Cattle breeding in Northern Australia: Revealing how consumers react to new technologies[1]

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Abstract

In Australia, *Bos taurus* cattle breeds produce high quality meat, superior in taste and tenderness characteristics. Nevertheless, these breeds do not thrive in the Northern Australian environment. Stem cell transplant techniques could improve northern beef cattle breeding programs by facilitating crossbreeding via natural service. Focus groups were used in this study to explore consumer reaction to reproduction technologies and the implications for buying intentions. Findings suggested that consumers may react negatively to unconventional breeding technologies but the degree of this aversion is contingent upon how the technology is described. These findings are relevant for preparation of choice modeling surveys.

Key words: Non-market valuation, consumers, focus groups, new technologies, beef

1. Introduction

Standards of livestock husbandry and the welfare of animals in livestock production systems are becoming increasingly important factors influencing customer perceptions of animal products in many markets (Strom 2006; Fisher 2006). If animal breeding research and animal selection decisions are to be appropriate, biological research must unite with socio-economic research to address issues associated with consumer attitudes towards foods of animal origin and how consumers weigh different social considerations such as animal welfare, traditional practices, regional distinctiveness against price in their purchase decisions over time FABRE (2006).

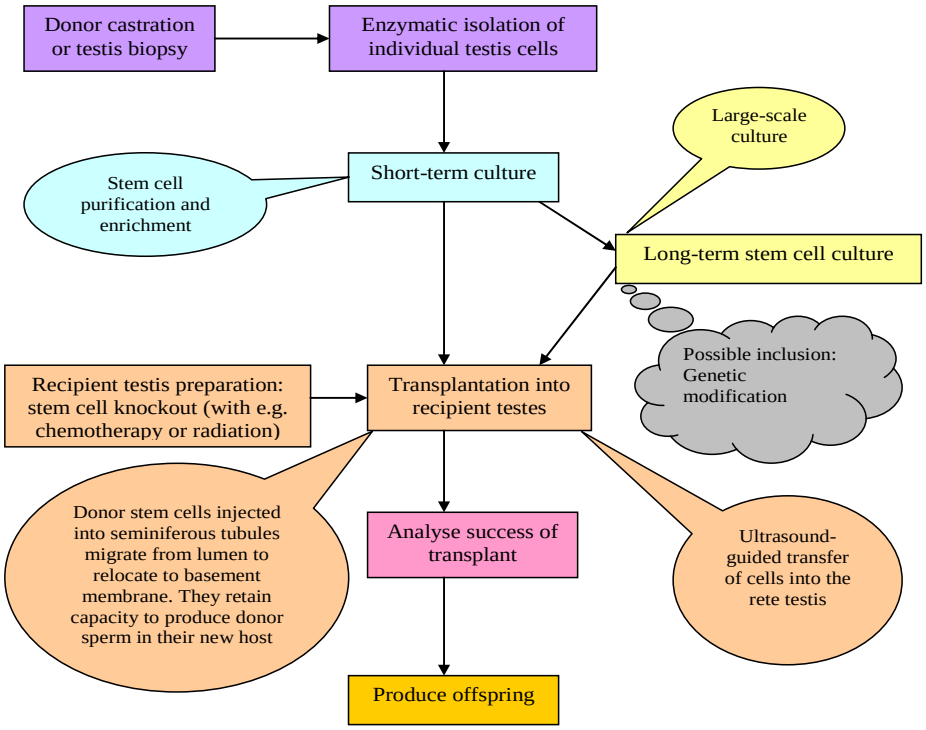
Breeding procedures, natural or artificial, that cause or are likely to cause suffering, injury or distress to any animals involved should not be practiced (e.g. Neeteson-van Nieuwenhoven *et al.* 2006; Gamborg *et al.* 2005), Even so, Gamborg *et al.* (2005) suggested that this provision still leaves room for breeding that causes minor or momentary suffering (e.g. natural delivery or embryo transplantation). Moreover, FABRE (2006) proposed that there is a need for research on the reproduction technologies required to underpin breeding and the effective dissemination of genetic improvement to all producers.

