Is 'Farmeromics' the missing omic?

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Abstract

Many publications requiring access to large datasets from commercial conditions, such as dairy genetics, note challenges with access to and quantity of data. Challenges include insufficient records and inconsistent trait definitions. This could be improved through developing closer relationships between farmers and researchers. In the same way that scientists innovate to develop the fields of genomics, phenomics, metabolomics, etc., can we advance our research by developing 'farmeromics' – defined as the study of farmer-driven, biological data recording, at scale? The purpose of this investigation was to compile examples of research studies that involved farmers in their co-design, including the calf vitality project, Feeding the Genes and ImProving Herds These examples could spark discussion on ways to strengthen collaboration between farmers, scientists and stakeholders to reach shared data-gathering objectives.

Key words: Co-design, farmer engagement, phenotyping, farmeromics

Introduction

It is likely that a reader of this Bulletin will intuitively recognize the importance of phenotypic data to drive genetic gain in dairy cattle and will easily recall Professor Mike Coffey's famous phrase, 'in the age of the genotype, phenotype is king' (Coffey, 2020). Yet, data availability remains a stumbling block in many research activities. Once example of this is calf health. For instance, in 2022, 1 in 5 Australian dairy herds systematically recorded calving traits (Axford et al., 2023). This low participation rate is inconsistent with trait preference data suggesting that farmers value calving ease similarly to mastitis, type traits and temperament - traits that are so essential that they are often included in national breeding indices (Axford et al., 2025a). Similarly, in Canada, up to 15% of farms had accessible calf health records (Hyland, 2022) suggesting that the problem isn't isolated to a particular country.

It's no surprise, then, that publications on the genetics of dairy health traits often include commentary on data-related challenges. Authors frequently cite under-reporting, inconsistent trait definitions, and a lack of standardization (Cuttance & Laven, 2019; Lombard et al., 2019; Lynch et al., 2024). Additional concerns include non-digitised storage and inaccessible data sources (Edwards et al., 2024). These issues are so widespread that they are frequently cited, yet solutions remain elusive. Proposing meaningful solutions remains far more difficult.

This raises an important question. What role can researchers play in getting closer to the source of the data - the farm and the farmer? Just as scientists have pioneered the fields of genomics, phenomics, metabolomics, etc., can we advance our research by developing 'farmeromics' – the study of farmer-driven, biological data recording, at scale? Encouragingly, both farmers and scientists have a strong history of driving change. Involving farmers more directly in research may unlock innovation that leads to more effective, practical improvements in research practice.

This investigation aims to compile examples of studies that involved farmers in their co-design and to highlight the impact that emerged from these collaborations.

Materials and Methods

Defining Farmeromics?

As introduced earlier, 'farmeromics' refers to the study of farmer-driven, biological data recording, at scale. To clarify this concept, it can be broken down into three components.

1. **Farmer driven.** This aspect focuses on listening to farmers to understand the motivators for data collection. Key questions include:
   - What problems do farmers want to solve using data?
   - What motivates farmers to record data in the first place?
2. **Biological data**. This refers to the type of data that is relevant to both farmers and researchers. It prompts consideration of:
   - What data do researchers need to answer scientific questions?
   - What data might already be available on farms?
3. **Recording at scale.** This component addresses the practicality of large-scale data collection efforts. It asks:
   - Do current recording practices align with the standard operating procedures common on today's farms?
   - Have researchers actively sought out this data from farmers?

The Approach

Retrospectively, a selection of successful projects that incorporated elements of "farmeromics" was compiled. These examples are not intended to be comprehensive, but rather illustrative and are offered to spark conversation. Each case demonstrates how farmer involvement in data collection and research design contributed, in part, to meaningful outcomes.

Results & Discussion

In Table 1, we introduce 3 research activities that featured a close association with farmers that are discussed in this paper.

Table 1. Project overview

Project	Aim
Calf vitality	Estimate variance components for calf health traits
Feeding the Genes	Study genetic by environment interaction in herds that varied by feeding system
ImProving Herds	Compare the cows' contribution to profit between cows differentiated by national index rank.

Example 1: Calf vitality

Australia's Calf Vitality Project aimed to estimate variance components for calf health traits in a country without obligatory or habitual recording practices (Axford et al, 2025b). During the initial stages of the project when farmer recruitment was underway to build a bespoke dataset, farmers proposed an additional phenotype which was a subjective score. In their words, they wanted to record calves that were 'rippers' or 'duds'. These colloquial terms were formed into a subjective scoring tool trait with 5 levels where A was a vigorous calf (a 'ripper'), B was a good calf, C was an average 'ok' calf, D was a dull calf that lacked vigour (a 'dud') and E was a dead calf. The approach was modelled on the familiar system for recording workability traits (milking speed, temperament and likeability) that was initiated thirty years ago and still well used today (Beard, 1993). Images reflecting the scoring tool were developed, as shown in Figure 1, to introduce the idea to project participants.

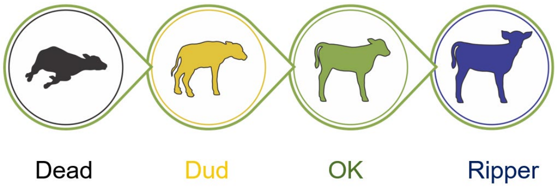

Figure 1. Visual descriptions of the calf vitality scores

What was the outcome?

