka.pdf>.

have greatest potential for methane (CH_4) reduction. According to the IPCC, of the total technical mitigation potentials, about 89 per cent is from soil carbon sequestration, about 9 per cent from mitigation of CH_4 and about 2 per cent from mitigation of soil nitrous oxide (N_2O) emissions.

Figure 1. Global technical mitigation potential by 2030 of each agricultural management practice showing the impacts of each practice on each GHG

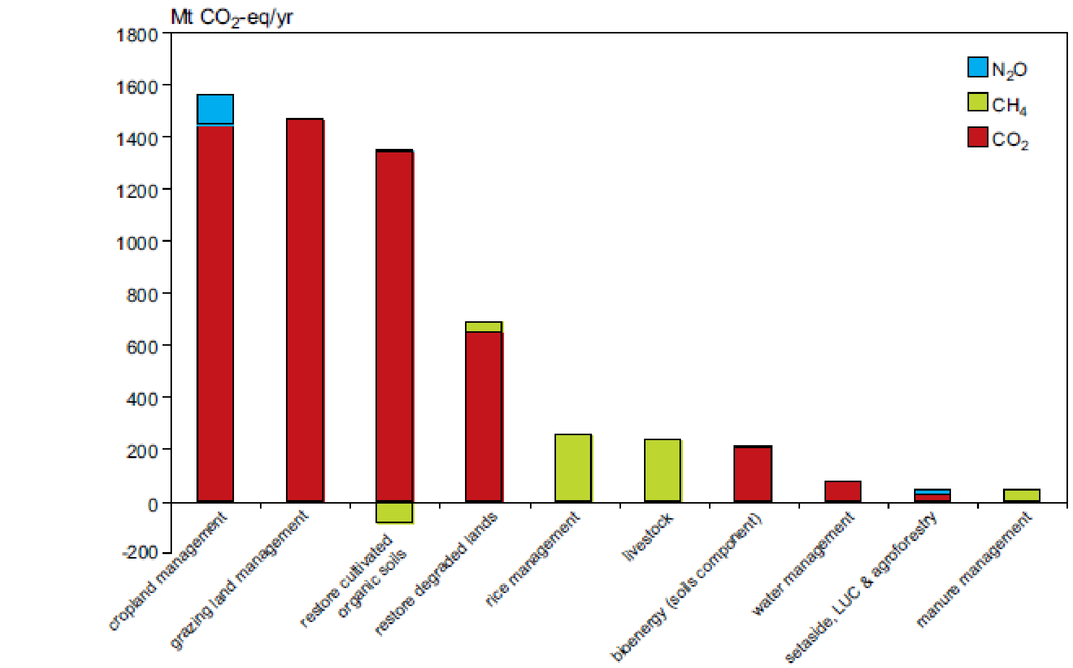

Figure 8.4: *Global technical mitigation potential by 2030 of each agricultural management practice showing the impacts of each practice on each GHG.*
Note: based on the B2 scenario though the pattern is similar for all SRES scenarios.
Source: Drawn from data in Smith et al., 2007a.

Source: IPCC AR4

10. Total mitigation potentials for the AFOLU sector are estimated to be ~3 to ~7.2 $GtCO_2eq$/yr in 2030 at 20 and 100 USD/tCO_2eq, respectively.

Figure 2. Mitigation potential for the AFOLU sector

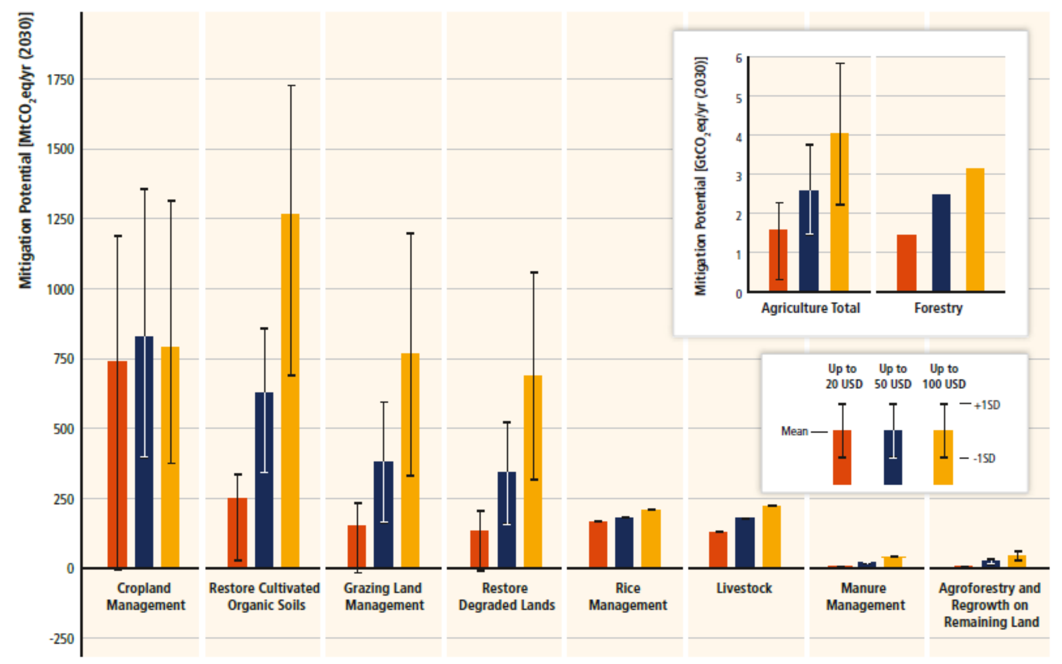

Figure 11.13 | Mitigation potential for the AFOLU sector, plotted using data from AR4 (Nabuurs et al., 2007; Smith et al., 2007). Whiskers show the range of estimates (+/- 1 standard deviation) for agricultural options for which estimates are available.

