USE OF FARM RECORDS AT SCALE FOR EMISSIONS MONITORING AND EFFICIENCY IMPROVEMENT

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Abstract

Over 70% of food-related greenhouse gas emissions globally, are due to agricultural practices. An increasing number of food companies have set ambitious climate targets that include scope 3 or value chain emissions that reach farm levels. These are increasingly matched by equivalent targets in financed emissions from banking and insurance industries, as well as government and inter-government commitments.

At the same time, farmers operate within thin, and at times negative, profit margins. Accounting for sustainability and making prioritisation decisions for practice change becomes difficult. Farmers' ability to prioritise substantial time and expenditure to measurement, compliance, and the availability of advice for practice change is limited. The scale of the challenge is substantial, with tens of thousands of farms needing to prepare emissions baselines and mitigation plans, potentially for multiple stakeholders. Assistance from advisors and specialists will need to be focused on genuine value-add rather than collation of data.

Systematic use of farm-level activity data from existing systems and tools of record, offers farmers, and finance and food companies, a scalable and efficient way to collate the information required by emissions calculators. However, it is vitally important that these data are standardised and validated to ensure overall accuracy. It can also provide a sufficient level of detail to enable informed discussion of options between farmers and their advisors. Validation and standardisation must ensure that activity data which may be compiled from a variety of sources is coherent and sufficiently representative of the farming system being modelled.

Introduction

Food companies have increasingly needed to set climate targets that include scope 3 or value chain GHG emissions that reach farm levels, and these are increasingly matched by equivalent targets in financed emissions from banking and facilitation, as well as government and inter-government commitments.

Food, fibre, and finance organisations are responding to the expectations of legislative and market disclosure requirements by building a detailed understanding of their GHG emissions profiles, including those from their farming supply chains. In many cases, this translates into a need to understand emissions at the farm-level, including the most material drivers of those emissions, and monitoring how they change over time as farmers use practice, technology, and systems change to reduce emissions.

Organisations seeking to understand their emissions profile have typically undertaken a variety of approaches. Some approaches result in "averaging" where efficient farmers are penalised through being assigned higher values (e.g. fertiliser application rate), not representative of their own farming practise. Other approaches bring increased precision but can be difficult to scale. It is often overlooked that the results generated in an emissions calculation do not provide the answer to emissions reductions as it is simply an output calculation. To understand the ability to reduce emissions and its limits, the primary activity data must be interrogated. We present an approach driven by farm-scale activity data from existing systems and discuss the benefits and challenges of this approach.

Typical approaches

Many food and finance organisations are still in the early stages of understanding the farm-level emissions that they will need to report and are experimenting with different ways to obtain this information. Broadly, variations on the following approaches have been used:

- *Using industry averages*, typically sourced from levy bodies or industry associations. In turn, these averages have often been sourced from modelling indicator farm types. This approach is inexpensive and a sensible starting point for understanding baselines and materiality but is likely to be insufficiently accurate over time and lacks any leverage to support on-farm change. Additionally, this method does not account for the variability of GHG emissions between farms with similar practises, making comparisons difficult and emissions reductions strategies impossible to implement and measure the impact.
- *Contracting farm visits* from assessors or farm advisors. Such visits can provide substantial depth of insight to both the food or finance organisation, and the farmers who receive visits and advice. This approach may struggle to scale to value chains with thousands or tens of thousands of contributing farms, or to be economically reproduceable to track change over time. Our experience also shows that the accuracy and consistency of data collected can be variable.
- *Deploying farm software* (farm management information systems: FMIS) which enables recording of key inventory categories and activities that are material to emissions, and which also support other traceability aspects of the farm system. This is a robust approach, but it can be hard for value chains to mandate a particular farm management tool and support farmers to use it.
- *Using a survey or calculator*, with farmers doing their own input and seeing the results. This has the benefit of every producer "knowing their number" (AgMatters, 2023). Surveys and calculators are often limited by the need to balance user-friendliness and

data collection time with accuracy (Colomb, et al., 2012). Data inputs may be aligned with "best recollection" or constrained by ease of entry, rather than reflecting the reality of farm activities. A further reality is that "knowing the number" does not provide enough of an impetus to change. We need farmers to understand the context of why the number is what it is and what to do about it. That comes from analysis of primary activity data and development or KPIs that drive efficiency and emissions reductions.

