Stakeholder engagement to support the development of next generation decision support tools

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Abstract

Making informed management decisions about mating and culling cows impacts farm financial performance and the health and welfare of cows. There is now an opportunity to develop next generation ('next-gen') decision support tools which combine genetic effects (e.g. breeding values), non-genetic effects and novel data sources to predict the future performance of cows. To ensure this next generation of decision support tools aligns to farmer needs, a series of focus groups and one-on-one interviews were held to seek feedback from 33 dairy farmers and industry stakeholders on tools being considered for development. A semi-structured facilitation approach was used to understand what information was currently being used to make decisions about culling and mating and gauge farmer interest in the next generation of management tools. Iterative thematic analysis of workshop and interviews transcripts and notes was then undertaken.

As anticipated, farmers are heterogeneous in their data recording and use of data in decision making. Differences in approach to data use could be broadly represented by two distinct data user groups, "data-driven" and "data-disconnected" and a third overlapping data user group, "data-dippers." Interest and demand for 'next-gen' tools varied – and appeared to be influenced by both individual farm factors and regional factors - though was generally positive. Individual factors also impacted whether farmers preferred a new culling or mating tool with no clear preference seen overall. A recurring theme in conversations was how interlinked mating and culling decisions are, with things like herd replacement rate being heavily influenced by both. All stakeholders identified features or data they viewed as important to include in 'next-gen' tools. However, less than half of these data sources are currently captured in the Australian dairy industry's central data repository. Whilst farmers were open to new tools – feedback was clear that such tools should not require duplication of data entry. Data access, availability and integration across systems at both individual farm and industry level is a key barrier to 'next-gen' tool development and adoption. The semi-structured facilitation style provided opportunity for diverse feedback and insights across a range of related topics to be captured. Feedback from stakeholders was that the opportunity to participate in workshops and engage directly with researchers was highly valued. As delivering a 'next-gen' tool accessible to most farmers is not yet possible, a decision has been made to not continue further tool development in the short term. The tool may be revisited in the future when data barriers are overcome. We will continue to explore other research that can answer some of the questions raised in this study and to ensure the findings of this study are disseminated to industry.

Keywords: sexed semen, beef on dairy, mating tool, culling tool, co-design.
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Introduction

Making informed management decisions about mating and culling cows impacts farm financial performance and the health and welfare of cows. Cow performance is influenced by many factors including genetic effects (e.g. breeding values), non-genetic effects (e.g. lactation number, calving date, illness) and farming system (e.g. feeding system, climate). Novel data sources (i.e. sensors), continued improvements to data pipelines, more frequent genetic evaluations and computing advances means an opportunity exists to develop new decision support tools which combine genetic effects, non-genetic information and novel data sources to predict the future performance of cows. Current management tools available in Australia do not jointly consider all these information sources. However, a limited number of these tools have been developed and implemented overseas, such as in Ireland (Kelleher *et al.* 2015) where farmer feedback and uptake has been very positive (Kelleher *et al.* 2018).

Adoption of decision support tools by dairy farmers is contingent on them been valued by farmers and industry stakeholders and meeting their needs. One approach for ensuring tools developed are relevant and meet the needs of the end-user is to use a co-design process, involving stakeholders throughout a project (Moser 2016). The benefits of involving farmers in dairy research and extension activities has been previously documented by (Crawford *et al.* 2007). An engaged stakeholder network is also helpful in the development and piloting of extension resources which in turn can help support adoption (Newton *et al.* 2021). To ensure the next generation of decision supports tools aligns to farmer needs, a series of focus groups and one-on-one interviews were held to seek dairy farmer and industry stakeholders' feedback.

Material and methods

A semi-structured facilitation style was used in series of workshops and interviews to seek feedback from 33 dairy industry stakeholders to understand farmer interest in "next-gen" (next generation) management tools from December 2023 – April 2024.

