Reducing on-farm emissions: successful farmer engagement by understanding the impact on productivity and profitability

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Abstract. The 'Tas Farming Futures' project is helping Tasmanian landholders across all farming sectors to reduce greenhouse gas emissions from their farming business. The project is part of the wider Carbon Farming Futures Extension and Outreach program funded by the Australian Government. A farm Emissions Reduction Planning approach (ERP) was developed which considers emissions from the whole farming system and recommends emission reduction strategies to suit individual farmers' specific circumstances. Reducing emissions intensity - measured as tonnes of carbon dioxide equivalent (tCO_2e) per unit of product - is strongly related to increases in resource use efficiency, productivity and profitability. Emissions intensity provides a useful benchmark for farmers to compare emissions with other similar farms in their region. Once landholders understand (in the context of their business) the impact that potential changes can have on emissions as well as production and profits, they become interested and engaged in emission reduction opportunities.

Keywords: Greenhouse gas (GHG), emissions, emissions intensity, engagement, profitability, productivity.

Introduction

'Tas Farming Futures' is a three-year (2012/13 to 2015/16) extension project working with agricultural industries in Tasmania. The main objective of the project is enabling Tasmanian farmers to undertake actions that will reduce greenhouse gas (GHG) emissions and/or participate in the Emissions Reduction Fund (ERF). The project is part of the wider Carbon Farming Futures Extension and Outreach program funded by the Australian Government.

A baseline survey of 29 farmers was undertaken to assess farmer knowledge and attitudes to carbon farming. Farmers felt that they had good knowledge of the main sources of emissions from their farming operations. However they rated themselves lower for knowledge of the extent of emissions from their farms and how to reduce them. This highlighted an opportunity for the project to work together with farmers to understand the emissions profile for their farms and ways to reduce emissions. In response to this information we developed a farm planning approach which aimed to increase knowledge and understanding, and which would also support practice change.

Emission Reduction Plans

The farm Emissions Reduction Planning (ERP) process was developed as an approach to engage farmers in emissions reduction planning as part of their 'business as usual' property management planning (PMP). A farm planning approach means that emissions reduction activities and considerations can be embedded into existing tools and farm decision making, rather than being considered separately. A guideline for developing ERPs was developed that is available so that consultants and farm advisors can use the approach beyond the life of the current project.

The first step for each farm plan includes an estimate of GHG emissions using the most appropriate calculator for the enterprise(s) on the farm, such as the University of Melbourne calculators (available at Greenhouse Accounting Frameworks. http://www.greenhouse.unimelb.edu.au/Tools.htm). It was found that although farmers at the start of the process were often sceptical about the usefulness of the GHG estimate, they found it informative once they viewed the data in the context of their own farm. The calculations highlighted where most of the emissions sources were e.g. enteric methane for livestock producers or diesel fuel and electricity for fruit growers. This calculation then provided a solid basis for further discussion and highlighted where efforts should be focussed to increase efficiency and profitability.

The ERP process was designed so that it could stand alone or be added to existing PMPs. Table 1 provides an overview of the suggested ERP approach.

Table 1. An overview of the ERP approach

Step	Main tasks
Pre visit	• Before the farm visit, explain the process of preparing an ERP, provide a list of data requirements so that farmers can consider the main topics and start collecting the data. • Confirm enterprise types to enable selection of most appropriate GHG calculator prior to farm visit.
Initial farm visit	• Clarify business goals and expectations for ERP process e.g. what do they want to get out of it? • Confirm existing farm plans and / or maps • Gather general farm data and information relating to ERP • Identify topics / questions relevant to individual farm (use checklist) • Provide general information (e.g. fact sheets) as appropriate • Obtain soil test results if relevant (carbon and/or nitrogen) • Obtain data for calculators Obtain data on production (e.g. total yields) to allow calculation of emissions intensity. • Farm walk, if relevant (NB this might include assessment of soils (using soil kits including labile carbon test), pastures or crops). • Undertake feed samples for testing, if relevant • Undertake soil sampling for analysis, if relevant.
Calculate GHG emissions	• Calculate GHG emissions using most appropriate GHG calculator (a range of calculators are available at the University of Melbourne website: http://www.greenhouse.unimelb.edu.au/Tools.htm) • Calculate emissions intensity.
Other calculations	• Undertake other calculations as appropriate/relevant: ○ Nitrogen use efficiency (NUE%) ○ Soil carbon (analysis of historical soil test data) ○ Black Magic[a] (to model changes in soil carbon based on different crops and management) ○ Livestock feed protein and energy balance ○ Energy efficiency ○ Pump efficiency.
Draft report	• Desktop research if required (e.g. industry benchmarks for GHG emissions or crop NUE; investigating carbon offset options) • Farm maps could be included (optional) • Prepare draft report.
Second farm visit to review report and support action planning	• Review GHG and other calculations and present draft report to farmer • If relevant, suggest that the farmer invites their agronomist or field officer to this visit to discuss findings • Support the farmer to develop their own action plan • Cross-check actions with existing PMPs and/or Farm Water Access Plans[b] (FWAPs), if relevant • Discuss how the ERP fits with information provided in existing plans (e.g. nutrient management, soil tillage, tree planting etc.) • Climate adaptation can also be discussed including longer term issues such as potential changes in pest and disease pressure; and in the medium-long term, farm planning to reduce risks e.g. if moving crops upslope what is the effect on energy use.
Finalise report and action plan	• Incorporate feedback from farmer and their advisor (if applicable) and present final report.
Group extension (optional)	• Prepare case studies, articles, field days, guest speakers, workshops, and/or discussion groups.
Annual review	• Re-visit annually to: ○ Review progress against the plan ○ Recalculate GHG emissions, NUE% and other calculations if appropriate ○ Revise action plan.