Artificial insemination (AI) is established in many livestock systems as a central method of animal reproduction with an essential role in breeding programmes and genetic dissemination (FABRE 2006; Foote 2002). In the initial stages of attempting to develop AI there were several obstacles including opposition from the general public who were against research that had anything to do with sex and associated with this was the fear that AI would lead to abnormalities (Foote 2002). The knowledge gained from the AI experience and the gradual acceptance of AI technology worldwide provided the impetus for developing other technologies such as cryopreservation and sexing of sperm, estrous cycle regulation, and embryo harvesting, freezing, culture and transfer, and cloning (Foote 2002).

In Australia, *Bos taurus* cattle breeds produce high quality meat with superior taste and tenderness characteristics. Nevertheless, they are not as hardy as *Bos indicus* cattle and wane in the Northern Australian environment. Breeding *Bos indicus* cows with a *Bos indicus* bull, ejaculating *Bos taurus* sperm, would improve the value of northern bred cattle by facilitating crossbreeding or introduction of new genetics via natural service (Hill and Dobrinski 2006). Being an alternative to AI in the cattle industry in areas where it is not practical (Hill and Dobrinski 2006), this CSIRO project aims to raise the performance of Australia's northern herd (18 million *Bos indicus*) by enabling mass production of *Bos indicus*/*Bos taurus* hybrids (CSIRO 2008). The first hybrid calves are expected by 2010 (CSIRO 2008).

The project uses stem cell transfer. Herrid *et al.* (2006) concluded that allogeneic transplantation of testicular cells can successfully occur between *Bos taurus* and *Bos indicus* cattle. The transplantation technique uses testis stem cells harvested from a donor animal that are then injected into the

seminiferous tubules where they migrate from the lumen to relocate to the base membrane and there retain their capacity to produce donor sperm in the new host (Hill and Dobrinski 2006) (Figure 1).



Source: (Based on Hill and Dobrinski 2006)

Figure 1: Stem cell transfer in male animals.

To gain some understanding about consumers' perceptions of this alternative production process to produce 'novel crossbred' beef, Mireaux *et al.* (2007) used repertory grid methodology whereby respondents considered the description of the goods and based on this consideration, ranked their preferences and likelihood of purchase. They found that consumers placed an equal ranking on 'novel crossbred' beef and Brahman beef produced by conventional breeding methods. However, their findings also indicated that despite age and gender, consumers would be significantly more likely to buy the 'conventional' beef over the 'novel crossbred' beef. Even so, the 'novel crossbred' beef seemed to be moderately well accepted and did not prompt a lot of concern during group discussions. Issues arising from this study included: the potential biases that could have arisen from the information provided to respondents; the importance of consumers' risk preferences in deciding whether they would buy a product that has been produced by techniques largely unknown to them; the level of knowledge of the 'novel crossbred' beef that they would require to make a rational decision about purchasing this product; the importance of consumers' perceptions of animal welfare associated with these techniques; and how 'high' or 'low' the price would have to be before consumers changed their desire to purchase the product.

Clear-cut production traits and improved food quality may increase the *market* value of the product, however, other concerns may lack an immediate market value (Gamborg *et al.* 2005). In the case of animal welfare, animal husbandry techniques that do not meet with the approval of consumers may not succeed commercially (Frewer *et al*. 2005). Some values (e.g. productivity) can be, and are, priced

whereas other values (e.g. animal welfare) are not usually directly priced and while there are trade-offs involved in the breeding process, e.g. between price of the product and the quality of the product, these trade-offs are easier to make when there is a direct market price attached (Gamborg *et al*. 2005).

