REVIEW OF GHG CALCULATORS IN AGRICULTURE AND FORESTRY SECTORS

A Guideline for Appropriate Choice and Use of Landscape Based Tools

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Disclaimer

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REVIEW OF GHG CALCULATORS IN AGRICULTURE AND FORESTRY SECTORS: *A Guideline for Appropriate Choice and Use of Landscape Based Tools*

Executive Summary

Climate change and its consequences are now recognized amongst the major environmental challenges for this century. Land based activities, mainly agriculture and forestry, can be both sources and sinks of greenhouse gases (GHG). In most countries, they represent significant share of total GHG emissions, around 30 % at global level. In order to reach global or national reduction target, as well as meeting food security challenges, agriculture and forestry sectors need to evolve. In parallel to IPCC work and progress on methodological issues, many GHG tools have been developed recently to assess agriculture and forestry practices. Denef et al. (2012) classify these tools as : calculators, protocols, guidelines and models. This review focus on calculators, i.e, automated web-, excel-, or other software-based calculation tools, developed for quantifying GHG emissions or emission reductions from agricultural and forest activities. This review considers calculators working at landscape/farm scale, including several productions: crop, livestock and forest. Eighteen major calculators were identified, amongst them EX-ACT, ClimAgri, Cool Farm Tool, Holos, USAID FCC and ALU. For the review, calculators identified have been tested and questionnaires have been sent to calculator developers for them to validate and complete the methodological analysis of their tool.

GHG calculators have been developed following different approaches, with different target and objectives. They are also suitable for a defined geographic coverage. A broad typology is proposed for classifying these calculators and help user to choose the most suitable for its need.

- **<u>Raising awareness</u>**: simple calculators, no training required, limited scope, reveal main hotspots, not solution oriented.
- **<u>Reporting</u>**: The aim is to describe and analyse in detail the current situation. These calculators were created to provide values for reporting, to allow comparisons between countries or farms based on a common basis and to help decision makers to elaborate adapted policies. These calculators take into account the full diversity of management practices in each area or farm.
- **<u>Project evaluation</u>**: Calculators for project evaluation compare a baseline to a "with project" situation. They can be split in between two sub categories, depending if they are carbon market oriented

- **Market and product oriented calculators**: These calculators provide GHG results per product. The aim is to compare different products rather than assessing a territory. This allows to compare emissions for a similar level of production (avoid leakage).

Table. Calculators classified according to their main objective and geographical zone.

OBJECTIVE OF THE USER		CALCULATORS AND GEOGRAPHICAL ZONE OF APPLICATION
Raising awareness		Carbon Calculator for New Zealand Agriculture and Horticulture (NZ), Cplan v0 (UK); Farming Enterprise GHG Calculator (AUS); US cropland GHG calculator (USA).
Reporting	Landscape calculators	ALU (World); Climagri (FR), FullCam* (AUS)
	Farm calculators	Diaterre (FR); CALM (UK); CFF Carbon Calculator (UK); IFSC (USA)
Project evaluation	Focus on carbon credits schemes	Farmgas (AUS), Carbon Farming tool (NZ);Forest tools : TARAM (world), CO2 fix (world)
	Not focus on carbon credits schemes	EX-ACT (World);US AID FCC (Developing countries), CBP (World), Holos(CAN), CAR livestock tools(USA)
Market and product oriented calculators		Cool farm tool (World); Diaterre (FR), LCA tools and associated database (SimaPro, ecoinvent, LCA food etc: data mainly for developed countries.)

AUS: Australia; CAN: Canada; FR: France, NZ: New Zealand; UK: United Kingdom; USA: United States of America; FullCam: calculator used by Australia for its national accounting only evaluates carbon fluxes. High accuracy level obtained coupling extensive dataset and bio-physical process models.

All tested calculators are accounting for main GHG sources and emissions and should be able to identify hotspots (with special care for areas subjected to land use change). All these calculators provide results in tonne of CO_2 equivalent (eqCO2)[1] but **they have some important differences concerning methodologies and scope, impacting significantly on results.** Therefore it is impossible to do a straight comparison between studies done using different calculators. While interpreting results, it is necessary to check for the scope and parameters accounted (ex: embedded emissions) and while comparing projects keep in mind **uncertainties**.

