Guidelines for conducting a carbon audit on grazing properties

Richard Eckard, Primary Industries Climate Challenges Centre, The University of Melbourne

Background

Since the COP21 Paris Agreement set the world on a course towards climate neutrality, many multinational supply-chain companies have set targets towards carbon neutrality by 2050. The red meat industry in Australia has also set the target of carbon neutrality by 2030 (CN30). These targets have created significant interest from livestock producers in understanding their carbon position and a potential trajectory towards carbon neutrality to meet future supply chain demands.

There are also a number of livestock producers already claiming to be carbon neutral, on the assumption that their pastures are photosynthesizing carbon out of the atmosphere and therefore should inherently be carbon neutral. Unhelpful in this discussion is a number of carbon auditors making fundamental errors in sequestration calculations, or more nefariously, promising farmers high returns than biologically possible. Longer term, the supply chain will penalise those who have not conducted their carbon audits with integrity. There is therefore a need for a common standard with scientific integrity in the carbon audits that we produce, to ensure that these are fully consistent with IPCC and national greenhouse gas inventory methodologies in Australia, but also compliant with a partial lifecycle assessment as per the Climate Active - National Carbon Offset Standard.

This short document aims to provide a standard by which the CN30 pathways, Nexus and IMS projects will conduct their farm carbon audits.

The basic concept

A whole farm carbon audit needs to comply with the following guidelines:

1) The methodology used should not be 'inconsistent' with the IPCC approved, Australian national greenhouse gas inventory methodology. In our farm audits, we use the National GHG Inventory Methodology, only making adjustments where these are required to be more specific to the farm rather than a state or country;
2) The methodology used should align with the Climate Active (formerly National Carbon Offset Standard), definition of carbon neutrality, aligned with the **ISO 14067 standard - Carbon footprint of products**. Specifically:
    a. The calculation should be conducted within a pre-farm to farm gate Life Cycle Assessment framework, with the boundary representing the whole of farming enterprise e.g. if there are separate physical properties within the farm enterprise, movement of product between farms needs to be included as Scope 1 emissions.
    b. The net carbon balance must be calculated on an annual timestep not a cumulative time-step, with the exception where large losses and gains in soil and tree carbon sequestration, due to climate variability, can managed as a running mean.
    c. The audit should include:
        i. Scope 1 emissions: All direct greenhouse gas emissions (CO_2, CH_4, N_2O) from within the farming enterprise. The audit should also include the annual net change in soil and tree carbon on an annual timestep (both positive and negative), but can be based on a genuine 10-year rolling mean.

ii. Scope 2 emissions: This would mainly be electricity purchased from a fossil fuel origin onto the farm. This is included as the farmer now has choice to generate or buy a renewable energy.
iii. Scope 3 emissions: Note that Scope 3 emissions should be included in a carbon neutral product audit, as these emissions are essential to producing that product, but not all Scope 3 emissions are included in carbon neutral property audit, only those that are essential to the management of the property. Scope 3 includes all pre-farm embedded emissions associated with the purchase of products onto the farm e.g. lime, steers, urea, herbicides. Some selected post-farm emissions are also included "where these are deemed to be under the control of the farmer's choice".

Tools

Greenhouse gas emissions

For the farm-based greenhouse gas emissions audit, we would recommend any tool that fully complies with the above protocol e.g. the GAF tools or FarmPrint. However, tools like the Cool Farm Tool are not acceptable as they are not consistent with the Australian National Greenhouse Gas Inventory method.

Soil Carbon

For the purposes of a farm-based carbon audit, soil carbon should ideally be measured *in situ*, using the sampling methodology originally developed under The Soil Carbon Research Program (SCaRP) and prescribed under the ERF (as per the "Standardised metrics for measuring soil carbon" document developed under CN30 Pathways). Soil organic carbon ideally needs to be measured in the top 30 cm (minimum) using the dry combustion method after removal of plant residues and root material carbonates (where present). Wet chemistry methods such as Walkley-Black are discouraged due to the high degree of variability in using this method. New laboratory methods using spectroscopic analysis can be considered if validated against the CSIRO or state department spectral libraries developed from SCaRP. *In situ* spectroscopic analysis are not valid.

Note that a single soil sampling event is insufficient to derive an annual time step change in soil organic carbon and would normally require a minimum of two soil sampling dates at least five years apart.

If soil samples are not available, using a simulation model is potentially acceptable, on condition that this has been validated in the peer reviewed literature for this situation it is being used in e.g. FullCAM, SOCRATES, DayCent, Roth-C, SGS model. These models must be validated to the local soil and farming system, ideally including at least 20 years of *in situ* management history and run using climate data from the Bureau of Meteorology.

Ideally, a combination of measurement and modelling is required to validate the history and trajectory of the change in soil organic carbon over time, with a detailed analysis of the soil profile providing associated chemical and physical properties used in the simulation. In this case, a time series of soil organic carbon analyses from dry combustion could be used if coupled with the above modelling protocol.

Tree Carbon

For the farm tree carbon audit, a very similar approach should be taken to soil sampling, where direct measurement by an accredited auditor, would be the highest standard applied. This can be coupled with modelling using any peer reviewed tree growth model, demonstrated to be applicable to the Australian context e.g. FullCAM, 3PG, with the same validation and the review requirements as per the soil carbon method. Tree carbon audits should contain all carbon pools, including carbon in timber, litter and soils beneath trees.

While the Greenhouse Accounting Framework calculators provide a look up table version of the FullCAM model, it should be clearly noted that this was not to the integrity of having complied with the process above. These lookup tables can only provide a general indicator.

The final calculation

The net carbon position of the farm enterprise or product from the farm is then obviously a summation of the emissions minus the annual change in soil or tree carbon for that annual time-step.

A Carbon account/audit (CA) is the same as Net Emissions (NE = t CO_2e/ business unit) and includes:

- All GHG from boundary of the farm enterprise
- Annual change in soil and tree carbon

The Carbon footprint (CF) of the product or emissions intensity (EI = t CO_2e/t product) uses the same calculation as above, but the dominator is now the unit of product produced. In this case we also include all Scope 3 emissions (pre-farm GHG and some post farm), as these are essential for the product produced.

Note that the denominator for emissions intensity requires further research, as this can be mass, dollars, units of protein, but ultimately may need to be based on Megajoules of energy (photosynthesis and fossil fuels), as this is the key choice the producer has on how to allocate and uitilise this energy for producing a product, plus this energy is the primary driver of their emissions.

Carbon neutrality is then calculated as Net zero t CO_2e/ denominator (being either the business enterprise or the product).