Technology Design and Marketing: Case Studies in Beef Cattle Breeding

T.G. PARMINTER, R.L. WILKINSON[1], I.S. TARBOTTON, J.L. CARTER,
W.H. McMILLAN[2] AND D.C. SMEATON

AgResearch, Whatawhata Research Centre, Private Bag 3089, Hamilton, New Zealand.

ABSTRACT

An assessment of farmer beliefs and attitudes to predict likely use of new beef breeding cow technologies was undertaken with farmers from Northland, King Country, and Hawke's Bay. In workshops, farmers evaluated the use of twinning through embryo transfer, artificial insemination with sex-sorted encapsulated semen, and terminal sires. The proportions of farmers likely to use the technologies to some extent, were 55, 72, and 83% respectively. Farmers identified the important interactions that would be expected to occur if the technologies were introduced into typical beef farming systems in their area. Attitudes towards each technology and towards selected technology attributes, indicated important considerations for future development of the technologies. These included their ability to: improve breeding cow returns; achieve easy care calvings; and integrate with sheep enterprise management to provide leafy feed for lambs. Consideration of these attributes in technology research, development, and marketing, is likely to improve technology uptake.

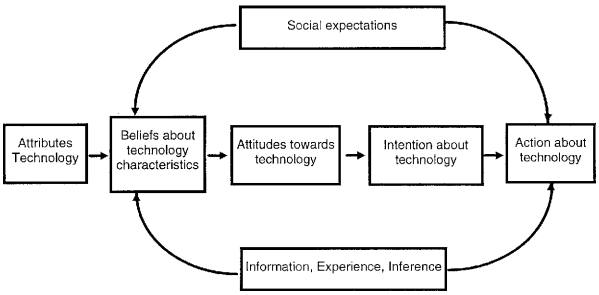
Keywords: extension; innovation; beef; breeding cows; reproductive technologies; farmer beliefs.

INTRODUCTION

Beliefs, Attitudes and Technology Adoption

The value of investing in research and development of new technology is enhanced when the research is shown to take into account the needs of users (Foundation for Research, Science and Technology, in press). The authors have previously reported (Parminter 1994, Parminter *et al.*, 1993) that the beliefs and attitudes of individual farmers towards technologies provided better estimators of their actual adoption decisions than other farm and farmer variables. In those studies, beliefs and attitudes about technologies were formed by farmers' perceptions of how the technologies interacted within the systems in which they were used. A model is shown in figure one to describe how farmers' beliefs and attitudes may effect their adoption behaviour. In the model, technologies are shown with attributes that can be measured quantitatively (e.g. price and effects upon animal reproduction). These attributes do not affect people's actions directly, instead it is the beliefs which are formed from farmers' perceptions about the relationships between technologies and their characteristics that affect attitudes, and so actions. Beliefs may include tangible and intangible characteristics such as; how using technologies will affect enterprise management and farm profitability. Not all of the farmers' perceptions of these relationships will be the same as the attributes described by scientists. Beliefs are formed following farmer experience with the technologies and other sources of information including that provided by farming authorities. Beliefs provide the basis for attitudes which lead to a general intention to use or not use the technologies. Attitudes are overall favourable or unfavourable dispositions by farmers towards technologies. Farmers dispositions being based upon whether their positive or negative beliefs about the technologies predominate. Beliefs are not themselves positive or negative, but attitudes (which are) can be much more emotional, linking technologies with people's "self" concepts.

FIGURE 1: Proposed Model Of How Farmer Beliefs And Attitudes Are Influenced And In Turn Affect Farmer Adoption Behaviour. *After Fishbein and Ajzen 1975.*



Intentions to behave in a certain way may be modified by opportunities, planning, and the availability of resources, before becoming apparent in farmers' actions. Social pressures, actual experiences, information, and inferences made from all of these, can modify the transition through each step in the model. Although (Parminter,1994) similar models have been applied to studies of existing farm technologies, no other studies have been undertaken of farmers' beliefs and attitudes towards new technologies that are not yet generally available.