[a] Black Magic was developed by the Tasmanian Institute of Agriculture and is designed to model changes in soil carbon under different crop rotations and management strategies. The model is very useful as an extension tool, because the data inputs are straightforward and the outputs can be used to compare different scenarios and to demonstrate the benefits of stubble retention, green manures and pasture. See Cotching (2014) for more information.

[b] An FWAP is required for the area of land on a property that receives water from any Tasmanian Irrigation scheme. The FWAPs identify risks and outline actions required to manage and monitor risks e.g. soil structure.

GHG calculators and emissions intensity as an engagement tool

The effectiveness of GHG calculators as an engagement tool is generally reliant on the link between improving productivity and reducing emissions. Whilst there is some interest in calculating emissions for personal knowledge or reducing emissions specifically, in practice the 'hook' for farmers is being able to understand the link between their farm's emissions and improvements in management practices that also improve productivity and returns.

We find that calculating emissions intensity provides an extra incentive for producers to engage with the project as it allows for comparison with other producers. Emissions intensity is the emissions in tonnes of CO_2e per tonne of product or another unit such as per hectare or per dry sheep equivalent (DSE) for livestock enterprises. Emissions intensity provides a useful benchmark for comparing efficiency with industry averages. It is particularly useful when engaging farmers within a discussion group setting and for monitoring farm emissions over time.

Increased productivity will almost always reduce emissions intensity. For example, increased weaning percentage will result in fewer emissions per unit of meat produced. Improved pasture productivity can reduce emissions intensity through shorter finishing times. If increased productivity means that more livestock can be carried (i.e. a larger flock or herd size), although the emissions intensity will be reduced the total farm emissions will most likely increase due to the larger number of livestock.

To enable calculation of emissions intensity, information should be obtained on total farm production e.g. tonnes of meat or fruit, stocking rate. Calculating emissions intensity and benchmarking emission intensity can be more challenging with mixed enterprises e.g. livestock and cropping. Sometimes emissions per hectare or per DSE are more appropriate or easier to calculate.

Property Management Planning example

In 2014, emissions reduction was incorporated into Cradle Coast Natural Resource Management's 'Beef Property Management Planning' program. Ten producers were involved in the program, with nine electing to undertake a GHG calculation through the 'Tas Farming Futures' project. The project staff provided producers with a GHG estimate for their individual farms and producers developed their own emissions reduction actions at a group workshop run by the project. Emissions per hectare varied widely for the group, from 0.4 to 6.9 tCO_2e/ha (the average was 3.0 tCO_2e/ha). The anonymous benchmarking data created the basis for discussion around the strategies that were presented (e.g. steer finishing times), an explanation of the differences between management strategies and what could be done on their farm to reduce emissions. This group benchmarking format worked well as it allowed discussion around the practicalities of reducing emissions and as a group producers developed ideas that would work for each of their own properties.

The political nature of GHG emissions reduction promotes a sense of scepticism among some producers. In this group, for example, one producer held a strong belief that the calculation was going to be used to blame farmers for Australia's emissions. Once the purpose of the project and process was explained, the production link was enough to convince the farmer of the practical purpose of the calculation.

GHG calculators also provide a tool for assessing different scenarios. The calculator outputs were used with this group to explain the link between emissions and productivity and also the link between net emissions and emissions intensity.

Tailoring outputs for farmers

The relevance of reducing GHG emissions often goes unnoticed by producers up until the point where broad industry-wide general information is distilled into farm-specific tangible actions. Completing a GHG calculation or other calculations at the individual farm level provides the basis to further develop these strategies. It indicates how the farm is performing compared to similar farms and the scope for improvement relevant to their management practices and day-to-day running of the farm.

