Briefing note: Carbon audits for Irish agriculture

Prepared by: Teagasc Working Group on Greenhouse Gas Emissions

Date: 16 December 2011

Definitions

- **Carbon-footprint**: the amount of greenhouse gas emissions (CO_2, N_2O, CH_4) associated with the production of a specific type of agricultural produce, expressed as kg CO_2-equivalent (CO_2eq) per kg produce (e.g. per kg beef, milk).
- **Carbon-footprinting**: the process of quantifying the carbon-footprint of a specific produce (e.g. beef, milk).
- **Carbon audit**: a formalised process of quantifying the total greenhouse gas emissions of a well-defined entity (e.g. one farm; one processor) for a specific purpose (equivalent to a financial audit).
- **Carbon Calculator**: commonly used generic term for a wide variety of software tools, used for either carbon-footprinting or for carbon audits. The purpose of carbon calculators is to arrive at a figure that approximates the absolute quantity of greenhouse gas emissions from a specific entity.
- **Carbon Navigator**: software advisory tool, developed by Teagasc, that identifies farm-specific management interventions that will reduce the carbon-footprint of the produce of that farm. The Navigator does not quantify *total* greenhouse gas emissions from individual farms, but it does numerically estimate the scale of potential *reductions*.
- **Activity data**: data that quantify the scale of agricultural activities associated with greenhouse gases at a given moment in time. Activity data are expressed as absolute numbers (e.g. number of dairy cows, national fertiliser N usage) and typically change over time.
- **Emission coefficients**: established numbers that quantify the greenhouse gas emissions associated with activity data (see above), and that are expressed as "emissions per activity unit", e.g.: nitrous oxide emissions per kg fertiliser N applied. Generally, the values of emission coefficients do not change over time, unless more accurate/representative values are obtained by new research.

Background

Recent months have seen an acute interest from Irish agri-food stakeholders, in carbon audits for agriculture. External drivers for this interest include the demands, placed by international retailers on Irish processors, to verify and quantify the sustainability credentials of their supply chains. These credentials include the carbon-footprint of Irish produce. Internationally, there has been a rapid development of a variety of approaches and methodologies to quantify the carbon-footprint of agricultural produce. In the UK, the British Standards Institution has developed standards for this purpose. The Joint Research Centre of the EU published a carbon footprinting study of livestock food products of different countries in the EU earlier in 2011 (Leip *et al.*, 2011). The FAO are about to launch a major initiative on benchmarking and monitoring the environmental performance of livestock supply chains which will provide sector-specific guidelines and methods for the life-cycle analysis of greenhouse gases. The Department of Agriculture, Food and the Marine (DAFM) will contribute to the cost of this study and Teagasc will be involved in the work programme. It is likely that such initiatives by intergovernmental bodies like the FAO will set standard methodologies for carbon footprinting of livestock products in the future. It is important that Teagasc has the research capacity to get involved in these initiatives in order to be able to interpret and comment on the outcome of such studies, to ensure that methodologies are suitable to fairly assess Irish farming systems, and to ensure that our efforts in carbon footprinting are compatible with emerging standards.

To date, in Ireland there has been a lack of clarity and coherence amongst agri-food stakeholders with regard to the optimal scale and application of such footprinting methodologies. The purpose of this briefing note is to provide greater clarity on this matter.

This briefing note was prepared by the Teagasc Working Group on Greenhouse Gas Emissions, and builds upon the knowledge and approach published in two earlier publications, i.e.:

1. Irish Agriculture, Greenhouse Gas Emissions and Climate Change: Opportunities, obstacles and proposed solutions. www.teagasc.ie/publications/2011/61/61_ClimateBillSubmission.pdf
2. Teagasc Submission to the Public Consultation on the Potential for Domestic Offsetting of Greenhouse Gas Emissions in Ireland. www.teagasc.ie/publications/2011/62/TeagascSubmissionOnDomesticOffsetting.pdf

The carbon-footprinting of agricultural produce, discussed in this briefing note, is a distinctly different subject from the National Greenhouse Gas Emissions Inventory, which is required under the UNFCCC Kyoto protocol and compiled annually by the Environmental Protection Agency, with input from Teagasc on agricultural activity data (see definitions). (www.epa.ie/whatwedo/climate/emissionsinventoriesandprojections/nationalemissionsinventories/) This briefing note does not relate to the National Greenhouse Gas Emissions Inventory.