Food and finance organisations that wish to recognise mitigation actions undertaken by farmers (or to support system change by discussing abatement options) inevitably have to move beyond averages or simple stock methods to farm-specific models. Indeed, this is a strength of more sophisticated model-based methods (Interim Climate Change Committee, 2019). At the same time, these organisations seek verification of sustainability claims (Gluckman, 2018). Simple farmer entry into calculators would need additional supporting data to support verification and transparency.

We propose an approach that combines scalable collection of data from farm software products and third-party sources (input suppliers, processors, and regulatory systems) that can be used to populate calculators or models, and which also supports verification by reference to original records.

Case study

Morrisons supermarket, the United Kingdom supermarket business, engaged with Map of Ag and Harper Adams University's School of Sustainable Food and Farming to help it collect data and insights that would support its supplying farms on their journey to reduced GHG emissions. Working with more than 2,700 farmers, Morrisons is British farming's biggest direct supermarket customer.

Map of Ag helped Morrisons use data to engage with farmers and calculate emissions profiles over a four-year period. Wherever possible, Map of Ag used automated processes to source farm-level data from automated sources that minimised data entry workload for farmers and improves accuracy and consistency of the data. This included animal inventory and movement records, production records, and increasingly, feed records.

Farmers reviewed the data and augmented it with information that could not be sourced from automated feeds. Baseline GHG emissions data, farm key performance indicators (KPIs), and group benchmarks were provided to farmers, and advisor engagement helped farmers to understand the material drivers of emissions and consider abatement options.

The programme used a range of calculation options, including AgRE Calc (SRUC, 2014) (Sykes, 2019) and Cool Farm Tool (Hillier, et al., 2011) and developed bespoke measurement approaches for beef and lamb so that the improved activity data could be used to its full potential. This was necessary to support the variety of farming value chains, which included beef, pork, eggs, lamb, soft fruit, and root vegetables.

Farmers in the programme provided feedback that the administrative workload of data collection was lower than they had expected, and they appreciated the understanding of their baselines and the options for reducing emissions. KPI dashboards have been particularly useful in identifying emissions reduction opportunities. Some farmers in the programme achieved substantial reduction in emissions, through farm systems changes that delivered greater efficiency in feed utilisation, reduction in nitrogen inputs and brought in feed, and genetic and reproductive system improvements.

Challenges and opportunities

Data connectivity challenges

Data connectivity platforms (such as Map of Ag's Pure Farming platform or international alternatives) or Monitoring Reporting and Verification (MRV) platforms may still experience challenges in accessing data from some sources.

FMIS solutions are frequently willing to make data available where permission has been granted by individual farmer subscribers. Inevitably an investment is required to provide data in an exportable format. This investment may be small (if the data connectivity platform can manage authorisation and take data in whatever form it is available) or significant (if the FMIS solution must implement authorisation and delegation of access and produce data in specific formats).

Concerns for FMIS vendors can be mitigated if they can levy an additional charge on their farmer subscribers or the value chain end users of data, as a means of covering their additional investment costs.

Technology vendors (FMIS vendors, data connectivity platforms, and MRV tools) have often found it difficult to engage with larger farm input suppliers and processors. Such organisations may have a curation role for data which they hold about farms, and this is reinforced where the input supplier or processor is farmer-owned or a cooperative. Data access concerns in these cases may go beyond the required investment in data integration infrastructure, and include questions of scale and focus, standardisation data protection and privacy.

Increasingly, technology vendors are complying with agricultural industry codes of practice such as the Australian National Farmers Federation (NFF) Farm Data Code (NFF, 2023) or the British Farm Data Council Farm Data Principles (Farm Data Principles Ltd, 2024). In combination with contractual measures for data protection and confidentiality, this should address concerns that input suppliers and processors may have about data supply.

Data quality challenges

Obtaining data from source will address some of the issues that surveys and calculators typically experience with data quality and validation. Nevertheless, opportunity for improvement remains.

In our experience, the quality of raw data captured via FMIS can vary, impacted by the level of data validation carried out by the FMIS products (for instance, validation of product and medicine names), the purpose for which farmers are recording data, as well as the formatting of data input (e.g. dropdown list versus free text). Informal observation indicates that data quality and internal completeness may be higher where recording provides direct value to farmers – often through decision support – rather than purely for compliance. Examples included feed recording for the purposes of ration formulation and improved animal performance, or accurate recording of agrichemical applications to manage withholding periods.

In contrast, data sets managed by third parties such as fertiliser purchases, milk statement and carcass kill sheet data have greater reliability. Input suppliers and processors typically have systems set up for accurate data capture, and any variances are likely to be disputed and promptly corrected.