Livestock example

Based on the GHG calculations undertaken through the project to date, methane (CH_4) generally accounts for up to 70% of the total emissions from Tasmanian livestock enterprises, nitrous oxide (N_2O) contributes around 30% of the total emissions and carbon dioxide (CO_2) emissions are very minor (due to the use of hydroelectricity). Upon receiving an emissions report for their farm, livestock producers naturally focus on CH_4 as it is the biggest piece of the 'pie' out of all sources of GHG emissions for their farm. From there, the focus can be tailored to feed or animal management, according to the farmer's interest or where the largest gains can be made on the individual property.

One of the initial ERPs we developed was for a mixed farm with a merino flock, grazing dryland pasture with high legume content and little nitrogen (N) fertiliser use. The emissions profile indicated 72% CH_4 and 28% N_2O. The farmer had little interest in reducing N_2O emissions from pasture and excreta because he felt that the N from legumes was driving pasture production. Due to the merino flock's low weaning rate (85%), the producer decided to focus on changing the genetics of the flock to increase reproductive efficiency and reduce emissions intensity for meat production. Another recommendation was to change the pasture legume base to a legume with condensed tannins (CT) to reduce both CH_4 and N_2O emissions. CT legumes (e.g. birdsfoot trefoil, Serradella, Sulla) have been shown to improve sheep and cattle performance by minimising CH_4 energy losses and protecting protein from degradation in the rumen (James & Hall 2014).

One year after developing the ERP, the farmer is now halfway through changing the sheep flock genetics by purchasing replacement ewes. This is expected to increase total emissions from the flock due to heavier sheep and more lambs, but should provide a substantial reduction in emissions intensity for the meat produced. In the final year of the project the emissions estimate will be recalculated for this property to compare with the baseline GHG calculation.

Vegetable industry example

It is very difficult to estimate farm N_2O emissions from fertilsers used in cropping, so a Nitrogen Use Efficiency (NUE) calculator was developed by the project team. It uses straight-forward, easily recalled data inputs i.e. crop yield, N fertiliser rates and products. This tool provides an indication of overall NUE which can be an indicator of potential N_2O emissions i.e. one potential loss pathway. The NUE calculator uses a 'partial nutrient balance' also known as a 'removal to use ratio' approach. It calculates NUE% based on the ratio of N applied in fertiliser and N removed with produce.

Although the calculator does not include N inputs from sources other than fertiliser, for example legumes, or losses such as leaching, it provides relatable results for the producer – losses and other inputs are still discussed with producers. The tool allows for the cost of the fertiliser to be included, which is used to estimate a dollar value for the potentially unused N fertiliser. It is this monetary loss value that offers a significant 'hook' for producers as often they have not considered N use from this perspective.

Participating producers identify that they undertake NUE calculations (as part of this project) for two reasons: either to establish whether or not they are efficiently using N fertiliser or, to validate their N fertiliser management practices to confirm if they are more efficient than industry averages. In the following example, NUE was calculated for 49 potato crops for Simplot Australia Limited for the 2013/14 season. The NUE% results ranged from 57% to >100%.

The range of results demonstrates the diversity of management practices implemented on each of the farms. In many cases the company field officer was able to pin point which practice required attention (e.g. timing of N fertiliser application, soil structure, or crop rotation). During a presentation for the field staff it was noted that the NUE calculator could be used as part of their annual review with farmers, in particular as encouragement of practices that could improve NUE and potentially save money. This included for example, potential improvements in monitoring and using soil N testing for making fertiliser decisions.

Sharing emissions reduction options with a wider audience

Case studies, field days and news articles have been used in addition to ERPs to help disseminate messages about GHG emissions reduction with a wider farming audience. The use of case studies has worked well in the Coal Valley region of Southern Tasmania which has a diverse enterprise mix. The local Coal River Products Association (CRPA), a membership organisation representing local agricultural producers, have identified a desire to understand how emissions reduction activities can be implemented across the different enterprise types represented by their members.

Five case study farms were identified by the CRPA and these were taken through the initial steps in the ERP process, including a farm visit and interview, GHG calculation and discussion of GHG emission reduction activities in line with their individual farm results. Rather than write the information in an ERP report, a case study was prepared highlighting the findings of the GHG calculation and the steps the farmer is taking (or intends to take) to reduce emissions, relevant to the particular enterprise type. The case studies include mixed cropping and livestock, prime lamb, cherry and apricots and vineyard enterprises.

Focused field days have also been held in the region highlighting aspects of two of the case studies relating to NUE and soil health and on efficient livestock production to reduce CH_4 and N_2O emissions.