Source: IPCC AR5

11. However, the mitigation through soil carbon sequestration projects is not eligible under the CDM in the agriculture sector. The mitigation potential in soil carbon sequestration can be realized only through afforestation and reforestation project activities.

3.2. Technologies/measures covered by CDM methodologies and standardized baselines

12. There are several CDM methodologies in the agriculture sector, but most methodologies have limited scope (e.g. applicable to specific mitigation activities with narrow scope). Most of the CDM methodologies relevant to agriculture are small-scale due to the small emission levels of project activities (farms are small production units compared to industrial plants). The relevant CDM methodologies are listed in table 1 below. Recently, one standardized baseline in the agriculture sector has also been developed.

Table 1. Key CDM methodologies and standardized baselines for projects in the agriculture sector

Large-scale methodologies		Number of projects	Number of PoAs
Manure Management	ACM0010 (AM0006 and AM0016): GHG emission reductions from manure management systems	59	0
	AM0073: GHG emission reductions through multi-site manure collection and treatment in a central plant	2	0

Alternative waste treatment	ACM0022 (AM0025 and AM0039): Alternative waste treatment processes	11	0
Small-scale methodologies			
Manure Management	AMS-III.D: Methane recovery in animal manure management systems	181	15
	AMS-III.R: Methane recovery in agricultural activities at household/small farm level	34	8
	AMS-III.Y: Methane avoidance through separation of solids from wastewater or manure treatment systems	3	0
	AMS-III.AO: Methane recovery through controlled anaerobic digestion	6	1
Alternative waste treatment	AMS-III.E: Avoidance of methane production from biomass decay through controlled combustion	41	0
	AMS-III.F: Avoidance of methane production from biomass decay through composting	56	10
	AMS-III.BE: Avoidance of methane and nitrous oxide emissions from sugarcane pre-harvest open burning through mulching	0	0
Rice cultivation	AMS-III.AU: Methane emission reduction by adjusted water management practice in rice cultivation	0	0
Enteric fermentation	AMS-III.BK: Strategic supplementation of a small holder dairy sector to increase productivity	0	0
Fertilizer	AMS-III.BF: Reduction of N_2O emissions from use of Nitrogen Use Efficient (NUE) seeds that require less fertilizer application	0	0
	AMS-III.A: Urea offset by inoculant application in soybean-corn rotations on acidic soils on existing cropland	0	0
Energy efficiency	AMS-II.P: Energy efficient pump-set for agriculture use	0	0
	AMS-II.F: Energy efficiency and fuel switching measures for agricultural facilities and activities	1	1
Approved standardized baselines (ASB)			
ASB	ASB0008: Methane Emissions from Rice Cultivation in the Philippines	0	0

Source: UNFCCC

13. Present approaches to calculate CH_4 and N_2O emissions are based on one or more approaches described below:

(a) **Model:** A model (e.g. Denitrification-Decomposition (DNDC) model) is used to predict CH_4 and/or N_2O emissions from agricultural lands, simulating the fundamental processes controlling the interactions among ecological drivers, soil environmental factors and relevant biochemical or geochemical reactions. This approach is applied for example in AMS-III.AU and AMS-III.BF. Manure management methodologies also employ IPCC models and default factors for ex-ante calculations;

(b) **Direct measurement:** A direct measurement is conducted using the static chamber-based method for measurement of GHG fluxes from soil systems. The static chamber-based method is based on trapping gases emitted from the soil

surface within a chamber and collecting samples from the chamber headspace at regular intervals for analysis by gas chromatography. The results from direct measurements are used to calibrate the model. This approach is applied in for example AMS-III.AU, AMS-III.BF. Manure management methodologies also often involve measurement of biogas generated;

(c) **Control group:** A control group is established at project and baseline conditions to compare emissions between project and baseline. This approach is applied, for example in AMS-III.AU, AMS-III.BF, AMS-III.BK.

3.3. Technologies/measures proposed in nationally appropriate mitigation actions

14. An assessment of technologies/measures applied in the nationally appropriate mitigation actions (NAMAs) was also carried out. The objective was to check whether there were technologies/measures that are of interest to host countries but not currently covered in the CDM.

15. There are 11 NAMAs relevant to the agriculture sector that have been submitted to the NAMA Registry and are publically available. The NAMAs are listed in table 2 below.