Missing data is more difficult to address through automated data capture. In New Zealand, mandatory movement status declarations for sheep are only required at the time when mobs are moved between locations, and individual identification is not required. In Australia, beef cattle are individually identified, but formal records are only required when animals move between properties. For some farms, this first record of an animal's existence may only occur at the end of an animal's lifetime. Audited records such as financial accounts, and information captured through farm audit programmes, may fill these gaps or at least identify where further data is needed.

One approach to dealing with data quality challenges has been to provide pre-filled data back for review by farmers, allowing them to identify errors and fill gaps. This may also be achieved by coordination with FMIS products or calculators.

We have also made use of algorithmic data validation rules. These identify outliers in farm-level KPIs such as per-animal or per-hectare production, nitrogen applications, and feed use. Future research could incorporate machine learning approaches to further automate data validation, as this approach has been effective for data validation in other domains (Redyuk, Kaoudi, Markl, & Schelter, 2021).

Opportunities for farmers

Using connected farm-level data from FMIS and third-party systems brings several benefits for farmers. Some of these apply specifically to emissions, while others are more general.

A key benefit for farmers is the potential to use detailed, farm-scale data in emissions calculations. This provides opportunities for farmers to evaluate efficiencies and systems approaches in their own farming practices. Where value chain rewards recognise efficiency gains, farmers can also benefit from financial recognition.

As the number of farms involved in value chain emissions analysis grows, participating farmers benefit from benchmarking, and potentially from further insights based on the gains or experience of other farmers.

At the same time, farmers involved with the case study made the point that the amount of time and effort required to gain detailed insights into their emissions profile was much less than expected – primarily because they did not have to collect and re-enter information.

Opportunities for rural professionals

Data connectivity and automation of data compilation does not reduce opportunities for rural professionals. For professionals able to embrace new ways of working, automation of data collection may deliver greater business efficiency, with less time spent collecting and entering data, and more time spent on activities and conversations that add value to farmers and growers.

In addition to reducing the time spent on data collection, richer data sets may offer rural practices the opportunity to deliver greater insights to farmers. Traditional models, while valuable, have operated on simpler inputs that can be collected from conversations with famers. A new generation of data analyses and predictive models may support a new level of insight from more complex data relationships.

Through better data insights, advisory activities can be targeted and farm specific. Importantly, the role for advisors and rural professionals grows from data collection and analysis, to making recommendations and supporting farm teams as they undertake systems changes.

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References

AgMatters. (2023, 05 31). *AgMatters - Know your number*. (N. Z. Centre, Producer) Retrieved March 2024, from https://www.agmatters.nz/goals/know-your-number/

Colomb, V., Bernoux, M., Bockel, L., Chotte, J., Martin, S., Martin-Phipps, C., . . . Touchemoulin, O. (2012). *Review of GHG Calculators in agriculture and forestry sectors: A guideline for appropriate choice and use of landscape based tools.* ADME (Agence de l'Environnement et de la Maîtrise de l'Energie). Retrieved from https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=a9e3ccc21114acc3173294e3e95a5efe8b2624b0

Farm Data Principles Ltd. (2024, 02 01). Retrieved March 2024, from Farm Data Principles: https://farmdataprinciples.com/

Gluckman, P. (2018). *Mitigating agricultural greenhouse gas emissions: Strategies for meeting New Zealand's goals.* Office of the Prime Minister's Chief Science Advisor.

Hillier, J., Walter, C., Malin, D., Garcia-Suarez, T., Mila-i-Canals, L., & Smith, P. (2011, 09). A farm-focused calculator for emissions from crop and livestock production. *Environmental Modelling & Software*, 1070-1078.

Interim Climate Change Committee. (2019). *Action on Agricultural Emissions.* Climate Change Commission, New Zealand Government.

NFF. (2023). *Australian Farm Data Code.* National Farmers' Federation. Retrieved from https://nff.org.au/programs/australian-farm-data-code/

Redyuk, S., Kaoudi, Z., Markl, V., & Schelter, S. (2021). Automating Data Quality Validation for Dynamic Data Ingestion. *Proceedings of the 24th International Conference on Extending Database Technology (EDBT).* Retrieved from https://sergred.github.io/files/edbt.reds.pdf

SRUC. (2014). *Farming for a Better Climate Report.* SRUC. Retrieved (No longer available online), from http://www.sruc.ac.uk/info/120200/climate_change_focus_farms

Sykes, A. (2019). *Developing an environmental calculator for application in the beef industry.* The University of Edinborough. Edinborough Research Archive. Retrieved from http://hdl.handle.net/1842/35537