Purpose of this document

There are two key-aspects to the aforementioned uncertainty surrounding the approach and methodology for carbon footprinting of Irish produce:

1. uncertainty surrounding the difference between strategies to quantify the carbon footprint ("counting carbon") and strategies to reduce the carbon footprint ("cutting carbon") of agricultural produce;
2. uncertainty regarding the scale at which carbon audits or carbon footprinting methodologies should be applied.

This briefing note aims to provide clarity on both issues.

"Counting carbon" *v.* "cutting carbon"

Strategies to quantify total greenhouse gas emissions are distinctly different from strategies to reduce greenhouse gas emissions, as follows:

- Quantification of greenhouse gas emissions focuses on the measurement of activity data (see definitions) that are associated with agricultural greenhouse gas emissions. The output of the quantification process is a figure that purports to represent the total greenhouse gas emissions from either a specific entity (e.g. a farm, a processor) or from a specific type of produce (e.g. beef, milk). By itself, this quantification process does not lead to reductions in carbon footprints of agricultural produce. However, such estimates can be used (and are required) to monitor and verify changes in carbon footprints of produce over time.

- Strategies to reduce greenhouse gas emissions focus on identifying management interventions (e.g. changes in grassland management, nutrient management, animal husbandry) for individual farms, that are known to result in reduced carbon footprints of farm output. Given the large degree of heterogeneity amongst farms (even within enterprise types) in terms of management strategies and the physical environment, different management interventions may be appropriate for different farms. For example, on one farm there may be scope for improvements in nitrogen management or animal breeding, while the option of introducing farm forestry may be more appropriate on a neighbouring farm. Whilst research (both national and international) has demonstrated that such management interventions will reduce greenhouse gas emissions, the extent and verification of such reductions will require accurate quantification through a process of carbon footprinting.

In summary, strategies are required for both the quantification and the reduction of greenhouse gas emissions. It is important to note that both tasks are highly complex, given the large degree of heterogeneity amongst farms, as well as the diffuse nature of agricultural greenhouse gas emissions. In other words: agricultural emissions are emitted from a large variety of sources (e.g. ruminants, manure, soil, fossil fuel consumption), which vary considerably between farms. This is in stark contrast with industrial greenhouse gas emissions, which result from a single source only (i.e. consumption of fossil fuels / energy) that can be readily quantified in most cases.

Given this complexity, there is a risk that the two strategies (quantifying and reducing agricultural emissions) will compete for financial and human resources, unless they are managed appropriately. Teagasc proposes that the two strategies can be pursued simultaneously, by differentiating the strategies by scale. In practice, this means prioritisation of *reducing* greenhouse gas emissions at individual farm level, followed by *quantification* of greenhouse gas emissions at processor and/or national level. This concept is explored in more detail below.

The issue of scale

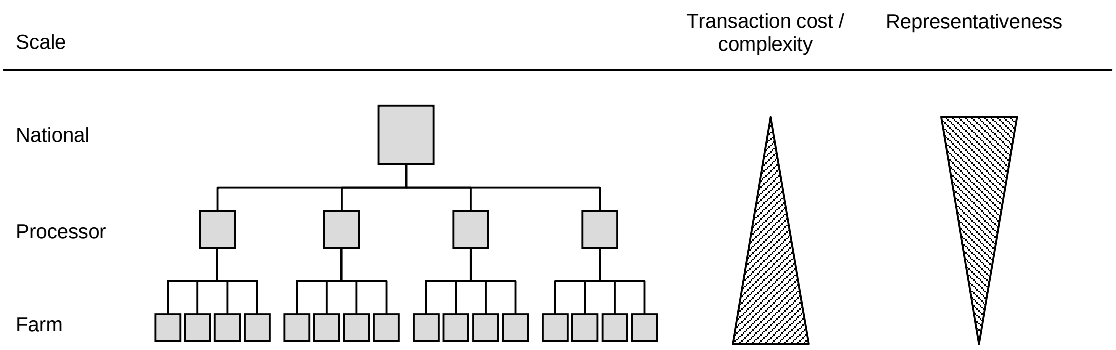

Figure 1: Carbon-footprinting of agricultural produce can be conducted at 3 different scales. The administrative transaction costs and the representativeness of the carbon footprints vary by scale.