Description of participants and workshops

Twenty-three dairy farmers and 10 service providers were interviewed via 5 workshops – 4 targeting farmer participation and 1 targeting service provider participation. A further 7 one-on-one interviews were conducted, primarily with participants who were unable to attend workshops. Several approaches were used to recruit participants. Targeted emails were sent to 2 mailing lists; a network of service providers providing reproduction advice to farmers, and farmers participating in the genomic information nucleus program in Australia (and therefore known to be actively engaged in good data recording practices). Dairy Australia regional extension staff based in major dairy regions were approached for support to hold regionally specific workshops. This supported including generalised workshop promotion and targeted invitations to encourage participation in workshops from stakeholders with diverse backgrounds. Two workshops in Northern Victoria and 1 interview (Melbourne) were conducted in person, with the remainder completed online.

Using a semi-structured facilitation style, these sessions first sought to understand what information farmers were currently using to make decisions on culling and mating. Participants were then introduced to the concept of 'next-gen' management tools, shown

an overseas case study and asked questions like: "*Does a tool like this interest you?*", "*What would you like to see in a tool?*" Participants were also shown some examples of different dairy breeding programs incorporating conventional dairy semen, female sex-sorted semen and beef semen and asked which best represented their business and how they allocated semen types.

Qualitative analysis

Iterative thematic analysis was conducted to code workshop and interviews transcripts and notes into categories, following Charmaz (2014). Five main categories were identified: current use of data; demand and interest in new tools; barriers to engagement; tool features and preferences and other insights. Additional analysis of each category sought to identify recurrent themes, differences within each category and possible reasons for differences. These insights are presented below. Early insights from the analysis were shared with key dairy stakeholders and a facilitated discussion held to seek their input on the implications of the findings on future project milestones including 'next-gen' tool development.

Results and discussion

As anticipated, farmers were heterogeneous in what data they record and how they use that information when making culling and mating decisions. Similarly, interest and demand for 'next-gen' tools varied – seemingly influenced by both individual farm factors and regional factors – though was generally positive. All stakeholders identified features or data they viewed as important to include in 'next-gen' tools. Data access, availability and integration across systems at both individual farm and industry level was identified as a key barrier to 'next-gen' tool development and adoption. The semi-structured facilitation style provided opportunity for diverse feedback and insights across a range of related topics to be captured. Feedback from stakeholders was that the opportunity to participate in workshops and share their insights was highly valued. Key research findings are highlighted in Table 1, and discussed in further detail in subsequent sections.

Farmer's current use of data in decision making varied

On-farm approaches to decision making varied widely across workshop participants (and their clients). While every farmer is unique, we propose differences in approach to data can be broadly represented by two distinct data user groups and a third overlapping data user group. Key features of each proposed user group are outlined in Table 2. The 'data-driven' user group tended to take a systematic approach to culling and mating decisions, often using Microsoft Excel to bring together information from multiple on-farm software programs. In contrast, the 'data-disconnected' user group recorded limited data and appeared comfortable making decisions with incomplete information. The 'data-dippers' shared features of each group, generally recording some data but not necessarily using it to support decision making. This also means the benefits of investing time and money into collecting data are not being realised. 'Data-dippers' are the users who are most likely to move between user groups - being at risk of becoming 'data-disconnected' but also having the potential to be encouraged to become 'data-driven'. Identification of user groups with differing needs that warrant consideration in tool design and development of research programs has been documented previously (Monks *et al.* 2021). Interestingly, we found limited external advice was sought in making culling decisions, but a much stronger practice of external advisor involvement (usually semen sales representative) occurs in mating decisions.

A range of data sources at both individual cow and herd level were reported by participants as being used in making culling and mating decisions. Here, we focus on individual cow information. Participants most often reported using herd test (or other milk recording) data – especially somatic cell count and yield to make culling decisions. Other information used included: fertility information (i.e. days open, pregnancy test results), age/parity, udder health temperament, and genetics/genomics. For mating decisions, data used included: days in milk, age/parity, health records, genomics,

Table 1. Summary of insights across key themes identified through qualitative analysis.