Table 2. List of NAMAs in the agriculture sector

ID	Party	Title	Mitigation technologies/measures
NS-147	Pakistan	Bio-energy generation and greenhouse-gases mitigation though organic-waste utilization	• Production of biogas from livestock wastes of dairy farms so as to capture and utilize the CH_4 gas as a source of bioenergy; • Management and utilization of bio-digesters’ slurry as source of bio-fertilizer to substitute the chemical fertilizer.
NS-149	Dominican Republic	Reducing Greenhouse Gases (GHG) Emissions in Pig Farms in the Dominican Republic	• Anaerobic digestion in the pig farms through the installation of 1,750 bio-digesters.
NS-152	Uganda	Promoting cultivation of high-yielding upland rice in Uganda	• The NAMA will address methane emissions from rice cultivation. Activities associated with rice cultivation that indirectly affect emissions in the agricultural sector include extent of water logging, clearing of forests and woodlands to open up new land for cultivation, and use of inorganic and/or organic fertilizers to improve yields.

ID	Party	Title	Mitigation technologies/measures
NS-154	Uganda	Developing appropriate strategies and techniques to reduce methane emissions from livestock production in Uganda	• Exploring appropriate feeding strategies that increase productivity while at the same time reduce methane emissions from enteric fermentations (e.g. feeding livestock on improve forages; feed supplements); • Exploring with various feed additives, including plant extracts and rumen modifiers (yeast, bacterial direct fed microbials, and enzymes); • Explore ways to improve feed efficiency through breeding and diet manipulation; • Exploring manure and pasture management on both small and larger farms.
NS-156	Uganda	Integrated Wastewater Treatment for Agro-process Water in Uganda	• The NAMA seeks to increase efficiency and value addition prospects for wastewater treatment of agro-processing firms by establishing an integrated wastewater treatment process using both an anaerobic and aerobic digester with sequencing batch reactor. From the two processes, GHGs especially methane will be captured in the form of biogas and using a generator converted to electricity, and/or used directly for cooking and lighting where the volumes of biogas generated are small. Also, the process will lead to generation of large volumes of bio-slurry that can be used for producing bio-fertilizers, while the treated wastewater can be re-used in some of the targeted facilities.
NS-72	Costa Rica	NAMA - Low Carbon Coffee - Costa Rica	• The NAMA addresses the two most important sources of GHG identified in the coffee sector: the farm (NO_2 mitigation and CO_2 fixation) and the mills (CH_4 and CO_2 mitigation). 1) Reductions in N_2O emissions, by adoption of efficient practices of fertilizer application. 2) Reductions in CH_4 emissions by improved water management in anaerobic treatment systems and by introducing technologies for wastewater treatment. 3) Reductions in CH_4 and CO_2 emissions through aerobic treatment and energetic use of pulp. 4) Reduction in CO_2 emissions coming for electrical energy savings by improving the coffee drying process. 5) Increased fixation of carbon by the spread of coffee agroforestry systems (intensified shading).

ID	Party	Title	Mitigation technologies/measures
NS-71	Costa Rica	Costa Rica Livestock NAMA	• Changes not only in the primary production of meat and milk, but also in the form of processing the product within the country’s agricultural chain. The technologies and processes suggested in the NAMA are: ✓ **Hedges-pasture sections:** Dividing pasture areas in farms into more pasture sections allows a more efficient use of pasture and space. ✓ **Rational grazing:** It is a management system of livestock farms that allows herd rotation in pasture sections at least every two or three days, increasing animal density and productivity per hectare. Moreover, due to longer recovery times, pastures are healthier as there is an increase in carbon sequestration in soil. ✓ **Pasture Improvement-feeding:** The incorporation of new pasture species results in a better nutrition of livestock, which increases productivity and reproduction rates. In addition, improved pasture reduces GHG emissions as it allows the herd to digest more efficiently and reduce enteric fermentation. ✓ **Improved fertilization plans:** The use of fertilizers is a major source of GHG emissions in dairy farms; therefore, information and capacity-building can contribute to implement them more efficiently and to implement other strategies such as organic fertilizers, slurries or new technologies, including slow-release fertilizers. ✓ **Measures in the processing industry:** The change toward renewable energy sources and the implementation of more efficient cooling systems. ✓ **Genetic improvement of the herd and excreta management.**
NS-206	Rwanda	Sustainable Fertilizers Production and Use	• The NAMA focuses on the development and implementation of sustainable fertilizer production and use accomplished across several subsector component programmes including: (a) creation of up to 600 community cattle agribusiness cooperatives for organic composting of manure and field residues in lieu of burning for reductions of GHG emissions; (b) improved production of finely granulated natural lime found in abundance in Musanze, Karongi and Rusizi districts of Rwanda; and (c) improved and sustainable agricultural fertilizer applications, soil erosion measures, and improved agronomic management of soils capacity development programmes implemented through Rwanda’s agricultural extension service and farmer schools in rural areas. • The key mitigation actions include the collection and production of livestock manure for organic fertilizer, improved efficiency in lime production and application, elimination and reduction of vertical lime burning, and improved agronomic management of soils, fertilizers, and crop yields.