Lagerkvist *et al.* (2006) conducted a study to find consumers' preferences for immunocastration in pigs by comparing willingness-to-pay estimates obtained from a choice experiment by having consumers trade off price and product attributes characterized by various levels of animal welfare, taste quality, and use of biotechnology in production of pork. The specific focus in this study was on castration of male pigs[3]. Pigs can be either surgically castrated (has welfare implications), or they can undergo immunocastration whereby the vaccine stimulates the male pig's immune system to ultimately inhibit reproductive processes (Lagerkvist *et al.* 2006). Lagerkvist *et al.* (2006) found that people seemed to accept potential food safety risks to alleviate animal welfare problems related to surgical castration but they preferred pork from surgical castrates over pork from intact boars indicating that taste quality as a product attribute dominates over animal welfare concerns.

This research indicates that consumers are able to make trade-offs between meat eating characteristics and production processes but as suggested by Mireaux *et al.* (2007), the information provided to them when making these trade-offs is likely to have an effect on their choices. Hallman *et al*. (2003) found general disapproval of animal-based "genetically modified" foods but many of the respondents who initially disapproved of the genetic modification of animals in an abstract sense later indicated that they approved when presented with specific examples, suggesting that opinions about genetic modification are malleable when additional information is presented (Hallman *et al*. 2003). van Eenennaam (2006) reported that half of respondents had never heard about traditional livestock crossbreeding schemes, and this widely used breeding approach received only a 31 per cent acceptance rating with 50 per cent of the respondents indicating that they considered the crossbreeding of animals to be morally wrong. This finding is in line with that of Bruhn (2003) found that less than 40 per cent of respondents indicated support for traditional crossbreeding practices while more than 40 per cent supported the use of biotechnology to produce leaner meat, or enhance animal disease resistance. While the author questions consumers' knowledge of livestock production practices it is possible that consumers may have a different opinion when the emphasis is on the food product as opposed to the production practice. Aldrich and Blisard (1998) who noted that a large proportion of consumers disapprove of traditional cross-breeding but this does not necessarily mean refusal to purchase milk and meat from common farm animals.

To extend upon findings of Mireaux *et al.* (2007) and using focus group methodology as described by Hartman (2004) and choice experiments, similar to Lagerkvist *et al.* (2006), the aim of this paper is to explain the development of the experimental design for a choice experiment and the subsequent experimental results. In particular, the study aims to determine if the description of reproduction technologies, and in particular stem cell technology, used in beef production influences consumers' buying intentions. The paper is divided into two parts. Part I details development of the experimental design and Part II reports methodology and results from the choice experiment. Conclusions are drawn in the final section.

2. Part I: Development of the experimental design

2.1 Methodology

Focus groups were conducted to explore people's perceptions of words and phrases used to describe the production technology and attributes to be used in the choice experiments. A questionnaire based on focus group findings was constructed and tested in an on-line pretest to further test the technology descriptions and the delivery mechanism before the main survey was completed.

[3] Castration of male pigs is routinely performed worldwide to reduce the odor or flavor of boar taint in pig carcasses (Lagerkvist *et al.* 2006).

Two focus group sessions were conducted by a moderator from Customers' Voice. The first session was held in May 2008 with the aim being to gain a better understanding about how consumers view meat purchases and how they react to various descriptions of reproduction technologies in livestock production. To further explore people's reactions to stem cell technology used in beef production and descriptions of specific words (e.g. stem cells), a second focus group was conducted in June 2008.

The focus groups were conducted at West Coast Field Services professional viewing rooms with participants recruited by the University of Western Australia (UWA). A short screener questionnaire was completed by all potential respondents to ensure that the focus group was made up of a wide range of age groups and professions. People working in fields of animal husbandry or research and/or were strongly opposed to genetic modification were not included in either focus group. Eight people were selected for each group.

How people purchased meat was explored in the Focus Group 1 with participants being asked to describe how and why they bought their meat and what they felt were important considerations when making their purchasing decisions. They were also asked to rank the importance of factors including price of meat, where the meat was produced and awareness of how the animals were raised. Discussion on interpretation of these factors followed. Respondents were then presented with an AI explanation and asked to record their perceptions and acceptance of this technology and whether they found the explanation confusing. The same procedure was followed when given a description of stem cell technology used in beef production. No group discussion took place until each of the written exercises was completed.