Theme	Insight
Current use of data	• Farmers are heterogeneous in recording and use of data. • Three potential data user groups identified (Table 2). • Advisors often used for mating but not culling decisions. • Wide variety of data sources used; milk recording data most often mentioned
Demand and interest in new tools	• Generally positive, enthusiasm varied across data user groups. • Appeared to be influenced by herd dynamics, economic, social, and business factors. • Mating and culling seen as interlinked (Figure 1), no overarching preference for one tool seen. • Need to illustrate value of tool highlighted.
Tool features and preferences	• Range of data sources and features for tool identified (Table 6). • Less than half of requested data currently captured in central data repository. • No requirement to duplicate data entry.
Barriers to engagement	• Lack of data access, interoperability and integration across software programs and platforms, on-farm & at industry level. • Many data sources, especially novel data sources, not linked to central data repository. • Farmers do not want to have to duplicate data entry. • Variable levels of data recording across herds.
Other insights	• Opportunity to contribute to discussion and engage with scientists valued. • Gaps in education and training including inbreeding knowledge, best practice with sexed semen, additional uses of cow genomic test results. • Utilising existing events (i.e. scheduled discussion groups) effective for hearing diverse viewpoints. • Service providers had rich and valuable insights.

Table 2. Overview of potential data user groups and their use of data in decision making.

Data-driven	Data-dippers	Data- disconnected
• Responded to targeted emails. • Described systems, processes and strategies for decision making. • Multiple farm software programs. • Described data management as labour intensive.	• Recording some data • Shared some features of 'data-driven' and 'data-disconnected' • Can move between groups.	• Limited data recording or use of data in decision making. • Could have smaller herd size. • Group recognised by both farmers & advisors.
Use of data in decision making		
• Used multiple data sources, often compiled in Microsoft Excel.	• Data not often used in decision making.	• Make decisions on limited/incomplete data.

phenotypic attributes (i.e. confirmation) and data from heat detection devices (i.e. collars). A key question farmers reported asking themselves when making mating decisions was; "*Do I want to breed a replacement from her?*"

Individual farm and regional factors appeared to influence demand and interest in 'next-gen' tools

Participants responded positively to proposed new tools and opportunities to bring genetic, non-genetic and environment information together in one place, with beliefs like: '*there's no one tool that integrates all of that data*," and that, "*It would be easier to have one app or one tool which gives you all the information*." However, variation existed amongst participants. 'Data-driven' users saw value in the more systematic approach 'next-gen' tools would offer, the opportunity to compare their current approaches to proposed tools, and were enthusiastic about opportunities to engage further with the project. The next most interested user group 'data-dippers' appeared to see most value in having something that would help them bring their existing data together, with one participant saying that while they collected all the information, they weren't really using it in decision making so; "*I (they) would find that tool very handy, we collect all that data, would be good to have the snapshot*". The 'data-dippers' are perhaps the most significant target audience for these tools because such a tool could help them move into 'data-driven' user group. Adoption by this user group could deliver greater potential benefits to the individual and industry than adoption by the 'data-driven' user group who already have manual processes to bring their data together. Finally, as the 'data-disconnected' group are comfortable making decisions with little or no data, it will be much harder to develop a successful value proposition to collect data and use it in tools. There are emerging opportunities for this group to 'passively' record more data via new technologies such as automated dairy equipment, sensors and virtual fencing, i.e. Bell and Tzimiropoulos (2018); Cabrera and Fadul-Pacheco (2021).

A recurring theme in conversations was how interlinked mating and culling decisions are. Key factors participants articulated that impacted both culling and mating decisions included: herd replacement rate, optimum herd age structure, herd reproductive performance, markets for non-replacement animals and calving pattern (extended lactations). The linkages between these factors and culling and mating decisions is shown in Figure 1. This connectedness could also contribute to why it was hard to see an overall clear preference across all participants for either a culling or a mating tool. However, participants were divided on value of a combined culling and mating tool with some fearing it could become too complicated.

