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An objective prioritisation method for agriculture RD&E

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ABSTRACT

We aimed to develop and test a relatively objective method for rapidly and accurately assessing the priority for research of interventions tendered as potential solutions to a prevailing problem in agriculture. In this test, our method aimed to direct research of evidenced-based strategies to ameliorate consistently high rates of foetal and calf loss experienced in northern Australia's beef herd. Detailed reviews of factors affecting foetal and calf loss and potential solutions were conducted. A simple economic analysis, based on rating management interventions for their impact on earnings before interest and tax, was then developed to enable rapid simultaneous business-impact comparison of multiple options. If the outcome value for an option is negative, it suggests that the option is less profitable than is prevailing practice, if approximately zero, it suggests that the option is very marginal, and more positive values suggest a higher potential benefit. The values obtained were further analysed by rating for incidence and researchability to derive research priority. This sequence of activities was conducted by peers representing a broad spectrum of beef business (managing an estimated 0.4 million cattle), science and agribusiness representatives from across northern Australia. A sensitivity analysis demonstrated that the method was robust in ranking both business impact and research priority. Ten foetal and calf-loss minimisation interventions were rated by producer and agribusiness representatives and the project team as a high priority for business. Four of these were excluded because of low incidence or low researchability, leaving six rated as having highest priority for research. Informal feedback from many participants indicated high satisfaction with the proposed method. The conclusion was that this method, with suggested variations, successfully discriminated priority for a large range of potential interventions for calf loss research, development and extension (RD&E). The method described could readily supplant commonly used more subjective methods and be used to assess priority for RD&E of other issues for multiple agricultural commodities, as well as simply for rapid assessment of management options within a production enterprise.

Keywords: beef cattle, calf loss, economics, northern Australia, priorities, research, management, objective.

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Introduction

Research, development and extension (RD&E) for agriculture is a significant cost, the majority of which is borne by governments in almost all countries. Even where commodity transaction levies are derived for RD&E, countries such as Australia match these with funds from general taxation revenue (Anon. 2019). As a general principle, the priorities for expenditure of available funds should be determined by representatives of the fund sources. For example, RD&E priority setting by private companies is very pragmatic and is dictated by the production and marketing needs of commodities they produce.

Within government-funded agencies, representatives who set RD&E priorities are usually senior bureaucrats under broad direction from politicians. Bureaucrats typically use a mix of subjective assessments built around economic models and a strategic plan; the latter is usually a non-specific document that can accommodate the considerable dynamics of policy and prevailing industry situations. The construction of models is

usually conducted by agency-employed or -contracted economists. Direct involvement of representatives from the supply chain of a relevant commercial industry may not be solicited. Therefore, priorities in this sector usually reflect government policy, with details determined by bureaucrats. This is acceptable as the funds available are from the entire community and RD&E agendas should represent community interests through political delegates.

In Australia, funds derived from an industry for RD&E and marketing are administered by companies that have this as their sole function (Anon. 2019). The method of setting priorities for fund expenditure has many similarities to that used by government agencies, although policy comes from a board and there are company and industry representatives instead of bureaucrats. The major difference is that individuals or businesses within an industry supply chain have the opportunity to provide their perspective in developing both strategic plans and detailed priorities. These contributors can be biased towards those with agri-political perspectives. Further, the methods used to interrogate their perspective on priority details can sometimes be based on simple and rapid workshop methods of listing and discussing perceived possible priorities, and then determining priority using subjective opinion, with the final listing being a reflection of the audience attracted to the prioritising procedures and their specific intentions.

Hartwich and Janssen (2000) summarised the primary methods available to prioritise research, with most being based on detailed economic modelling by specialists, with input from experts and some supply-chain representatives. These authors also described the Analytic Hierarchy Process that can be used *ex ante* and *ex post* to rank research options against multiple potential outcomes. Byerlee (2000) promoted the methods based on economic surplus analyses from both a quantum and efficiency perspective, common to many international RD&E agencies, such as reported by Mutangadura and Norton (1999). In medicine, the lack of a saleable commodity such as that produced by an agricultural industry, has fostered on-going development of consensus derived from professional opinion as the preferred method of defining research priorities within available resources (Humphrey-Murto *et al.* 2017). As good as all these methods are, any imbedded economic analyses are only as accurate as their input. Analyses are typically conducted by consultant economists who apply inputs they are familiar with to their own complex models that unfortunately require substantial inputs for which firm data are not always available, leading to estimates based on informed guesswork that may introduce error. There is also little ownership of this process by the intended beneficiaries, such as, for example, a government making a decision on behalf of its constituents without consultation.