ID	Party	Title	Mitigation technologies/measures
NS-210	Rwanda	Energy Efficiency Improvement in the Tea and Coffee Sector in Rwanda	• This NAMA targets mitigation through the promotion of energy efficiency activities in the Tea and Coffee sector in Rwanda. The promotion of energy efficiency will focus on energy intensive activities in the tea and coffee industry pertaining to thermal energy and electrical energy requirements, namely roasting, drying, processing and packaging.
NS-200	Uruguay	Sustainable production with low-emission technologies in agriculture and agroindustry production chains.	• This NAMA consists of the creation of a programme focused on the transformation of the different kinds of waste generated in the agriculture and agroindustry production chains in various types of energy or by-products, aiming at the development of a low-carbon sustainable production model. • The activities proposed are the following: ✓ Strengthening of the policy framework to promote sustainable production schemes and implement low-emission technologies in target sectors; ✓ Energy production and other forms of waste valorization in target sectors; ✓ Laboratory research for target sectors for technology development, adaptation, assessment and transfer; ✓ Demonstration of the feasibility of production of energy by waste, which improves the reduction of GHG emissions, low emission waste treatment plan and energy generation in full-size production processes in the targeted sectors.
NS-217	Mongolia	Multi-purpose utilization of biochar in Mongolia	• Within a biochar project, emissions reductions could come from changing fresh organic matter to a much more stable form of carbon through the production of biochar, from increasing soil carbon stocks upon biochar application, possible reductions in soil emissions of GHGs, enhanced carbon storage in growing crops and decreases in fertilizer and other energy-intensive agricultural inputs.

Source: <http://www4.unfccc.int/sites/nama/SitePages/Home.aspx>.

16. Some of the technologies/measures proposed in the above NAMAs are not covered in the existing CDM methodologies, such as the following, while many others may not be eligible under the CDM as per the current modalities and procedures:

(a) Grazing land and livestock management (e.g. improved breeds with higher productivity);

(b) Crop nutrition management (e.g. improved fertilizers).

3.4. Other initiatives to advance GHG mitigation in the agriculture sector

3.4.1. The Global Alliance for Climate-Smart Agriculture

17. The Global Alliance for Climate-Smart Agriculture (GACSA)[2] was launched on 23 September 2014 at the United Nations Climate Summit in New York. GACSA is a

[2] <http://www.fao.org/gacsa/en/>.

voluntary alliance of partners dedicated to addressing the challenges facing food security and agriculture under a changing climate. In particular the alliance has the objective of scaling up the Climate-Smart Agriculture (CSA) approach, a concept which was originally developed by FAO.

18. As defined by FAO,[3] CSA integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges. It is composed of three main pillars: i) sustainably increasing agricultural productivity and incomes; ii) adapting and building resilience to climate change; and iii) reducing and/or removing GHG emissions, where possible.

19. The FAO published a sourcebook that aims to elaborate the concept of CSA and demonstrate its potential, as well as its limitations. This sourcebook has been used as a reference tool for planners, practitioners and policymakers working in agriculture at national and subnational levels, dealing with the effects of climate change.

20. The future development of CDM methodologies should take into account developments under GACSA. However, under CSA, emission reductions tend to be concentrated in the sequestration sector – through afforestation (agroforestry) and soil carbon improvement.

3.4.2. The GHG Protocol Agriculture Guidance

21. In 2014 the World Resources Institute released the GHG Protocol Agricultural Guidance,[4] the first global guidance to measure GHG emissions for the agriculture sector. The guidance is a supplement to GHG Protocol’s Corporate Standard and covers all agricultural subsectors, including livestock, crop production, and land-use change. The GHG Protocol Agricultural Guidance is intended to promote sector-wide adoption of emissions management practices by harmonizing how agricultural companies worldwide measure and report their emissions.

3.4.3. FAO report on the use of geothermal energy in food and agriculture

22. The recently published FAO report titled “Uses of Geothermal Energy in Food and Agriculture”[5] explores uses of geothermal energy for food production and processing in developing countries. According to the report, of the 23 developing countries that are using geothermal, the majority currently apply it to space heating and recreational purposes only, leaving its significant potential for agricultural uses untapped.

23. Future methodological work should take into account progress in this area.

3.4.4. Various GHG calculators to calculate mitigation impacts of projects in the agriculture sector

24. Besides some calculation tools developed for methodologies under other GHG programmes (see section 3.4.5 – for example some GS methodologies are accompanied

[3] <http://www.fao.org/climatechange/climatesmart/en/>, <http://www.fao.org/climate-smart-agriculture/en/>.

[4] <http://www.ghgprotocol.org/standards/agriculture-guidance>.

[5] <http://www.fao.org/3/a-i4233e.pdf>.

with calculation tools), there are a number of GHG calculators that have been developed by other international organizations, some of which are summarized in table 3 below.

Table 3. GHG calculators to calculate mitigation impacts of projects in the agriculture sector