Farmers' interest in the proposed tools – and their decisions about culling and mating – appeared to be context-specific in that it related to their current herd dynamics, business circumstances, social factors and market conditions. Herd fertility came up in conversations often. For example, '*I would say that we don't really have much choice in culling and breeding decisions if you don't have good fertility,'* illustrating how herd dynamics may influence farmer interest in engaging with tools. Farmers who were already using sexed dairy semen and/or beef semen in their herds appeared more interested in the proposed mating tool. However, this interest was in turn influenced by availability of markets for dairy-beef calves or surplus heifers which varies from season to season. The development stage the dairy business was also a consideration. For example, a business focused on growing herd size had limited use for a culling tool and was less likely to be investing in data capture. The relevance of tools in the context of the time of year, was also mentioned. For example, it was suggested that in Tasmania there were more potential applications of tools to support culling decisions in Autumn as involuntary culls (i.e. empty cows, chronic mastitis and lameness) have already been removed from the herd. Changing demand and interest in tools over time aligns with our previous research (Newton *et al.* 2021). Also, while participants could see value in a tool, feedback was received that for farmers to engage with a

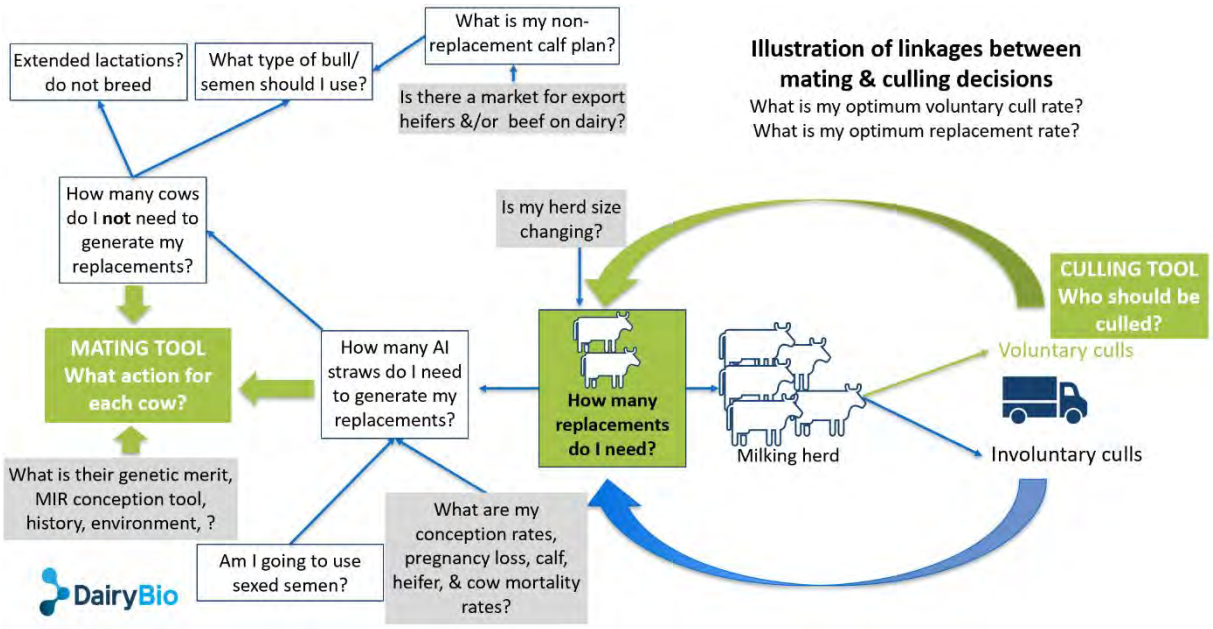

Figure 1. Diagrammatic illustration of some of the linkages between mating and culling decisions on farm and some of the other factors influencing that decision. Three core questions are shown in green text boxes, grey and white text boxes show some of the factors impacting the answer for those questions.

tool they needed to perceive that the tool will provide them benefits and value above current process. The importance of education and extension resources that illustrated this was also discussed.