Agricultural industry engagement and ownership in developing priorities is an important step in the process of support for R&D and subsequent adaptation of outcomes to their businesses. Objective and accurate methods to derive priorities directly from a supply-chain that are related to expected business outcomes are necessary in setting RD&E priorities for publically administered funds. This paper describes a relatively objective economic modelling-based method to prioritise RD&E that is simplified to allow easy understanding by any participant, is able to reduce impact of political agendas and enables a high level of input control by the supply chain to set their priorities; i.e. it can be a formal analysis by business for business. The method is demonstrated in its application to set priorities for RD&E for beef foetal and calf loss, a major problem in northern Australia (McGowan *et al.* 2014).

Materials and methods

Potential interventions for research

A research team composed of nine scientists from three agencies and six beef producers commissioned an internal and an external review of potential interventions that could ameliorate the high incidence of calf wastage in northern Australia (McGowan *et al.* 2017). Primary documents available were the comprehensive reviews by Burns *et al.* (2010) and Fordyce *et al.* (2014). The internal review prepared a comprehensive list of practical interventions that possibly had the potential to achieve sustained reductions in calf loss. Each intervention was assessed for potential business impact, advantages, disadvantages and research application.

Impact on business

An initial beef herd business model set to 3000 adult equivalents was constructed with representative data for each of the four main country types used for beef cattle breeding herds in northern Australia (Table 1). The analyses included all business costs and not just variable costs as economic models often do. Initially, the elements of the equation, EBIT (earnings before interest and tax) = Production × Value − Costs, were then each independently altered by 5% to calculate expected percentage change in EBIT. Next, the relative impact of annual growth (liveweight gain), survival (converse of mortality rate) and reproduction (lactation rate = number of calves weaned / number of cows retained) on production were independently examined in each country-type model by measuring change in herd annual liveweight production when each was altered by 5% (not 5% units). The resultant percentage impacts were adjusted by the same proportions, so the sum equalled the percentage impact on EBIT of a 5% change in production. These calculated percentage impacts of the prescribed changes in costs, value per kilogram, growth, mortality and reproduction on EBIT within country type weighted by the relative cattle populations estimated to be within each country type (Table 1) were proportionately adjusted upward to add up to 100% (Table 2).

Table 1. Data used to calculate weighted impact on profit of key drivers for northern Australian beef businesses with 3000 adult equivalents in different country types.

Item		Northern forest	Northern downs	Central forest	Southern forest
Production (kg/year)	Base	328 555	325 852	339 504	497 898
	Growth +5%	334 157	486 108	517 409	532 270
Mortality −5%		332 810	484 242	511 540	527 607
Lactation rate +5%		339 504	497 898	525 917	543 368
Costs	Base	$444 466	$414 877	$443 612	$437 556
Value/kg (2015 values)	Base	$1.77	$1.77	$1.77	$1.78
EBIT	Base	$137 635	$162 050	$158 306	$448 312
Proportion of northern Australian herd		0.30	0.20	0.22	0.28

Percentages given are percentage change, not percentage units change; Lactation rate, proportion of retained cows weaning a calf; EBIT, earnings before interest and tax.

Table 2. Business outcomes used for rating options for change in management, assessment questions, and calculated relative business impact in northern Australian beef herds.

Business outcome	Question asked	Relative impact on profit
Growth	Will annual live weight gain be increased?	12% (10, 13)
Survival	Will the survival of post-weaning age cattle be affected?	10% (7, 12)
Reproduction	Will the number of calves weaned/cows retained change?	16% (13, 19)
Costs	How will business costs excluding finance and tax be altered?	−25% (−28, −20)
Product value	Will c/kg paid for sale cattle overall be affected?	37% (36, 40)

These values are calculated from relative impacts on earnings before interest and tax resulting from 5% changes in the business outcome.
Values are means, with the range of percentages across country types in parentheses.