Name	Description
Ex-Ante Carbon-balance Tool (EX-ACT) <http://www.fao.org/tc/exact/ex-act-home/en/>	The EX-ACT is an appraisal system developed by FAO providing ex-ante estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. The EX-ACT is a land-based accounting system, estimating C stock changes (i.e. emissions or sinks of CO_2) as well as GHG emissions per unit of land, expressed in equivalent tonnes of CO_2 per hectare and year. The tool helps project designers to estimate and prioritize project activities with high benefits in economic and climate change mitigation terms. The EX-ACT can be applied on a wide range of development projects from all AFOLU sub-sectors, including besides others projects on climate change mitigation, sustainable land management, watershed development, production intensification, food security, livestock, forest management or land use change.
CCAFS[6] Mitigation Option Tool (CCAFS-MOT) <https://ccafs.cgiar.org/mitigation-options-tool-agriculture-0#.VgCE7vOJkdk>	The CCAFS Mitigation Option Tool (CCAFS-MOT) is developed by researchers at the University of Aberdeen, in partnership with CCAFS, the International Centre for Tropical Agriculture (CIAT), and the University of Vermont’s Gund Institute for Ecological Economics. The CCAFS-MOT estimates greenhouse gas emissions from multiple crop and livestock management practices in different geographic regions, providing policy-makers across the globe access to reliable information needed to make science-informed decisions about emissions reductions from agriculture. Unlike these agricultural calculators, CCAFS-MOT i) ranks the most effective mitigation options for 34 different crops according to mitigation potential and in relation to current management practices and spatially-linked climate and soil characteristics; ii) has low input data requirements – approximately 10 minutes needed; iii) runs in Excel; and iv) is freely downloadable from the CCAFS website.
GHG Protocol in Brazil <http://www.ghgprotocol.org/Agriculture-Guidance/Brazil-Agriculture-Guidance_Project-Overview>	In Brazil, the GHG Protocol conducted the intensive review and road-testing of the Guidance, and also developed an accompanying GHG emissions calculation tool. This Excel–based calculator estimates the emissions from crop and livestock production, as well as land use change.
European carbon calculator to promote low carbon farming practices <http://mars.jrc.ec.europa.eu/mars/Projects/LC-Farming> <http://www.solagro.org/site/476.html>	In 2012, the European Commission's Joint Research Center contracted Solagro to create a "Carbon calculator to promote low carbon farming practices". This carbon calculator is designed for assessing the life cycle GHG emissions from different types of farming systems across the whole EU. It quantifies direct and indirect GHG emissions according to the international standards and guidelines on Life Cycle Assessment

6 CCAFS is the Consultative Group on International Agricultural Research (CGIAR)’s Research Program on Climate Change, Agriculture and Food Security.

Name	Description
	and carbon footprint. In addition to the GHG emission quantification, the tool proposes mitigation options and sequestration actions suitable for single farms. Specific farming practices are recommended on the basis of emission reduction potential, potential leakage effects, inherent costs of implementation, and impact on other environmental issues.
Cool Farm Tool (CFT) <http://www.coolfarmtool.org/CoolFarmTool http://www.goldstandard.org/resources/agriculture-requirements>	The Cool Farm Institute and Gold Standard are jointly developing this CFT. The CFT is an online[7] GHG calculator, originally developed by Unilever and the University of Aberdeen, to help farmers measure and understand on-farm greenhouse gas emissions. The CFT has been tested and adopted by a range of multinational companies who are using it to work with their suppliers to measure, manage, and reduce greenhouse gas emissions in the effort to mitigate global climate change.
Agriculture and Land Use National Greenhouse Gas Inventory (ALU) Software <http://www.nrel.colostate.edu/projects/ALUsoftware/>	The ALU Software is developed by Colorado State University with funding provided by US Environmental Protection Agency, US Agency for International Development and US Forest Service. The ALU Software is designed to make the inventory process easier to implement and consistent with guidelines provided by the IPCC. It guides an inventory compiler through the process of estimating GHG emissions and removals related to agricultural and forestry activities.

3.4.5. Technologies/measures covered by other GHG programmes

25. The standards of the following GHG programmes were investigated to assess methodologies that have already been developed or are currently under development:

    (a) The American Carbon Registry (ACR);

    (b) The Climate Action Reserve (CAR);

    (c) Verified Carbon Standard (VCS);

    (d) The Gold Standard (GS);

    (e) Australia’s Emissions Reduction Fund (ERF);

    (f) Joint Crediting Mechanism (JCM).

26. Table 4 below provides information on the methodologies of the above GHG programmes in the agriculture sector as per the mitigation options listed in IPCC AR5 (see appendix).

27. It can be seen that other GHG programmes have developed various methodologies that include soil carbon sequestration, which is not eligible under the CDM.

[7] The Excel-based version of the CFT is also available and can be downloaded from the website.

Table 4. Methodologies developed by other GHG programmes

Land-based agriculture		**Covered by CDM**
Croplands — plant management	• *VCS: VM0017 Adoption of Sustainable Agricultural Land Management* • *VCS: VM0021 Soil Carbon Quantification Methodology*	-
Croplands — nutrient management	• ACR: Changes in Fertilizer Management • ACR: Reduced Use of Nitrogen Fertilizer on Agricultural Crops • CAR: Nitrogen Management • *VCS: VM0017 Adoption of Sustainable Agricultural Land Management* • *VCS: VM0021 Soil Carbon Quantification Methodology* • VCS: VM0022 Quantifying N2O Emissions Reductions in Agricultural Crops through Nitrogen Fertilizer Rate Reduction • ERF: Reducing greenhouse gas emissions from fertiliser in irrigated cotton • *ERF: Estimating sequestration of carbon in soil using default values (model-based soil carbon)* • JCM: Methodology for N2O reduction by using coated fertilizers (Draft methodology is developed but not approved yet)[8]	• AMS-III.BF • AMS-III.A
Croplands — tillage / residues management	• *GS: Increasing Soil Carbon Through Improved Tillage Practices*	-
Croplands — water management	-	-
Croplands — rice management	• ACR: Rice Management Systems • CAR: Rice Cultivation	• AMS-III.AU
Rewet peatlands drained for agriculture	• *ACR: Restoration of Degraded Wetlands of the Mississippi Delta* • *ACR: Restoration of California Deltaic and Coastal Wetlands (currently under development)* • *VCS: VM0024 Methodology for Coastal Wetland Creation* • *VCS: VM0027 Methodology for Rewetting Drained Tropical Peatlands*	-
Croplands — set-aside and land-use change (LUC)	-	-
Biochar application	-	-