In Focus Group 2, the emphasis was on obtaining information from the person most responsible for household grocery purchases and on specific words used in the explanations. Respondents were again presented with the AI and stem cell technology explanations and asked to record their perceptions and acceptance of these technologies and whether they found the explanations confusing. They were given similar exercises for explanations pertaining to AI, stem cells, genetic modification and stem cells, radiotherapy, and the use of stem cells in human health.

Findings from the focus groups (see below) were expanded upon to develop choice experiment questionnaires for pre-testing. There were four questionnaires, each designated a different description of the technology. The first version (A) included the key words, 'stem cells' and 'radiotherapy', the second version (B) referred only to 'stem cells' omitting 'radiotherapy' while the third (C) did not mention either term but instead referred to a 'treatment' for cattle. The remaining version (D) focused on artificial insemination rather than stem cell use. In each of these four treatments the reproductive technologies represented an alternative to the conventional reproductive technology (see Appendix 1 for descriptions). The Online Research Institute (ORU) (see Appendix 2) was selected to distribute the questionnaires during September 2008. A quota of 50 respondents for each group was set. Respondents were asked to make choices between steaks (see Figure 2 for an example of a choice question) that differed in terms of the following 'attributes': reproduction technology used; whether the cattle were finished in the "paddock" or "feedlot"; state of origin for the beef production; price of the beef (Appendix 2). They were reminded that taste, texture and appearance of all steaks were the same as their usual steak. Respondents were also asked to consider attitudinal, behavioral and knowledge questions.

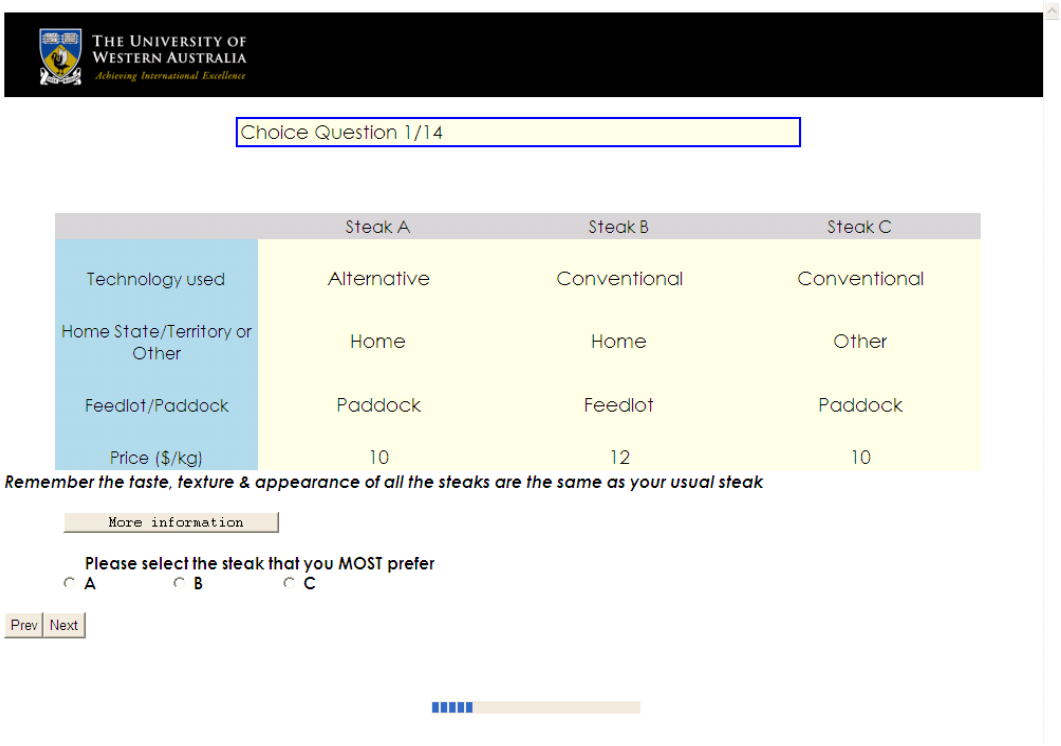


Figure 2: A typical choice set that a respondent would consider in the on-line questionnaire