Over 50 farmers participated in the calf vitality project and contributed detailed health phenotypes and genotypes from ~20,000 calves. While it is difficult to apportion the success of the data collection activity to one or more factors, it is likely influenced by the high level of farmer interaction during the initiation of data collection. At the completion of data collection, about half of the participating farmers actively recorded this new trait. Of all the calf traits, calf vitality had the highest estimated heritability (11%) as described, along with more detailed genetic parameters in Axford et al. (2025b). Further, this trait attracted farmer engagement to the project and generated the most conversation of all the calf traits during industry events.

Why did it work?

Underpinning the definition of 'farmeromics' is the principle of co-design. In this context, co-design' means involving farmers and advisors in a project from the beginning to increase engagement, acceptance, transparency and reduce the possibility of failure. Fleming et al. (2023) extends co-design to include 'co-development' and 'co-delivery' as part of a Co-3D spectrum for project delivery. Calf vitality was 'co-designed' by first listening to the problems as farmers expressed them. Then, we developed a mechanism of recording data that fitted with their routines and targeted a problem that farmers wanted to solve. When the value proposition was strong (ie, breeding for healthier calves), and the barriers to participation were low (ie, simple recording), farmers were willing to provide data that was earlier though to be unavailable.

Example 2: Feeding the Genes

With hindsight, 'Feeding the Genes' (Morton et al., 2015) was successful, in part due to elements of 'Farmeromics'. The aim of this project was to investigate the interaction between genetic merit and feeding system on the performance of cows in Australia herds. A feature of the Australian dairying system is a heterogeneity of feeding systems. Dairy Australia has identified five broadly defined feeding systems ranging from predominantly pasture and conserved fodder with low concentrate use, through to total mixed rations. Farmers were asking questions about the performance of high genetic merit animals in each of these systems, especially for phenotypic measures of milk production and longevity.

This study required feeding system data that was not routinely recorded and stored for herd-recorded herds. A survey was conducted to gather the required data and it is here that that we find principles of 'Farmeromics'. The survey was:

- focused on questions that farmers were asking,
- short – with just 5 questions,
- targeted – candidate herds with selected on the basis of production and longevity data, and
- backed by industry advocates – a multi-disciplinary team that included well-known spokespeople were leading the survey.

What was the outcome?

The survey attracted a high response rate of 24% meaning that ~300,000 lactations from 505 herds were able to be used in the milk production analysis. The ability to link feeding systems and herd performance enabled research that concluded there were clear benefits to using high genetic merit sires in each of the five feeding systems.

Why did it work?
In this example, the availability of feeding system data was critical to the research but not readily available. By asking farmers for this information in a way that was simple and with a clear value proposition, the response rate exceeded expectations. 'Simple' for the end user shouldn't be confused as 'easy' for the researcher. Significant effort was required to develop the survey questions with a multi-disciplinary team of advocates in order to achieve success.

Example 3: ImProving Herds
Many models that are used to derive economic indexes target an outcome based on a definition of profit, for example Pro$ in Canada (Van Doormaal et al., 2015), Balanced Performance Index (BPI) in Australia (Byrne et al., 2016), Net Merit in the United States of America (Van Raden et al., 2025) and others. Farmers and advisors often seek information that validates the profit predicted in indices with practical, 'real' herd examples. One of the aims of Australia's ImProving Herds project was to compare the cows' contribution to profit between cows differentiated by BPI rank. This required a comparison of individual cow lifetime performance information with farm financial data to calculate margin over feed and herd costs (MOFH) as a measure of contribution to farm profit (Newton et al., 2017). However, detailed farm financial records are rarely captured in routine herd recording. In this project, two disparate datasets were initially combined from different agencies, with agreement from farmers. Later, consultants with specific expertise in compiling and assessing farm financial data were engaged to collect this data for a diverse range of herds with high value herd performance and genomic data that were important to the study. This information enabled an analysis that linked farm financial performance with genetic merit at an individual cow level resulting in the calculation of each cow's contribution to profit. This formed the basis of a series of practical case studies that appealed to farmers and service providers.

What was the outcome?
On average, high-BPI cows contributed ~AU $300 per cow per year more to margin-over-feed and herd costs (MOFH) than did their low-BPI herd mates (Newton et al., 2021). Additional milk income easily compensated for the higher feed costs associated with high BPI cows. Further, a sensitivity analysis showed that this result holds true even if milk price fell by 50% while feed cost stayed the same or feed cost doubled and milk price stayed the same. As the case studies were conducted in a range of environments, this project generated many stories that formed a well-used extension resource.

Why did it work?
In this project, looking beyond the traditional data sources revealed opportunities previously thought 'too hard'. As discussed by Newton et al., (2021), iterative discussions with dairy farmers, economists, service providers and technical independent geneticists from overseas were required to develop this research study. Consistent with co-design principles, communication and early extension activities were incorporated within a research project and this enabled the involvement of representatives from across the herd improvement industry throughout the project. While challenging to manage, the iterative feedback cycles on the project methodology and messaging created new opportunities.

Conclusions

In these three examples, involving farmers
- revealed new data that was not previously unknown to exist, through discussion,
- fine-tuned the research question, through conversations, so that the project's discoveries were more meaningful to the intended audience,
- ensured that proposed practice changes had considered practical implications, and,

• benefited communication and extension activities that raised awareness of the research findings.

At its heart, 'farmeromics' is a prompt to ask, 'how can we do a better job of working with farmers to capture important data and make great research projects even more meaningful?'

Acknowledgments

The calf vitality project was funded by DairyBio, an initiative of Dairy Australia, Agriculture Victoria and The Gardiner Foundation and contributed to a PhD project at La Trobe University. The author thanks her PhD supervisors, DataGene colleagues, Kevin Jones, Nancy Charlton and calf vitality participants for the conversations that sparked this article.

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