Participants articulated many features of 'next-gen' tools they saw as important

Where interest in proposed tools existed, participants clearly articulated features of tools or required data inputs they saw as most important. This included:

1. Milk yield, fat and protein from herd test results.
2. Alternate milk recording sources (in line meters and automatic milking system).
3. Mid-infrared (MIR) spectral data (including MIR Conception tool (Ho and Pryce 2020)).
4. Clinical mastitis cases and somatic cell counts.
5. Other health information (i.e. lameness, metritis, antibiotic use).
6. Fertility (i.e. insemination events, calving events, calving interval).
7. Pregnancy scanning results.
8. Novel sensor data (i.e. collars and smart tech).
9. Genetic and genomic information (i.e. breeding values).
10. On-farm software recording systems

11. Temperature-humidity records.
12. Economic parameters.

Of primary importance was the ability to draw upon milk recording data captured from herd testing as well as inline meters and automatic milking systems. Features of the tool that participants identified as important included:

- Ability to pull data from existing sources – no duplicate data entry.
- Ability to consider lifetime data, not just lactation information.
- Account for the flow on effects of decision making (i.e. how value of extra pregnancy changes over a lactation, poorer conception rates with sexed semen).
- Ability for user to manually adjust starting parameters, economic assumptions etc.
- A dashboard for easily visualisation.
- A traffic light or grouping system to facilitate management of cow groups not individual cows in large herds.

When the data sources identified through this study were cross-referenced against the information currently available in Australian dairy's central data repository only 4 were fully accessible (1, 4, 6 and 9 in the list above), and a further 4 had partial or limited availability (3, 5, 7 and 10 in the list above). By 2026, improved accessibility was only expected from: addition of milk recording data from in-line meters and automatic milking machines, and improvements to availability of MIR spectral data. Not all milk samples are processed on machines with MIR capabilities. Historically, only data collected from Bentley machines has been utilised with incorporation of data from FOSS brand MIR machines in DataGene's 2023/24 Operating Plan (DataGene 2023). Data access, availability and integration was identified as a key barrier to 'next-gen' tool development and usage and will be discussed further in the next section.

Data access, availability and integration is a key barrier to 'next-gen' tool development

"I was thinking the last 20 years have been very, very bad for data in Australia because now we've got data sitting in many places and almost no one's talking to each other." These sentiments shared by a service provider highlight the biggest barrier to 'next-gen' tool development. At individual farm level as well as wider industry level, data access, interoperability and integration across software programs and platforms was identified as a key barrier to development and uptake of 'next gen' tools. Participants were very clear in the message that they did not want to have to duplicate data entry - a point raised during nearly all workshops; *'the biggest issue I've got is how certain systems/ apps don't talk to one another. How does it get into the system without having to double handle it?'* A key implication of this is that any tool developed needs to integrate into existing data pipelines. This represents a significant challenge. There is also no easy way to combine data from different farm software systems on-farm. This is challenge shared by dairy herds and other farming enterprises globally (Wolfert *et al.* 2017). This means that not all data is being used in decision making – especially for data user groups lacking skills set or motivation to manually combine data themselves.

Compounding this challenge, not all data collected on-farm is currently entering the central data repository in Australia. For example, veterinarians provided feedback that much health information is missing from the repository, believing a major barrier was health record data formats not aligning to data formats/reporting structures used for

transferring data in and out of the repository. The proprietary nature of some data being collected by new technologies (i.e. heat detection collars and automatic milking systems) hinders development of data sharing agreements (and pipelines) and makes data centralisation difficult. Big variation in digital literacy also exists and service providers advised that it is likely that some data is still being captured on paper only. The ongoing use of paper-based records in dairy recording has previously been identified by Zottl *et al.* (2015). Such data challenges are not unique to either Australia or the dairy industry, as previously reviewed by Wolfert *et al.* (2017). Locally, the DataConnect project aims to explore opportunities for the Australian herd improvement industry to work pre-competitively on data exchange and integration (DataGene Pty Ltd. 2023). More broadly, initiatives like iDDEN (International Dairy Data Exchange Network) which was launched in 2020 with the aim of streamlining data exchange between dairy herds, milk recording organisations, dairy equipment manufacturers, farm software providers and other service providers have potential to help address these challenges (Reents and Pekeler 2021). While these initiatives are encouraging, overall the dairy industry has made slow progress in adopting data integration technologies (Cabrera *et al.* 2021). So, at present this remains a key barrier to successful development and adoption of 'next-gen tools' in Australia.