Basic economic analysis of research options

A matrix was constructed of all potential interventions (new practice vs current practice) against outcomes (effect on growth, survival, reproduction, costs and product value). The interventions were broadly categorised within feedbase, reproduction, health and stress, and genetics. With consideration to both primary and secondary impacts, the differences between each two compared interventions in their impact on outcomes were rated from −3 (large reduction expected) to +3 (large increase expected); 0 indicated no change expected; for example, if a change from prevailing practice to an alternate practice is expected to increase reproduction rates by a moderate level, a rating of 2 would be applied.

Calculation of impact on business of a change in practice was conducted by summing the products of impact rating and relative impact on EBIT. As each option comparison is a basic economic analysis, a negative value indicates that the change is likely to reduce EBIT, a value of approximately zero may have marginal impact on EBIT, and the more positive the value is, the more profitable the change is likely to be. The results were within the range of −2 to 2 and were divided by 4 to bring them within a one-point range, i.e. −0.5 to 0.5. The influence of changes in herd inventory with each change was not included in the calculations, primarily because herd size was fixed.

Research priority ranking

A second stage of group consensus produced an overall research priority rating for each intervention. Initially, the range of values for business impact was adjusted upward by the same value, so the lowest was zero. Each adjusted economic analysis output was then multiplied by both of the following:

- Relative incidence (0–3: nil, low, moderate, high) of the risk factors being affected. Although some changes may have large effect, they will rate as a high priority for research only if the opportunity to apply the alternate management to ameliorate the specific risk factor(s) is widespread.
- Researchability (0–3) of the comparison. This takes account of whether the research has already been undertaken, as well as the ease or difficulty expected to conduct research of the compared options. The latter relates to infrastructure required, the cost of undertaking the research, and whether a method exists or can be devised to test the comparison fairly.

Sensitivity analysis

A sensitivity analysis using the project-team and producer-group data was conducted by measuring the change in ranking for business impact and research priority for all options considered when the relative contributions of growth, reproduction, survival, costs and product value were each multiplied by 1.2, by 0.8 (i.e. 20% changes, not 20 percentage units) or when growth and survival (as their relative impacts were the lowest) were altered by 5 percentage units. In each analysis, *pro rata* adjustments were made for each other component so the total remained at 1.

Conduct of the prioritisation

The review was considered by the project team members. The scientists were drawn from Queensland (5), New South Wales (2) and the Northern Territory (2), with many having experience across northern and southern Australian beef business. The six business representatives were selected to represent beef breeding in large and small business, company and private business, regions from south-eastern Queensland to the top end of the Northern Territory, owners and managers, and gender. Having an understanding of the review, the project team conducted their ratings for business impact and research priority over a 3.5-h period on the morning of 13 October 2016 in Richmond, north-western Queensland.

On the afternoon of the same day, an open invitation attracted eight representatives from agribusiness (banking and merchandise and commodity traders), and 16 from beef businesses representing central Queensland through to central Northern Territory, large and small business, private and company business, owners and managers, and men and women. The participants collectively have responsibility for an estimated 0.4 million cattle, which is about 0.3% of the north Australian beef herd. After an initial presentation that reviewed the scale of the problem and the known risk factors for foetal and calf loss in northern Australia, the beef business people were divided into five self-arranged groups, and the agribusiness people formed a sixth group. Over a 1.5-h period, each group rated all intervention comparisons for business impact. In all groups including the project team, consensus was used to produce each rating. Groups were asked to add other intervention comparisons that they considered were not adequately covered by those presented. Facilitators, some of whom were from the project team and had earlier experienced the process, kept the process on track, provided clarification on request and ensured consensus included opinion of all participants irrespective of personality.

Data analyses were conducted within 30 min of collection. The ratings agreed by the project team to prioritise interventions for research were applied to business-impact evaluations by all groups. Business impact and research priority were averaged for the five producer groups.

Results

The process stimulated sustained dynamic discussion among the project team, the producer groups and the agribusiness group. The project team had the advantage of already knowing the interventions to be considered. The other groups were largely unaware of the management options for comparisons until the sheet listing them was distributed by the facilitator.

The groups' attention was disrupted when the facilitator was describing the process by handing out the matrix tables to be filled in. In retrospect, the listing of management options in the matrix should have been described by the facilitator prior to handing out the sheets. Assigning facilitators to each group to keep participants targeted on the question appeared to greatly assist the process, even though they appeared naturally focussed and did not dwell excessively on any rating in arriving at consensus.