[1] CO_2 equivalent: Carbon dioxide equivalent is a quantity to express the relative impact on the radiative forcing, i.e. on the global warming, of a substance (mostly greenhouse gases) compared to that of CO_2, and is calculated using the Global Warming Potentials. GWPs are measurements of the relative radiative effect of a given substance compare to that of CO_2, over a specific time period. For instance the official values for Clean Development Mechanism of methane (CH_4) are set to 21 (meaning that 1 kg of CH4 is as effective, in terms of radiative forcing, as 21 kg of CO_2) and to 310 for nitrous oxide (N_2O), based on a secular time scale.

Main challenges with landscape assessment is how to consider the **heterogeneity of production systems and biological processes involved in GHG emissions**. Up scaling from farm scale to landscape assessment implies a change in data availability. At plot scale and farm scale, technical data are easily available and can be provided directly by farmers. At regional scale, data inventory often needs to be obtained from statistical data base or expert knowledge, increasing uncertainties. For accounting of biological processes, calculators either use biophysical models (e.g: Roth-C and Century) possibly linked with spatial databases, or average emission factors provided by IPCC or national studies. Such links between model

and spatial dataset exists in the GEFSOC System (CENTURY and RothC linked to a GIS) and APEX (the multi field version of EPIC) for instance. Accounting for time dynamic is especially important for considering soil and biomass carbon pool, with large quantities of CO_2 at stake. These pools are impacted by management and land use changes. In the future, proxy (e.g. Near Infra-Red Spectroscopy) or remote sensing (satellite image analyses) technologies might enable for cheap direct measurement of the carbon stock changes. Further development of process based models and cheap direct measurement methods for GHG fluxes, linked with GHG calculators are required to improve assessments accuracy.

Major hotspots which deserve special focus in GHG assessments and calculators are:

- Arable land: N fertilisation practices, crop residue decomposition, rice production, peat land conversion, land use change and management change (impact on carbon stock).
- Livestock: Feeding practices and accounting method for imported food (share of pastures), management of dejections and accounting for organic manure use.
- Horticulture: accounting of energy and infrastructure
- Forest: soil carbon, plantation vs natural forest, land use change