A further challenge to 'next-gen' tool development highlighted by participants was the need to build a tool that can accommodate the big variability in the amount on-farm data captured by individual farms. A key point made was that the farms that would benefit most from 'next-gen' tools may not be collecting the data needed to drive the tool effectively (i.e. 'data-disconnected') users. For this user group it was suggested that support to determine basic parameters such as herd replacement rate would be helpful. In comparison, while time savings could be expected for 'data-driven' user group, the value gained from improved decision making would be smaller. Possible solutions included: developing a tool that accommodates variable levels of data recording, for example a tiered tool with access determined by data recorded. A further discussion point was whether Australia needed more mandatory recording on-farm. Whilst likely to receive negative pushback from some farming groups, mandatory recording is widely used throughout Europe and additional recording may also soon be required as part of anticipating greenhouse gas emissions reporting requirements.

Semi-structured facilitation style provided diverse insights across many areas

The semi-structured facilitation style created opportunities to uncover valuable feedback on areas related to culling and mating. In addition to the discussion around optimum replacement rate and herd age structure discussed previously, feedback on the need for ongoing education and training was received. Areas highlighted by participants included:

1. understanding what best practise use of sexed semen is, including access to more resources and case studies;
2. how to use genomic data to make decisions in the milking herd (i.e. uses beyond choosing heifer replacements); and
3. limited knowledge about the impact of inbreeding, where to seek advice or report concerns about potential new lethal/detrimental conditions.

A further finding from this approach was the value that participants placed on having access to a forum to discuss the use of data in decision-making and the opportunity to engage directly with researchers. One discussion group provided feedback that it was the first time a scientist had attended one of their monthly meetings in 14 years of discussion group operations. Another participant said, "*it's not often I get to sit down and have a discussion with a geneticist…. Probably the first time we've done it, I'm*

enjoying it." These findings are supported by a recent review of literature on agricultural adoption which found scientists can influence adoption by engaging with a range of service providers, supporting group learning (i.e. discussion groups) and through direct involvement with on-farm trials and demonstrations (Nettle *et al.* 2022).

One limitation of this project is the potential for bias in respondents, however several approaches were used to help with getting feedback from a representative sample. Firstly, including service providers in the participant group. With a large client base, often over multiple dairy regions, they provided perspectives representing a diverse cross-section of dairy farmers and were a rich and valuable source of information. Farmers who respond to an open invitation to discuss 'next-gen' management tools are already likely to be motivated to engage with these tools. The second approach, tapping into existing events, such as dairy discussion group meetings, was found to be an effective strategy to hear more diverse viewpoints in workshops. Participation at these events was driven by other activities of the discussion group such as a free lunch, discussing regional challenges and peer-to-peer learning.

Conclusion

The stakeholder engagement work undertaken here has found participant interest and demand for 'next-gen decision support tools – to enable more informed mating and culling decisions – varied, though has generally positive. Individual farms' current data recording practices, business stage, herd and economic factors appear to influence interest in the tools being proposed with no clear consensus on whether greater demand for culling or mating tools existing overall. A key barrier identified in this study was lack of data integration and access across software platforms on-farm and at lack of pipelines to aggregate data in the central data repository - particularly for novel sensor devices. Coupled with a clear message that farmers do not want to double enter their data, this represents a major barrier to being able to compile the dataset needed to develop 'next-gen' decision support tools. Low levels of data recording in some herds and limited data aggregation will also hinder the number of farms able to use the tool. When these insights were reviewed by funders and key stakeholders, a decision has been made to not continue further tool development in the short term. This is primarily due to the fact delivering a 'next-gen' tool accessible to most farmers is not yet possible and other industry priorities have since emerged. Attention now turns to ensuring the findings of this study are documented and disseminated – particularly to support industry initiatives to improve data connectedness. We will continue to explore other work that may be possible to answer some of the questions raised in this study.

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