Economics

Most of the farmers engaged throughout the project so far, have been able to identify opportunities to reduce their farm emissions and increase productivity. Changes can often be implemented with small up-front costs and the anticipated benefits can be received relatively quickly. This is in contrast to some natural resource management actions, such as tree plantings, that can require large up-front costs and long delays before any benefits are realised i.e. a long pay-back period.

Where GHG emissions and productivity are strongly linked there are opportunities for farmers to reduce emissions in quick and cost effective ways. With livestock, inexpensive husbandry improvements can increase reproductive rates within a year, bringing a reduction in emissions intensity with an increase in productivity and saleable stock. When re-sowing pastures, if CT legumes can be included, there is a modest up-front cost. However there can be a reduction in both CH_4 and N_2O emissions while improving liveweight gain, fecundity, N cycling and parasite resistance. This is associated with economic benefits in the short term.

NUE in cropping is another example of almost immediate financial benefits from reducing emissions. For example the small up-front cost of a soil N test can be paid back many times over by reducing N fertiliser costs – and therefore reducing N_2O emissions from fertiliser. Savings from improved fertiliser management can be substantial if crops are currently over fertilised or if yield is limited by factors other than N.

Conclusions and lessons learned for engaging farmers in GHG emissions reduction

GHG emissions reduction is a complex issue and one that is further clouded by scepticism relating to political uncertainty or public perceptions relating to climate change. The 'Tas Farming Futures' project has overcome these issues by increasing producer and industry understanding of the link between emissions reduction and productivity, and ultimately that it is 'good for business and the environment'. The project has done this by highlighting the links between emissions and farm productivity, efficiency and economic benefits.

The use of existing industry tools (including GHG calculators and calculations of emissions intensity) and those developed by the project (e.g. NUE calculator and the ERP process) has enabled the project team to deliver specific and targeted farm information that has engaged the Tasmanian farming community in the process of reducing GHG emissions. In developing a flexible ERP process, extension officers have been able to tailor the project outputs to the needs and interests of the participating farmers and leave behind a legacy process that can be applied by others beyond the life of the project.

Evaluation at the end of the project will assess the overall change in awareness, knowledge and understanding as well as on-farm changes implemented, or intention to do so. GHG emissions estimates will be re-calculated to assess changes in farm business GHG emissions.

Lessons learned for engaging farmers in GHG emissions reduction include:

- Provide a clear and succinct description of the process for developing an ERP. Participating farmers should be provided with clear explanations of the process used to develop an ERP, but caution should be exercised to not 'overwhelm' them with too much information up front e.g. long lists of data required.
- Engage all parties involved in the running of the business in the initial conversations about the ERP process, what is involved and how the information will be used. This can be particularly important for obtaining data from the person who looks after record keeping.
- During the initial site visit it is important to gain a good understanding of the business to ensure that the most suitable calculator(s) is used. One of the main challenges of completing a calculation is obtaining all the necessary data.
- Data collection for GHG calculations can be hampered by:
    - The time it takes to gather all the information if record keeping practices are not adequate or if the required information is stored in multiple locations; and/or
    - A lack of data. For example the majority of livestock producers do not undergo feed testing and therefore crude protein and dry matter digestibility data is often missing.

- Provide producers with a summarised list of data requirements prior to the site visit. Data can also be collected through general discussions with the farmer, which has proven an effective means to overcome some of the challenges of collecting data.
- Distinguish between which data can be estimated or averages used and which data needs to be provided by the farmer, this helps to avoid them feeling overwhelmed by the data collection process. In many cases, data required can be obtained through conversation during the interview process as some data can be easily recalled by farmers e.g. annual rainfall, soil types, stock feed and cropping rotations. In addition, some data can be extrapolated from other information e.g. asking about calving dates or the time that stock is normally sold, can help with estimating the livestock numbers for each season / month.
- Completing a site visit has proven more effective at gaining data than relying on emails and phone calls.
- Where possible engage farmers in developing their own emissions reduction actions to ensure that they are relevant and so the farmer has 'ownership' of the actions.
- Discussion groups can be used in the ERP process. Emissions reduction planning in a discussion group setting has been found to be effective in helping farmers to discuss and weigh up emission reduction options.
- Benchmarking of GHG emissions is a useful learning tool. Discussion groups give an added element of enabling farmers to benchmark their GHG emissions and emissions intensity figures with other farmers.
- The ERP process can be adapted to produce case studies and articles to enable sharing of information with a wider audience. This enables these farmers to be seen as 'champions' and early adopters of emissions reduction opportunities to inspire and encourage others to learn from their examples.

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