In addition to the recommended interventions, eight alternate interventions were offered by beef business representatives within the project team and those attending by open invitation, with ratings given by at least one group for four of these.

There was considerable variation in the expected business impact of potential interventions (Table 3, Fig. 1). Although the overall averages were very similar for the three groups, the variation between the five producer groups was substantial, with the average standard deviation at 0.09. The correlations for impact evaluations between producers and both the research project team and the agribusiness

Table 3. Means and variations for business impact and research priorities, and correlations between ratings among different groups.

		Agribusiness	Producers	Project team
Averages ± s.d.	Business impact	0.10 ± 0.14	0.09 ± 0.09	0.09 ± 0.14
	Research priority	1.10 ± 1.16	0.79 ± 0.70	0.89 ± 0.73
Correlations	Agribusiness		0.84	0.80
	Producers	0.39		0.86
	Project team	−0.01	0.44	

Business-impact correlations are below the diagonal; research priority correlations are above the diagonal.

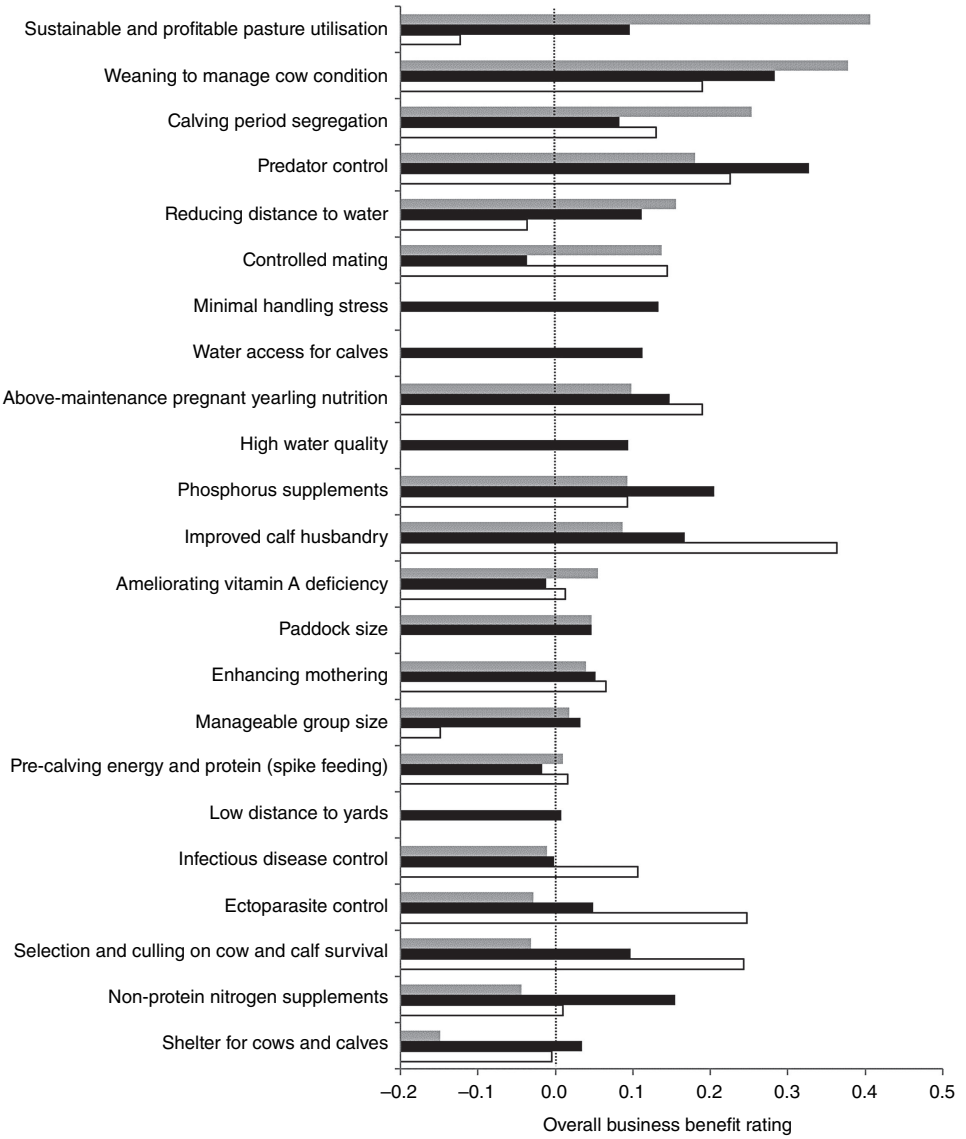

Fig. 1. Rating of business impact by the project team (shaded), beef producers (black) and agribusiness (clear) of interventions to control foetal and calf loss, Richmond 13 October 2016.

group were moderate, and the correlation was nil between the latter groups (Table 3).