[1] Landcare Research NZ Ltd, PO Box 69, Lincoln 8152, New Zealand.
[2] AgResearch, Ruakura Agricultural Centre, Private Bag 3123, Hamilton, New Zealand.

This paper examines the results of a quantitative methodology being applied to study the potential use by farmers of new undeveloped technologies intended to improve breeding results on beef breeding cow farms. It tests the hypothesis that farmers likely to use the technologies have different belief relationships than those unlikely to use them.

MATERIALS AND METHODS

Technologies

Two of the three technologies in this study had been the subject of applied research projects but were not yet commercialised, and the third had been included in the previous paper. (Parminter, 1994). Technology (i) was embryo transfer induced twinning in beef cattle using embryos of known parentage, breed, and sex (McMillan, 1996). Technology (ii) was the production of calves of known sex through artificial insemination with slow-release encapsulated semen (Vishwanath *et al.*, 1992). This was taken to be the use of superior genotypes in a single fixed-time artificial insemination programme, i.e. all the cows in the herd inseminated on one day with slow-release semen. Technology (iii) was the use of terminal sires to produce progeny all destined for slaughter. This technology was defined as being the use of exotic (or continental Europe) breed bulls in natural mating to produce crossbred calves for finishing (Baker and Morris, 1981).

The use of terminal sires was already practised by many of the respondents in this study, but none of the farmers who participated in the workshops had had direct experience with either technology (i) or (ii). However they were all able to contribute freely to the material collected at each workshop by making (usually collective) assumptions about each of the technologies and inferences, based upon comparable experiences. Farmer experiences included using artificial insemination on dairy farms, having experience with infrequent spontaneous twinning in beef cows, and managing sheep flocks with multiple births.

Overview of Multidimensional Analysis using the Galileo Method

Using a method developed for sociology and market research a multidimensional analysis of beliefs and attitudes was carried out (Woelfel and Fink, 1980). In the previous research on beef breeding cows (Parminter, 1994), logit regression analyses enabled evaluation of the large number of variables (102) in that study. One disadvantage of that method was that the inter-relationships between variables (including beliefs) were not able to be described. In order to study these inter-relationships, the Galileo method of scaling beliefs across a number of dimensions (Woelfel and Fink, 1980) was used. Respondents were required to provide distance measurements of the relationships between their belief concepts. They used a standard mental interval scale and answered questions about paired belief comparisons. The standard scale provided to all the respondents had concepts familiar to them. It was "Angus cows and Friesian cows are 100 units apart". From the results, the Galileo program provided tables of the mean distances between each of the concepts for statistical analyses (Woelfel and Fink, 1980). The distance measurements were also used by the program to build belief maps of the respondent's belief networks (Figures 2 and 3)

This methodology has previously been applied to the use of high fecundity sheep technology by Hawke Bay farmers (Saunders and Townsley, 1991) and in a study of horticultural consultants in the Bay of Plenty (Paine, 1991).

Sampling and Measurements

Farming organisations were approached to organise workshops in Northland (Mangonui, Dargaville, Warkworth), the King Country (Taumarunui), and Poverty Bay (Gisborne, Wairoa). A workshop process was used to encourage interaction between farmers so that their responses reflected their combined knowledge. Farmers (140) attended the six workshops lasting four to five hours. Briefly, the process followed was:

1. at the start of each workshop, farmers filled out their initial individual questionnaire.
2. they then met in groups to define a 'typical' beef breeding cow farm in their area.
3. then videos were shown describing each of the three technologies. To minimise changing perceptions through the workshop process itself, the technologies were presented to farmers in an objective manner.
4. after this, the groups considered the technologies and "brain stormed" (Moss, 1991) to describe the preferred and undesirable attributes of each technology.
5. finally the farmers completed a second questionnaire similar to the first one.