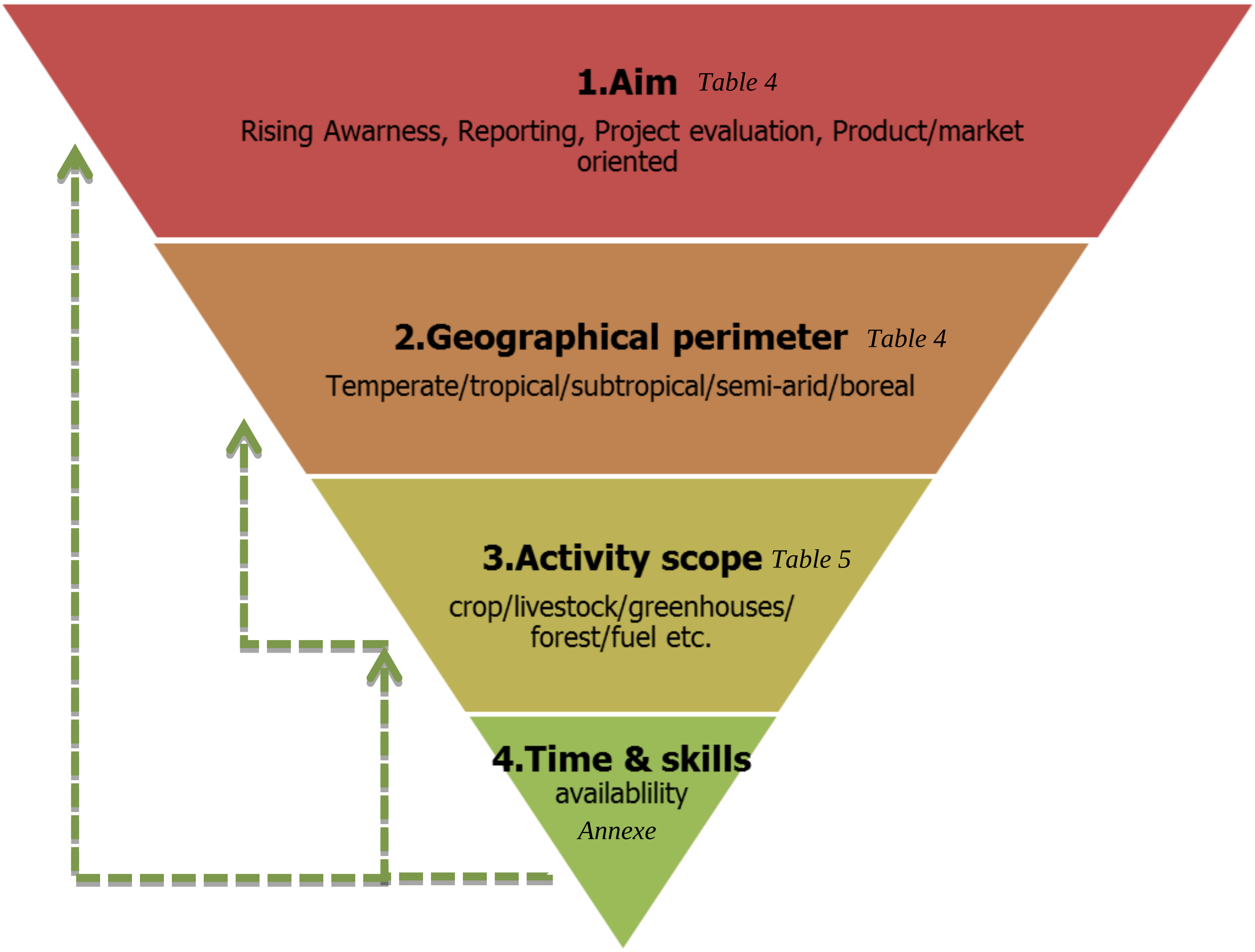
Calculators provide results in CO_2-eq/year, CO_2-eq /hectare, CO_2-eq /project or CO_2-eq /quantity of product (e.g kg of milk, cereals etc.). Best indicators must be considered depending on the aim of the assessment. However, the link between emissions per area (ha) and production level of the area needs to be kept in mind in order to avoid leakage, i.e. an increase of emissions outside of the studied perimeter induced by changes of production in the studied area. Permanency issues also need to be kept in mind: some reductions/increases of emissions are temporary, while others are continuous due to change in production systems. A very important point is that environmental/sustainability assessment cannot be restricted to GHG assessment and improvement of GHG balance must not be done ignoring possible drawbacks on other criteria (e.g. increase of pesticide use, water scarcity, reduced biodiversity etc.).

In highly productive systems, GHG assessment should focus on improving input efficiency per production. For low production area, focus should be stressed on agriculture resilience and food security, through improvement of agronomic practices. There are clear synergies between agronomic efficiency and agro-ecology practices/climate smart agriculture.
An important finding of this review is that adapted calculators for each situation are already available, however in many regions calculators only provide results with very high uncertainty and links with socio-economic parameters are still missing. Further development of the calculators would help policy makers and project managers to better account for climate change issues. Calculator developers must always keep in mind what kind of indicators and results are best suited for assessing any situation. Further methodological standardisation, as for LCA methodology which follows international standards (e.g. ISO 14040) could bring clarity and help building clear and transparent references.

Finally; depending on the aim of the user, each calculator tries to find the best compromise between user-friendliness, time consumption and result accuracy. As long as GHG assessment is mostly voluntary and limited economic return is expected (no CO2 tax, no labelling etc.), cost and skill requirements for using GHG calculators should remain limited. If more restrictive policies would be implemented, then method standardization and improved accuracy would become essential.

Suggested process for choosing GHG assessment calculator

Users should select tools according to more and more specific criteria, helped by the tables provided in the full report. However, if no tool is available for the specific target and area, the choice must go on more general tools, with a feedback process.



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