The foetal- and calf-loss control interventions that were rated to have greatest business impact by producer and agribusiness representatives and the project team (each group's result was ≥0.08) were improved calf husbandry, phosphorus supplementation, predator control, weaning to manage cow condition, calving-period segregation and above-maintenance pregnant yearling nutrition. Alhough the agribusiness sector did not agree, the other groups also rated sustainable and profitable pasture utilisation as a high-priority intervention.

When the above priorities were presented to all participants in a plenary session, there was general agreement that it represented relative business impact, but not research priority, which was applied after the group had dispersed. Informal feedback from many participants indicated high satisfaction with the proposed method. The consensus indicated that this novel technique was able to discriminate high-priority strategies objectively and accurately for research and was superior to subjective methods previously experienced.

The values produced by the project team used to calculate research priority for each group are shown in Table 4. Although there was broad variation in priority for options to control foetal and calf loss (Table 3), the correlation among all groups was high (Table 3), indicating high agreement. Variation among the five producer groups was indicated by the average s.d. of 0.04. The foetal- and calf-loss control interventions that were rated to have highest research priority by producer and agribusiness representatives and the project team (each group's result was ≥0.90) were phosphorus supplements, improved calf husbandry, reduced paddock size, enhancing mothering (mixing mature cows with first-calving

Table 4. Ratings (0–3) used to multiply with all business-impact ratings to produce research priorities for interventions.

Item	Incidence of risk factors affected	Researchability
Feedbase		
Sustainable and profitable pasture utilisation	3	0
Phosphorus supplements	3	3
Reducing distance to water	2	2
Non-protein nitrogen supplements	2	0
Pre-calving energy and protein (spike feeding)	3	2
Above-maintenance pregnant yearling nutrition	3	2
Ameliorating vitamin A deficiency	0.5	0.5
High water quality	1	3
Water access for calves	2	2
Reproduction		
Calving-period segregation	3	1
Weaning to manage cow condition	3	0.5
Controlled mating	3	1
Enhancing mothering	3	3
Stress and health		
Predator control	3	0.5
Manageable group size	2	1
Minimal handling stress	2	2
Low distance to yards	3	2
Shelter for cows and calves	2	3
Infectious-disease control	3	3
Improved calf husbandry	3	3
Paddock size	3	3
Ectoparasite control	2	0.5
Genetics		
Selection and culling on cow and calf survival	3	1

Ratings were derived by consensus within a meeting of the project team comprising researchers and representative beef producers.
Empty cells indicate no business-impact data were available.

cows), above-maintenance pregnant yearling nutrition, and infectious disease control (Fig. 2).

The sensitivity analysis showed that in 93% of cases, ranking by either producers or the project team of either business impact or research priority remained unaltered, or changed by one rank (Table 5). Little change in rankings for the top-priority interventions occurred when growth and survival and product value were altered. When reproduction was altered, there were more changes in ranking but the overall impact on the top several interventions was considered to be small. When changes were made to the input value for costs, there was a bigger impact on model output, with 19% of interventions moving by >1 point either to become more important in research ranking or less important.

Discussion

The method described in this paper of in-depth review, brief economic analyses by the target group, and filtering for RD&E need successfully identified impact of options on business outcome and was effective in establishing priority for research and development. The validity of the method presented in this paper was exemplified by the participants' expression of satisfaction during a plenary session and that the conclusions reached on business impact through basic economic analysis were consistent and in broad agreement with their general perceptions. However, when using this method, it appears critical that participants are facilitated through the process to ensure that they remain focussed on the questions being asked and how to respond. This ensures that uninformed opinion does not cause aberrations in ranking. The accuracy and robustness of the procedure, including the involvement of producers managing an estimated 0.4 million cattle, should encourage research providers in northern Australia to adopt the priorities identified for foetal- and calf-loss research in this region.