Carbon-footprints of agricultural produce can be derived at 1) national scale; 2) processor scale and 3) farm scale (Figure 1).

1. National scale

The national carbon footprint of produce (e.g. milk, beef, etc) represents the national *average* CO_2eq emissions per kg produce. These figures can be derived from activity-data (e.g. animal numbers, N-fertiliser application rates, etc) that are readily available in national databases such as Teagasc's National Farm Survey, and from national (or international) emission coefficients (e.g. percentage of N fertiliser lost as nitrous oxide). Examples of such studies include: Lovett *et al.* (2008), Foley *et al*. (2011), Leip *et al*. (2011) and O'Brien *et al*. (2011a). The marginal administrative transaction costs of these desk studies are relatively low. At the same time, the representativeness of these figures is high. Whilst emissions may vary significantly between individual farms and fields, any variation in activity data is aggregated in the national figures, while farm-specific deviations from the emission coefficients are averaged in the national figures.

2. Processor scale

Processors may wish to establish the carbon-footprint of their own products. Most of the greenhouse gas emissions of the supply chain take place inside the farm gate. The quantification of the average emissions of the produce from the suppliers of each processor does not require detailed carbon-audits – or a carbon census – of all supplier farms. Instead, it can – more efficiently – be established from farm-audits on a statistically representative number of farms. The representativeness of this estimate depends on the degree of heterogeneity among the supplying farms.

If processors choose to establish the average carbon-footprint of their products, then it is essential that all processors follow the same methodology for quantification, so that all footprints are equitably represented. Teagasc – in collaboration with Bord Bia – has developed such a quantification methodology for beef production (Crosson, 2011) and is currently developing an equivalent methodology for dairy production (O'Brien *et al*., 2011b). These quantification methodologies are following the British Life Cycle Analysis standards and will be PAS 2050 accredited (PAS 2050, 2011). For beef production, this methodology was piloted on 200 beef enterprises. For dairy production, this will be achieved by the initial collection of primary farm data from 100 farms that supply Ireland's largest milk processor. Subsequently, this certified model can be employed at national scale to deliver a representative carbon footprint for Irish milk produce, once the sample of farms is extended to give a fully representative picture for the 18,000 dairy farms in Ireland.

3. Farm scale

In theory, it is possible to perform detailed carbon-audits on *all* farms, and to aggregate the footprints of the produce of the individual farms up to processor level or national level. However, there are significant drawbacks to this approach:

- *High administrative transaction costs:* accurate on-farm audits require significant time and human resources, as it depends on the quantification of numerous on-farm parameters. Anecdotal evidence from pilot efforts suggests that the time required for a single on-farm audit may be equivalent to a full year of contact-time with agricultural advisors. Hence, such efforts to quantify or “count” the carbon-footprint are likely to compete with – and reduce the effectiveness of – efforts to reduce or “cut” the carbon-footprint.
- *Low accuracy:* it is technically impossible to directly quantify all on-farm emissions, e.g. carbon-sequestration rates or nitrous oxide emissions. These emissions vary greatly between individual farms/fields as a result of e.g. soil type and management, but can only be measured using long-term monitoring with high-tech equipment in controlled experiments. Therefore, these emissions can only be accounted for by applying “national average emission rates” to individual components of on-farm emissions, which will inevitably lead to significant inaccuracies of emissions at farm level.
- *Issues surrounding equitability/representativeness:* a significant proportion of greenhouse gas emissions are outside the control of the farmer. For example, nitrous oxide emissions depend largely on soil type, while animal husbandry interventions (which determine methane emissions per kg product) may be constrained by the physical farm environment. Therefore, individual farms are subject to different physical constraints in their efforts to reduce their carbon-footprint. As a result, there is a real risk that single carbon-footprint figures of the produce of individual farms are not an equitable reflection of the degree of management/effort that individual farms are employing to reduce the carbon-footprint of their produce, and that – instead – such figures are primarily a reflection of the physical environment in which the farmer is operating.
- *Uncertainty regarding the usefulness:* for dairy produce, it is technically impossible to use the carbon-footprint number of an individual farm as a “label” on dairy food products, as the milk of numerous producers is – by definition – bulked and mixed during transport and processing. Therefore, any such label can only represent the average carbon footprint of the produce of the supplying farms, which may be obtained by footprinting a representative sample of the supplying farms, rather than by a full census. For beef produce, it would – in theory – be possible to use the carbon-footprint number of an individual farm as a “label” on beef products; however, this raises concerns on equitability, discussed in the previous bullet point. Therefore, for beef produce, too, it would be preferable for any labels to represent the average carbon-footprint of the supply chain, which again may be obtained from a representative sample of supplying farms.