[8] As compared with AMS-III.BF and VCS: VM0022 "Quantifying N2O Emissions Reductions in Agricultural Crops through Nitrogen Fertilizer Rate Reduction", the draft JCM methodology claims that it offers wider application and reduced monitoring burden, while being sufficiently robust.

Grazing lands — plant management	• ACR: Grazing Land and Livestock Management • *ACR: Compost Additions to Grazed Grasslands* • *VCS: VM0017 Adoption of Sustainable Agricultural Land Management* • *VCS: VM0021 Soil Carbon Quantification Methodology* • *VCS: VM0026 Methodology for Sustainable Grassland Management (SGM)* • *VCS: VM0032 Methodology for the Adoption of Sustainable Grasslands through Adjustment of Fire and Grazing* • *ERF: Sequestering carbon in soil in grazing systems* • *ERF: Estimating sequestration of carbon in soil using default values (model-based soil carbon)*	-
Grazing lands — animal management	• *VCS: VM0026 Methodology for Sustainable Grassland Management (SGM)* • *VCS: VM0032 Methodology for the Adoption of Sustainable Grasslands through Adjustment of Fire and Grazing*	-
Grazing land — fire management	• *VCS: VM0032 Methodology for the Adoption of Sustainable Grasslands through Adjustment of Fire and Grazing* • ERF: Emissions abatement through savanna fire management[9]	-
Revegetation	-	-
Organic soils — restoration	• *ACR: Avoided Conversion of Grasslands and Shrublands to Crop Production* • *CAR: Grassland* • *VCS: VM0017 Adoption of Sustainable Agricultural Land Management* • *VCS: VM0021 Soil Carbon Quantification Methodology*	-
Degraded soils — restoration	-	-
Biosolid applications	-	-
Livestock		
Livestock — feeding	• ACR: Grazing Land and Livestock Management • ACR: Reduced Carbon Intensity of Fed Cattle (currently under scientific peer review) • ERF: Reducing greenhouse gas emissions by feeding nitrates to beef cattle • ERF: Reducing greenhouse gas emissions by feeding dietary additives to milking cows • GS: Dairy Efficiency Accounting – Increase input efficiency while reducing emissions per kilogram of milk (currently under development)	• AMS-III.BK

9 This methodology aims to abate GHG emissions from fire largely through using fire during the early dry season with the intent to reduce the proportion of the total area burned by all fires that occur in the late dry season.

Livestock — breeding and other long-term management	• ERF: Beef cattle herd management	-
Manure management	• ACR: Grazing Land and Livestock Management • CAR: Mexico Livestock • CAR: U.S. Livestock • CAR: Organic Waste Composting • CAR: Organic Waste Digestion • VCS: VMR0003 Revisions to AMS-III.Y to Include Use of Organic Bedding Material • GS: Revised Consolidated Baseline Methodology for GHG Emission Reductions from Manure Management Systems and Municipal Solid Waste • ERF: Destruction of methane generated from manure in piggeries • ERF: Destruction of methane from piggeries using engineered biodigesters • ERF: Destruction of methane generated from dairy manure in covered anaerobic ponds	• ACM0010 • AM0073 • ACM0022 (AM0025 and AM0039) • AMS-III.D • AMS-III.R • AMS-III.Y • AMS-III.AO • AMS-III.E • AMS-III.F • AMS-III.BE
Integrated systems		
Agroforestry (including agropastoral and agrosilvopastoral systems)	-	-
Other mixed biomass production systems	-	-
Integration of biomass production with subsequent processing in food and bioenergy sectors	-	-
Agroforestry (including agropastoral and agrosilvopastoral systems)	-	-
Bioenergy		
Bioenergy	-	• Type I small-scale methodolog y
Demand-side options		
Reduced losses in the food supply chain	-	-
Changes in human diets towards less emission intensive products	-	-
Demand-side options related to wood and forestry	-	-
Energy		

Renewable energy or energy efficiency in food production, processing and/or food storage	• GS: Suppressed Demand Small-scale Methodology for Energy Use for the Processing of Agricultural Products • GS: Suppressed Demand Small-scale Methodology for Low GHG Food Preservation • GS: Cool Farm Tool – to reduce emissions for agricultural commodities along the production and supply chain (currently under development) • JCM: Installation of Energy-efficient Refrigerators Using Natural Refrigerant at Food Industry Cold Storage and Frozen Food Processing Plant	• AMS-II.P • AMS-II.F

Source:

- The American Carbon Registry (ACR): <http://americancarbonregistry.org/carbon-accounting/standards-methodologies>.
- The Climate Action Reserve (CAR): <http://www.climateactionreserve.org/how/protocols/>
- The Verified Carbon Standard (VCS): <http://www.v-c-s.org/methodologies/what-methodology>.
- The Gold Standard (GS): <http://www.goldstandard.org/>.
- The Australia’s Emissions Reduction Fund (ERF): <http://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector>.
- Joint Crediting Mechanism (JCM): <http://www.mmechanisms.org/e/initiatives/methodology.html>.