The use of a very basic economic analysis in rapid options assessment enables such an analysis to be used in the process of comparing large numbers of options. This is a breakthrough concept, introducing objectivity to a common practice that is unfortunately usually conducted using simple subjective methods. Compared to the method we have successfully demonstrated, a standard economic analysis uses a lot more data inputs, considers only variable costs, produces quantitative gross margins, and takes a lot longer to conduct, even to conduct one analysis.

The process is a variation on well established techniques for prioritisation of research by using comprehensive review in addition to economic analyses and/or professional opinion. Where business outcomes are targeted, the multiple methods summarised by Hartwich and Janssen (2000), plus those using professional opinion such as the Delphi technique (Hsu and Sandford 2007) and other similar techniques (Spool 2004; Anon. 2016), could all be excellent foundations enhanced by the addition of a simple economic analysis process such as we have proposed. It can lead to having primary decisions built on an analysis conducted by representative members of a target group who are well informed and able to make

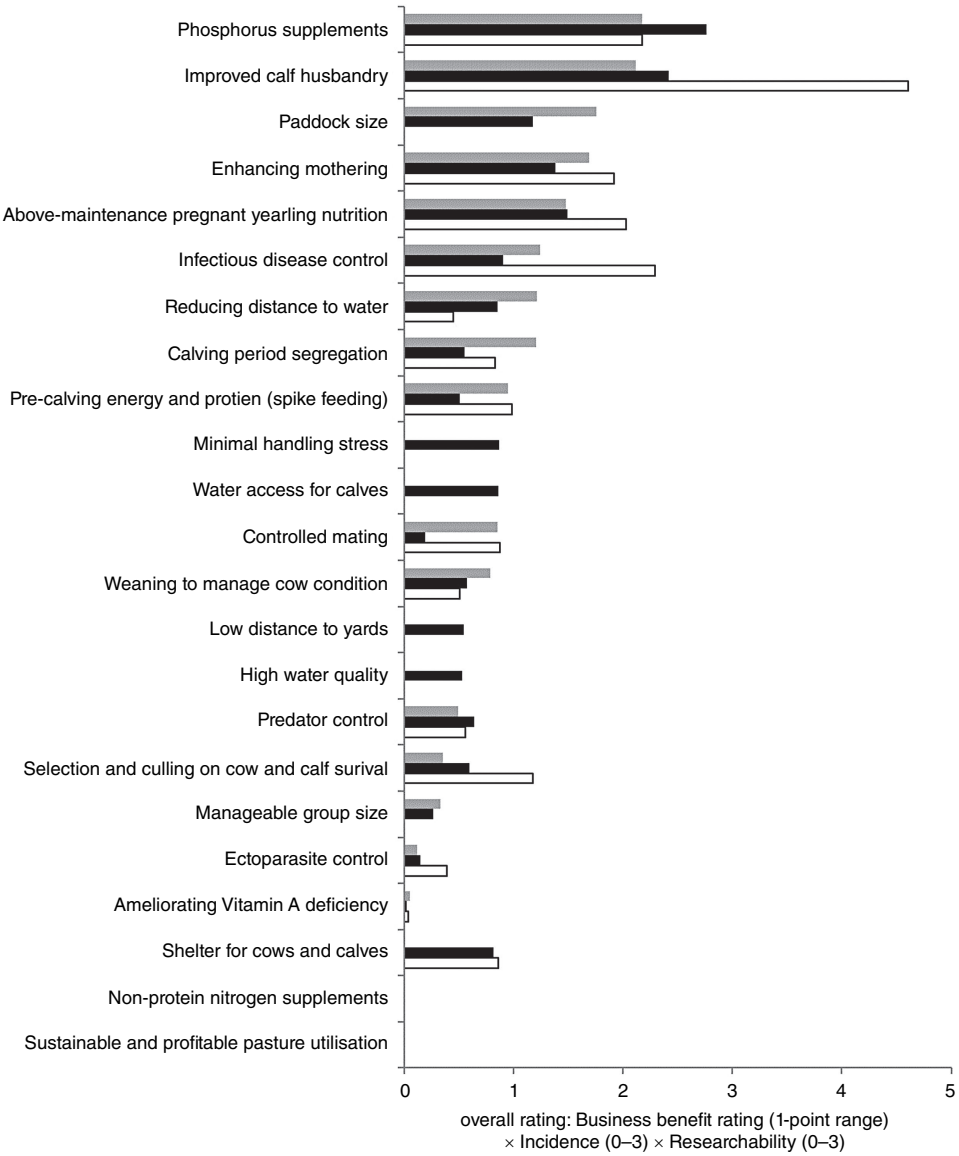

Fig. 2. Rating of research priority by the project team (shaded), beef producers (black) and agribusiness (clear) for interventions to control fetal and calf loss, Richmond 13 October 2016.

competent decisions. This is a participatory process, and, thus, is powerful in creating ownership of funded activities by the target group. This may result in greater uptake of new recommendations from ensuing research.