The questionnaires had sections on farmers' demographic information, their attitudes and beliefs, and their likely use of the technologies. Likelihood of use was scored along a dashed line between the extremes of "unlikely to use" and "likely to use". Respondents marks along the line were converted to numerical scores for analyses (Himmelfarb, 1993). To examine how much the beliefs and attitudes of farmers differed with likeliness-to-use, the belief maps of the quartile least likely to use each technology (quartile one), were compared with those for the quartile most likely to use the technologies (quartile four).

From the previous research, (Parminter, 1994) the main belief objects affecting farmer adoption decisions and included in this study were: conditioning leafy feed for lambs; having well reared young stock; controlling woody weeds; fitting existing farming methods; enabling easy wintering management; enabling easy care calving; and improving breeding cow returns.

To these were added concepts representing the new technologies: terminal sires, artificial insemination, and embryo transfer. To measure how farmers currently related the technologies to themselves, the concept "your present farm" was added. The concept "your ideal farm" was intended to provide an indication of farmers' perceptions about their idealised relationship with the technologies.

Statistical Analysis

The Galileo program provided a matrix of means and standard errors of belief distances for further analysis. Two-dimensional belief maps have been produced in this paper to simplify interpreting results. The results for Gisborne, Wairoa, and Taumarunui which had similar farm descriptions (Table 1) were combined for comparisons with Northland to identify any regional differences.

TABLE 1: Farm and Personal Information from farmers Attending Workshops

Variables	Northland	Gisborne/King Country
Number of Farmers	83	49
Farm Area (ha)	331	902
Number of Breeding Cows	223	302
Number of Finishing Cattle	207	214
Number of Breeding Ewes	607	3249
Number of Farm Workers	2	4
Age of Farmers	48	46
Years spent farming	27	28

The analyses tested the following issues: farmers' belief maps changes between the initial and final questionnaires; regional differences in belief maps; differences between the belief maps associated with each of the technologies; beliefs of people likely or unlikely to use the technologies; information that would encourage farmers to use the technologies.

RESULTS AND DISCUSSION

Description of the Farmers and Their Properties

Gisborne farmers had on average larger properties than Northland farmers (Table 1). Gisborne farmers also tended to have lower overall stocking rates, and a higher proportion of sheep to cattle. Farmer age and "time spent farming" were similar across districts. Fewer small holdings (80 hectares or less) were present than was expected from Statistics Department data (Statistics Dept, 1996).

Belief Mapping Results

There were no changes in farmer attitudes towards any of the technologies during the workshop. There was also no difference in the results between regions. In Table 2, the mean scores of farmers likely-to-use the technologies are shown for each quartile of technology users. Farmers considering terminal sire technology scored it higher on average in each quartile then embryo transfer. There was a very low average score for the second quartile for embryo transfer indicating that less farmers were uncertain about this technology and they tended to either score it very low or very high.

Many belief relationships were tested and found to be significant ($P<0.05$). Differences between the quartiles of likeliness-to-use were greatest for terminal sire technology and artificial insemination technology. The belief maps for embryo transfer (with results intermediate between the other two) are shown in figures 2 and 3. The maps are of the first two dimensions (of twelve), describing 76% of the variance in farmers' belief relationships. Concepts which are stable between the two quartiles are shown in similar positions in both charts. Concepts which have changed in relation to the others that were surveyed, are shown in different positions on each chart. The amount of difference between concept positions on each map is proportional to differences in the strength that beliefs are held by farmers in the two quartiles.

TABLE 2: Comparison of Mean Likely-To-Use Scores for Three Beef Breeding Cow Technologies. A score of 1.0 indicates unlikely to use; a score of 20 indicates likely to use

	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Terminal Sire	5.0 a	17 b	20 c	20 c
Artificial Insemination	5.0 a	12 d	18 e	20 c
Embryo Transfer	1.0 f	7 g	14 h	20 c

Means with different letters are significantly different ($P<0.01$)

FIGURE 2: A Typical Belief Map of Farmers Unlikely-to-Use Embryo Transfer Technology (labels have been shortened from the text to save space).