28. Based on the above analysis, the following area could be further explored for possible development of new methodologies and standardization of existing methodologies:

(a) Grazing land and livestock management:

(i) New methodologies for grazing land and livestock management (e.g. improved breeds with higher productivity);

(ii) Simplification and streamlining of existing livestock methodology AMS-III.BK;

(iii) Avoidance of methane and N_2O emissions from fire management (e.g. expansion of AMS-III.BE);

(b) Crop nutrition management:

(i) New methodologies for nutrition management (e.g. the use of improved fertilizer such as coated fertilizers);

(ii) Simplification and streamlining of existing fertilizer methodologies AMS-III.BF and AMS-III.A to facilitate the development of local/regional standardized values;

(c) Rice cultivation:

(i) Development of standardized baselines using AMS-III.AU, i.e. consider replication of ASB0008 to other rice-producing countries;

(d) Manure management:

(i) Revisions to AMS-III.Y to include use of organic bedding material;

(e) Food processing and/or food storage to reduce emissions in the agriculture sector:

(i) New methodology for mitigation actions in food processing and/or food storage;

(f) Application of renewable energy for agriculture (e.g. solar-powered water pumps).

3.5. Further work

29. In summary, the following further work is proposed for consideration by the Board to advance this product:

(a) To explore the possibility of developing new methodologies and/or revision of existing methodologies to include specific technologies/measures for which existing CDM methodologies have only a partial coverage**, as listed in paragraph 28**;

(b) To explore areas of further simplification and streamlining to facilitate development of standardized baselines, **as listed in paragraph 28.**

4. Impacts

30. Simplification and broadening will potentially facilitate the development of more CDM projects and programmes in the agriculture sector.

5. Subsequent work and timelines

31. Based on the guidance from the Board, further work proposed in this concept note will be conducted in 2016.

6. Recommendations to the Board

32. The secretariat recommends that the Board provide feedback on the analysis and conclusions contained in this concept note and/or provide any other guidance in this regard.

Appendix. Mitigation opportunities in the AFOLU sector indicated in IPCC AR5

1. According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5), the agriculture, forestry, and other land use (AFOLU) sector is responsible for just under a quarter (10–12 $GtCO_2eq$/ year) of anthropogenic greenhouse gas (GHG) emissions mainly from deforestation and agricultural emissions from livestock, soil and nutrient management.

2. Both supply-side and demand-side mitigation opportunities are included in the IPCC AR5:

    (a) On the supply side, emissions from land-use change (LUC), land management and livestock management can be reduced, terrestrial carbon stocks can be increased by sequestration in soils and biomass, and emissions from energy production can be saved through the substitution of fossil fuels by biomass;

    (b) On the demand side, GHG emissions could be mitigated by reducing losses and wastes of food, changes in diet and changes in wood consumption, although quantitative estimates of the potential are few and highly uncertain.

    (c) Increasing production without a commensurate increase in emissions also reduces emission intensity, i.e. the GHG emissions per unit of product that could be delivered through sustainable intensification.

Table. Summary of mitigation options in the AFOLU sector

Forestry	
Reducing deforestation	**C:** Conservation of existing C pools in forest vegetation and soil by controlling deforestation, protecting forest in reserves and controlling other anthropogenic disturbances such as fire and pest outbreaks. Reducing slash and burn agriculture, reducing forest fires.
	CH_4, N_2O: Protection of peatland forest, reduction of wildfires.
Afforestation/ Reforestation	**C:** Improved biomass stocks by planting trees on non-forested agricultural lands. This can include either monocultures or mixed species plantings. These activities may also provide a range of other social, economic and environmental benefits.
Forest management	**C:** Management of forests for sustainable timber production including extending rotation cycles, reducing damage to remaining trees, reducing logging waste, implementing soil conservation practices, fertilization and using wood in a more efficient way, sustainable extraction of wood energy.
	CH_4, N_2O: Wildfire behaviour modification.
Forest restoration	**C:** Protecting secondary forests and other degraded forests whose biomass and soil C densities are less than their maximum value and allowing them to sequester C by natural or artificial regeneration, rehabilitation of degraded lands, long-term fallows.
	CH_4, N_2O: Wildfire behaviour modification.