Methods of establishing research priorities that use iterative peer assessments of pre-defined options (Humphrey-Murto *et al.* 2017) enable each participant to refine their own opinion to reach consensus on priority. However, it remains a subjective opinion. Our method is a more objective process that includes and streamlines the RD&E prioritisation process and achieves very short engagement of peer groups. The stage of canvassing professional opinion in various alternate techniques can be reached quite quickly and in as little as 1–2 days. In contrast, well established commercial consultancies can conduct the process over a year or more.

Sensitivity analyses demonstrated that the priority rankings were quite robust, and most sensitive to changes in cost compared with other components of business impact. This suggests that costs may be considered as more than one component of business outcome if this prioritisation method is refined for further use. For example, it varies between businesses how capital costs are annualised, and this will affect the rating of cost impact of interventions requiring significant capital inputs in comparison to others that mainly require elevated variable expenses.

To discriminate impact on business, the method used percentage change in outcomes rather than percentage-unit change. This enabled fair comparison when small percentage-unit change could change single-digit variables such as mortality by a large degree. This may also be contentious for some because it reduces the relative impact of changes in mortality rate in comparison to most previous analyses, showing that even a one percentage-unit change can have a large impact on business outcome.

Table 5. Business impact and priority rankings of interventions by producers (Prod) and the project team (Team), and maximum number of places by which rankings were altered during a sensitivity analysis when impacts on growth (Grow), survival (Surv), reproduction (Repro), business costs (Costs) and product values (Value) were varied by nominated amounts.

Item		Phosphorus supplements	Improved calf husbandry	Enhancing mothering	Above-maintenance pregnant yearling nutrition	Infectious disease control	Shelter for cows and calves	Reducing distance to water	Selection and culling on cow and calf survival	Predator control	Weaning to manage cow condition	Calving-period segregation	Pre-calving energy and protein (spike feeding)	Manage-able group size	Controlled mating	Ectopa-rasite control	Ameliorating vitamin A deficiency	Sustainable and profitable pasture utilisation	Non-protein nitrogen supple-ments
Initial ranking																			
Bus impact	Team	10	7	11	8	14	18	5	16	4	2	3	13	12	6	15	9	1	17
	Prod	3	4	11	6	15	12	8	7	1	2	10	17	14	18	13	16	9	5
Res priority	Team	2	1	3	4	5	16	7	13	11	10	6	8	12	9	14	15	16	16
	Prod	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	17
Change in ranking																			
Grow × 1.2	Neg	−1	0	0	0	0	0	−1	0	0	0	0	0	0	0	−1	0	0	0
	Pos	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0
Surv × 1.2	Neg	−1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−1	0	0
	Pos	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0
Repro × 1.2	Neg	−1	−1	0	−1	−1	0	−1	0	0	−1	−1	−3	−1	0	−1	−1	0	0
	Pos	0	0	1	0	0	0	0	0	1	2	1	0	0	4	1	0	1	0
Costs × 1.2	Neg	1	−1	−2	0	−1	−1	0	−2	0	0	−1	0	−2	−1	0	−1	0	0
	Pos	2	0	0	2	0	2	2	0	0	0	0	0	1	0	1	0	0	1
Value × 1.2	Neg	0	0	0	0	0	0	0	0	−1	0	0	0	0	0	−2	0	0	0
	Pos	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
Grow × 0.8	Neg	0	0	−2	0	0	0	0	−1	0	0	0	0	−1	0	0	−1	0	0
	Pos	2	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0
Surv × 0.8	Neg	0	0	−2	0	0	0	0	0	0	0	−1	0	0	0	−1	0	0	0
	Pos	2	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Repro × 0.8	Neg	0	0	−2	0	0	−1	0	−1	0	0	0	0	−1	−1	−1	0	0	0
	Pos	2	0	0	0	0	2	1	0	1	0	2	0	1	0	1	0	0	1
Costs × 1.2	Neg	−3	0	0	−2	−1	−1	−2	0	−1	−1	0	−3	−1	0	−1	0	0	−2
	Pos	0	1	1	0	1	0	0	2	0	2	1	1	0	4	1	1	0	0
Value × 0.8	Neg	0	0	0	−1	0	0	−1	0	0	−1	−1	0	−1	0	0	0	0	0
	Pos	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	1
Grow + 0.05	Neg	−1	−1	0	0	−2	−1	−1	−3	−1	−2	0	0	0	−2	0	0	−1	0
	Pos	0	1	2	1	0	1	1	0	1	0	1	1	0	1	1	1	1	2
Surv + 0.05	Neg	0	0	0	−1	−1	−1	−1	−2	−2	−1	−1	0	−1	0	0	0	0	0
	Pos	0	0	1	0	0	0	0	0	1	2	1	1	0	1	0	2	1	1