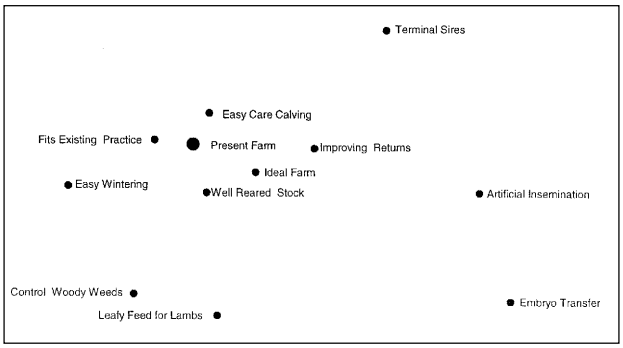
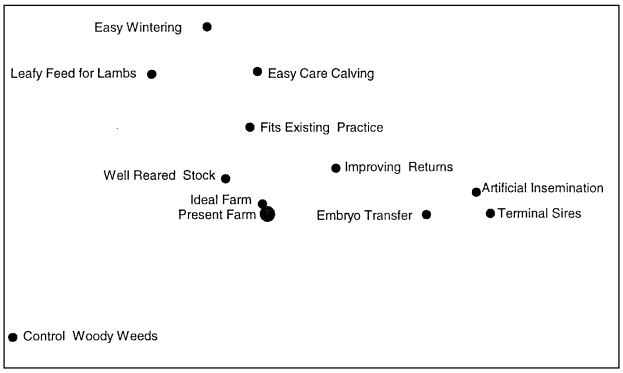


FIGURE 3: A Typical Belief Map of Farmers Likely-to-Use Embryo Transfer Technology (labels have been shortened from the text to save space).



Implications for Technology Development

Potential adopters of each technology including embryo transfer associate technologies more closely with their present farming operations and with their visions of

ideal farms. Across all the technologies, likely users (quartile four) farmers generally placed less importance than unlikely-to-use farmers (quartile one) upon a need to control woody weeds, and manage easy wintering systems. Likely users placed more emphasis upon well reared young stock, improving breeding cow returns, and linking all three technologies with their present farm. Belief relationships can have negative or positive effects upon peoples' attitudes towards technologies. For example a strong relationship such as that between a technology and "improving breeding cow returns" can encourage farmers to have a positive attitude towards the technology. Conversely, negative attitudes can result from other strong relationships such as that between a technology and "controlling woody weeds". Information can be provided to farmers to encourage them to change their beliefs and develop more positive attitudes towards a technology. The Galileo program was used to identify and prioritise key beliefs affecting farmer attitudes towards the technologies in this study.

Farmers likely to use the technologies needed information to substantiate their existing beliefs in the financial returns from the technologies.

Farmers currently unlikely to use the technologies needed information to change the belief relationships that dominated their attitudes. Based on our current findings, we propose that to encourage a greater use of terminal sires, farmers should be provided with information on: the effects of a terminal sire enterprise upon integrated grazing of breeding cows and sheep to provide leafy feed for growing lambs; the effects of a terminal sire enterprise upon having well reared young stock for finishing cattle and herd replacements; and disassociating the link between terminal sires and an idealised farm, and strengthening the link with present farming circumstances.

To encourage a greater use of artificial insemination, farmers should be provided with information on: the effects of an enterprise using artificial insemination upon integrated grazing of breeding cows and sheep to provide leafy feed for growing lambs; how to access good terminal sires; and disassociating the link between artificial insemination and an idealised farm, and strengthening the link with present farming circumstances.

Finally, to encourage greater use of embryo transfer, farmers should be provided with information on: how to access good quality terminal sires; the effects of using embryo transfer upon obtaining well reared young stock for finishing cattle and herd replacements; and the effects of an embryo transfer programme upon integrated grazing of breeding cows and sheep to provide leafy feed for growing lambs.

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