Land-based agriculture	
Cropland management	
Croplands — plant management	**C:** High input carbon practices, e. g. improved crop varieties, crop rotation, use of cover crops, perennial cropping systems, agricultural biotechnology.
	N_2O: Improved N use efficiency.
Croplands — nutrient management	**C:** Fertilizer input to increase yields and residue inputs (especially important in low-yielding agriculture).
	N_2O: Changing N fertilizer application rate, fertilizer type, timing, precision application, inhibitors.
Croplands — tillage/ residues management	**C:** Reduced tillage intensity; residue retention.
	N_2O:
	CH_4:
Croplands — water management	**C:** Improved water availability in cropland including water harvesting and application.
	CH_4: Decomposition of plant residues.
	N_2O: Drainage management to reduce emissions, reduce N runoff leaching.
Croplands — rice management	**C:** Straw retention.
	CH_4: Water management, mid-season paddy drainage.
	N_2O: Water management, N fertilizer application rate, fertilizer type, timing, precision application.
Rewet peatlands drained for agriculture	**C:** Ongoing CO_2 emissions from reduced drainage (but CH_4 emissions may increase).
Croplands — set-aside and LUC	**C:** Replanting to native grasses and trees. Increase C sequestration.
	N_2O: N inputs decreased resulting in reduced N_2O.
Biochar application	**C:** Soil amendment to increase biomass productivity, and sequester C (biochar was not covered in AR4 so is described in Box 11.3).
	N_2O: Reduced N inputs will reduce emissions.
Grazing Land Management	
Grazing lands — plant management	**C:** Improved grass varieties/sward composition, e. g. deep rooting grasses, increased productivity, and nutrient management. Appropriate stocking densities, carrying capacity, fodder banks, and improved grazing management.
	N_2O
Grazing lands — animal management	**C:** Appropriate stocking densities, carrying capacity management, fodder banks and improved grazing management, fodder production, and fodder diversification.
	CH_4
	N_2O: Stocking density, animal waste management.
Grazing land — fire management	**C:** Improved use of fire for sustainable grassland management. Fire prevention and improved prescribed burning.
Revegetation	
Revegetation	**C:** The establishment of vegetation that does not meet the definitions of afforestation and reforestation (e. g. Atriplex spp.).
	CH_4: Increased grazing by ruminants may increase net emissions.
	N_2O: Reduced N inputs will reduce emissions.

Other	
Organic soils — restoration	**C:** Soil carbon restoration on peatlands; and avoided net soil carbon emissions using improved land management.
	CH_4: May increase.
Degraded soils — restoration	Land reclamation (afforestation, soil fertility management, water conservation soil nutrients enhancement, improved fallow).
Biosolid applications	**C:** Use of animal manures and other biosolids for improved management of nitrogen; integrated livestock agriculture techniques.
	N_2O
Livestock	
Livestock — feeding	**CH_4:** Improved feed and dietary additives to reduce emissions from enteric fermentation; including improved forage, dietary additives (bioactive compounds, fats), ionophores/antibiotics, propionate enhancers, archaea inhibitors, nitrate and sulphate supplements.
Livestock — breeding and other long-term management	**CH_4:** Improved breeds with higher productivity (so lower emissions per unit of product) or with reduced emissions from enteric fermentation; microbial technology such as archaeal vaccines, methanotrophs, acetogens, defaunation of the rumen, bacteriophages and probiotics; improved fertility.
Manure management	**CH_4:** Manipulate bedding and storage conditions, anaerobic digesters; biofilters, dietary additives.
	N_2O: Manipulate livestock diets to reduce N excreta, soil applied and animal fed nitrification inhibitors, urease inhibitors, fertilizer type, rate and timing, manipulate manure application practices, grazing management.
Integrated systems	
Agroforestry (including agropastoral and agrosilvopastoral systems)	**C:** Mixed production systems can increase land productivity and efficiency in the use of water and other resources and protect against soil erosion as well as serve carbon sequestration objectives.
	N_2O: Reduced N inputs will reduce emissions.
Other mixed biomass production systems	**C:** Mixed production systems such as double-cropping systems and mixed crop-livestock systems can increase land productivity and efficiency in the use of water and other resources as well as serve carbon sequestration objectives. Perennial grasses (e. g. bamboo) can in the same way as woody plants be cultivated in shelter belts and riparian zones / buffer strips provide environmental services and supports C sequestration and biomass production.
	N_2O: Reduced N inputs will reduce emissions.
Integration of biomass production with subsequent processing in food and bioenergy sectors	**C:** Integrating feedstock production with conversion, typically producing animal feed that can reduce demand for cultivated feed such as soy and corn and can also reduce grazing requirements. Using agricultural and forestry residues for energy production.
	N_2O: Reduced N inputs will reduce emissions.
Bioenergy (see Box 11.5 and Section 11.13)	
Bioenergy	
Demand-side options	
Reduced losses in the food supply chain	Reduced losses in the food supply chain and in final consumption reduces energy use and GHG emissions from agriculture, transport, storage and distribution, and reduce land demand.
Changes in human diets	Where appropriate, reduced consumption of food items with high GHG

towards less emission-intensive products	emissions per unit of product, to those with low GHG products can reduce GHG emissions. Such demand changes can reduce energy inputs in the supply chain and reduces land demand.
Demand-side options related to wood and forestry	Wood harvest in forests releases GHG and at least temporarily reduces forest C stocks. Conservation of wood (products) through more efficient use or replacement with recycled materials and replacing wood from illegal logging or destructive harvest with wood from certified sustainable forestry (Section 11.10) can save GHG emissions. Substitution of wood for non-renewable resources can reduce GHG emissions, e. g. when wood is substituted for emission-intensive materials such as aluminium, steel, or concrete in buildings. Integrated optimization of C stocks in forests and in long-lived products, as well as the use of by-products and wastes for energy, can deliver the highest GHG benefits.

Source: IPCC AR5

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