This basic analysis does not account for all potential impacts. For example, it does not account for the interest associated with opportunity for changes in wealth. However, this is a marginal cost in relation to the impact of briefly considered opinion to produce ratings during the prioritisation process. Once an intervention is identified as a priority, refinement of the analysis using standard procedures would be conducted by economists to quantify potential impact.

A number of interventions were found to be high-value business practices that did not warrant further significant RD&E investment. Most notable of these were the use of sustainable and profitable grazing management practices, weaning, predator control, and use of non-protein nitrogen supplements. The main reason for this was their very low researchability ranking in relation to the outcome, i.e. foetal and calf loss. Beef producers in particular considered that these practices were already well researched and demonstrated, with no need for further research to assess the impact on foetal and calf loss. We accept that some RD&E practitioners and beef business operators may have strong alternate opinions. However, a strength of the process is that it uses a comprehensive, logical and objective process to position the outcome as defensible.

During the process, several alternate interventions were offered by the assessment groups. Those that were offered without any ratings included the following: using a tick-resistant breed; using a 'more suited' breed which denotes ability to produce milk and mother the calf while also being fertile and adapted; vaccination against leptospirosis; and, wild pig control. These had been previously considered (McGowan *et al.* 2017) and had not been specifically included because they were either covered by interventions already assessed or did not appear to offer any opportunity to alter foetal and calf loss.

The inclusion of product value as an outcome that may be affected by interventions is contentious because previous reports such as that of McLean *et al.* (2014) have indicated that product-value variation does not appear to discriminate business success. However, from a basic principle perspective, this outcome was retained because it is certainly true that when general market prices increase, there is a general increase in beef business profitability. Although value per kilogram was included at an outcome variable in the analysis, a large majority (84%) of ratings by participants were zero (negligible change in product value), which supports the general contention of McLean *et al.* (2014).

The method described in this paper collected consensus from groups of beef business representatives. A variation on this may have been to have individuals respond independently and then use means of responses, taking account of the variance. This would be undertaken in an open consultative manner so that shared opinion can improve the final opinion of each respondent, which is the basis of professional opinion techniques such as the Delphi method. The selected priorities are not expected to be different, but the variance would better express degree of confidence. An example of this approach was used to assess biosecurity risk factor importance for livestock-disease transmission by the Population Medicine Group at the Royal Veterinary College in the UK (Anon. 2005), although it still relied on a relatively complex iterative procedure for ranking professional opinion, rather than directly quantifying options using economic or similar analyses, a limitation recognised in that report.

Independently of research prioritisation, one potential use of the very basic economic analysis used in this prioritisation process is rapid one-option comparisons by an agricultural business where the relative impacts on business outcomes are validated. This may help streamline economic analyses where specific data are very limited and may have to be guessed to operate standard models that demand a high number of inputs. An example of this is in establishing breeding objectives for an enterprise; this has been successfully conducted by one of the authors. All potential objectives were listed and assessed with calculated relative impact on EBIT multiplied by the lowest value of 1–3 ratings on the frequency of the targeted problem, the heritability and whether the traits can be measured.

It is concluded that the method described in this report was very successful in defining the priorities for foetal- and calf-loss interventions research in northern Australia. This method, with suggested variations, could be used to assess priority for RD&E of other issues, as well as simply for assessing management options within a production enterprise.

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