The Carbon-Navigator

It is Teagasc’s view that at farm level, the focus and emphasis of farmer-advisor contact should be on *reducing*, rather than counting, the carbon-footprint of agricultural produce. To this effect, Teagasc is developing the Carbon-Navigator; this is an easy-to-use software aid to guide advisors and individual farmers in identifying aspects of farm management that are known to effectively reduce their carbon-footprint of their produce. These are:

- Economic Breeding Index
- Grazing season length
- Nitrogen management
- Slurry management and storage
- Energy consumption

It evaluates the performance of each of these management aspects against the performance of the top 10-percentile of similar farm enterprises in similar areas / physical environments, and allows farmers to set their own future targets. A pilot roll-out of the Carbon-Navigator for dairy enterprises is planned for 2012, to be followed by roll-outs of equivalent Navigators for beef, sheep and tillage enterprises.

At processor level and national level, the effectiveness of these changes in management can be captured and quantified by on-farm audits on a statistically representative sample number of farms (see above).

Conclusions

1. Teagasc recommends that, if it is desired to quantify carbon footprint for a given farm population (e.g. national or processor level), that the best approach would be to employ a suitably chosen representative sample of suppliers for that population. This approach would be preferable to an alternative of conducting a carbon footprint census of all supplying farms.
2. At farm level, Teagasc recommends that the emphasis should be on communicating to farmers the adoption of management practices that will lead to a reduction in the carbon footprint of their farms. As well as focusing on the reduction of emissions, this approach should also lead to a marketing dividend in that the existence of this programme could be used by processors as a marketing aid in the selling of produce from their raw material suppliers.

References

Crosson, P. (2011). Whole farm systems modelling of greenhouse gas emissions from livestock production systems. *Proceedings of the XIX Congress of the Animal Science and Production Association (A.S.P.A.)*, Cremona, Italy, 7-10 June 2011, p.43.

Leip, A., Weiss, F., Wassenaar, T., Perez, I., Fellmann, T., Loudjani, P., Tubiello, F., Grandgirard, D., Monni, S., Biala, K. (2010): *Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS) – final report.* European Commission, Joint Research Centre, 323 pp.

Foley, P.A., Crosson, P., Lovett, D.K., Boland, T.M., O'Mara, F.P. and Kenny, D.A. (2011). Whole-farm systems modelling of greenhouse gas emissions from pastoral suckler beef cow production systems. *Agriculture, Ecosystems and the Environment* **142**, 222-230.

Lovett, D.K., Shalloo, L., Dillon, P., O'Mara, F.P. (2008). Greenhouse gas emissions from pastoral based dairying systems: The effect of uncertainty and management change under two contrasting production systems. *Livestock Science* **116**, 260-274.

O'Brien, D., Shalloo, L. (2011a). *Greenhouse gas emissions from dairy systems. Irish Dairying Planning for 2015 (Moorepark Open Day 2011)*. Teagasc IE pp. 120-122.

O'Brien, D., Shalloo, L., Buckley, F., Horan, B., Grainger, C., Wallace, M. (2011b). The effect of methodology on estimates of greenhouse gas emissions from grass-based dairy systems. *Agriculture, Ecosystems & Environment* **141**, 39-48.

PAS 2050 (2011). *Specification for the assessment of the life cycle greenhouse gas emissions of goods and services*. British Standards Institution. Retrieved from http://www.bsigroup.com/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050