2.2 Results and discussion

Participants in Focus Group 1 had varying perceptions about 'meat' depending on how they intended to cook it and who it was for. Therefore in developing the choice experiment questionnaire, people were asked to value meat that was specifically defined as '*their usual beef steak*'. Also participants did not necessarily think in terms of price per kilo and hence in the questionnaire it was clearly stated in the valuation question that the question pertained to the '*price they paid for their usual beef steak in $/kg*'. In line with findings from Alfnes (2004) and Carpenter *et al.* (2001), participants placed importance on quality characteristics of the meat and gave little thought to the production process. Hence when constructing the questionnaire, the attributes were clearly explained so that all survey respondents had the same basic knowledge about the production technologies of interest. In addition, the focus groups participants mentioned some ethical concerns with e.g. free range chickens and the treatment of animals in general and so basic welfare information stating that production '*meets animal ethics and welfare guidelines*' were included in the questionnaire.

Generally the findings from the first focus group indicated that consumers had enough knowledge and experience to value meat with different attributes but the technology descriptions needed rewriting to remove some ambiguity. Discussion centred on whether the beef would be the same quality as they would normally buy and so it was decided to take the word '*quality*' out of the technology descriptions so that it didn't cause confusion for the choice experiment. When given the technology descriptions, participants were able to comprehend the technique being used although it was decided that the descriptions could be simplified as the participants didn't want so much scientific information. Words that could be misinterpreted such as '*normal*' were reviewed. After group discussion, the majority of the group said they would purchase meat produced as outlined in the AI technology description. There was concern about purchasing meat produced with a technology using stem cells and radiotherapy. Two participants said they would be likely to purchase meat produced this way, four were unsure and two said they would be unlikely to do so. Radiotherapy was linked negatively with cancer treatments and so it was decided to include in the survey a version of the technology description that included the

term '*radiotherapy*' and others that did not. These descriptions were developed to differ in terms of the use of certain keywords thought likely to trigger strong and/or emotive responses. There was also confusion with the link between stem cells and embryos and hence it was decided in Focus Group 2 to differentiate between embryo and adult stem cells. When discussing animal breeding the main focus was on genetic modification, which was viewed negatively. Hence it was decided in the technology descriptions for the survey to include an explanation stating that this process is not genetic modification; "*Note that these cattle and the meat from them are not classified as genetically modified or GM food*".

As in Focus Group 1, participants in Focus Group 2 did not spontaneously think about how the meat they eat was produced. This was largely because they felt that meat in Australia was 'safe'. They did not spontaneously mention any breeding issues such as AI, or genetic modification. Overall, participants did not object to the technology description. There was some confusion by the phrase, '*produce identical sperm*' and so in the questionnaire the relevant sentence was rewritten as "*a Northern bull can be treated so that he produces sperm resembling that produced by the Southern bred bull*". There were also still concerns about connections between the words '*embryos*' and '*stem cells*' and they found it difficult to understand that '*adult*' stem cells did not necessary come from an adult being. It was therefore decided in the technology description for the survey to leave out any reference to '*embryo*' or '*adult*'. Generally respondents were concerned about the potential impact on people who ate meat produced using radiotherapy as part of the production process. This finding further supported the decision to explore this aversion further in the survey. Further information pertaining to providing medication to the cattle that had undergone radiotherapy was viewed negatively and as it added confusion to the technology description it was decided to exclude it from the survey.

Qin and Brown (2006) used focus group discussions to compare the effect of limited and detailed information on how participants formulated their opinions about the good in question, salmon. They concluded that an effective communication piece about a specific genetically engineered application should contain basic and specific, including process- and product-related, information to help the recipient formulate consequences, and hence, opinions. However, in this study, participants felt that additional information sheets on various aspects such as adult stem cells were not required. Even so it was decided that for the main survey having an understanding of respondents' concerns about the technology was important and so attitudes questions pertaining to stem cells were included in the questionnaire. In addition, survey respondents were given the option to access further information if they wished to.

Half of the participants in Focus Group 2 indicated that they would eat meat produced by using the alternative technology and the other half said that they would not. When asked what would entice them to eat such meat, participants suggested; a low price, CSRIO backing, the Heart Foundation tick, if it tasted good, strict guidelines ensuring the animal was not hurt, endorsement from a key person (e.g. Gordon Ramsay), and an awareness of the long term effects on the animal and people who consume it.

The questionnaire for the on-line pretest was successfully distributed by ORU and within three working days the participant quota was filled and the data was immediately ready for processing. Data obtained from the survey indicated that respondents generally understood the questions and responded to them in a consistent manner. Preliminary analysis of the choice questions provided an indication about the weights being placed on the attributes, and whether they changed as the description of the technology changed. There was a preference for steak that was produced in the respondent's "home' state, but this effect did not vary across the four versions of the technology description. Respondents preferred steak produced from cattle that were not finished in feedlots and this effect also did not vary across the four versions of the technology description. As a consequence in the questionnaire for the main experiment, additional questions were included to determine if respondents ignored any of the attributes used in the choice set.

There was a preference for steak that was produced using 'conventional' technology over that produced by the 'alternative'. The degree of this effect is modified by the description (A, B, C and D) used. The strongest adverse response was associated with the description of the technology which used the "stem cell and radiotherapy" terminology. There were smaller, but still significant, adverse responses to the other two technology descriptions that used the 'alternative technology' (versions B and C). However, the effect was the same as the adverse response that was generated by describing AI (version D). This suggests that there may be a generic effect associated with describing a specific breeding technology as something other than conventional, and that the stem cell technology did not deviate from that until the use of "radiotherapy" was included in the description.

Respondents presented with technology versions A and B (descriptions that explicitly included "stem cells") were asked their views about the use of stem cell technologies to enhance cross breeding cattle in the Australian beef industry. Of those whose description of the technology included the terms '*stem cell*' and '*radiotherapy*', 63 per cent of respondents expressed some concern, while 49 per cent of respondents who where given the stem cell only description indicated that they had some concern with the technology (Figure 3). While this finding is preliminary, it is inline with expectations from the focus groups and added to justification for including in the survey, four versions of the information describing the technology.

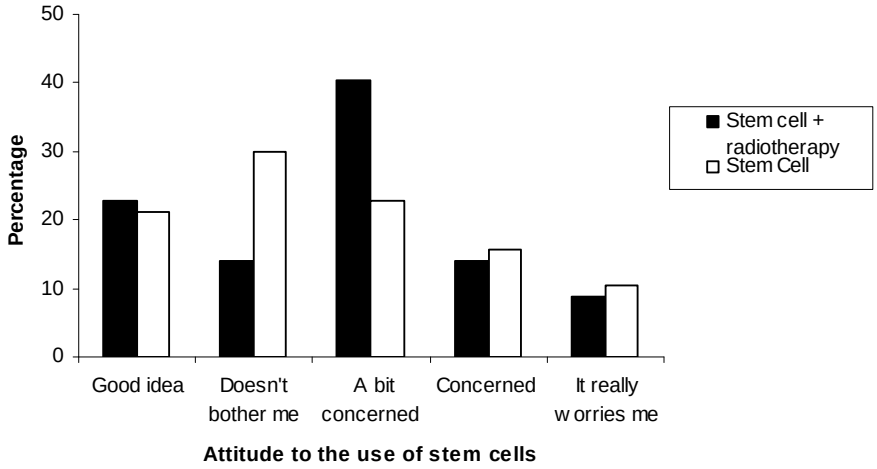


Figure 3: The number of respondents who selected each option for describing their attitudes towards the technology, by description of that technology

People who expressed concerns about the use of the technology were then asked what of a selected number of reasons captures their concerns. While the level of concern about the technology appeared to be higher in the '*stem cell + radiotherapy*' description, of those replying to this question, there seemed to be little difference in the causes for concern across the two groups (Figure 4).

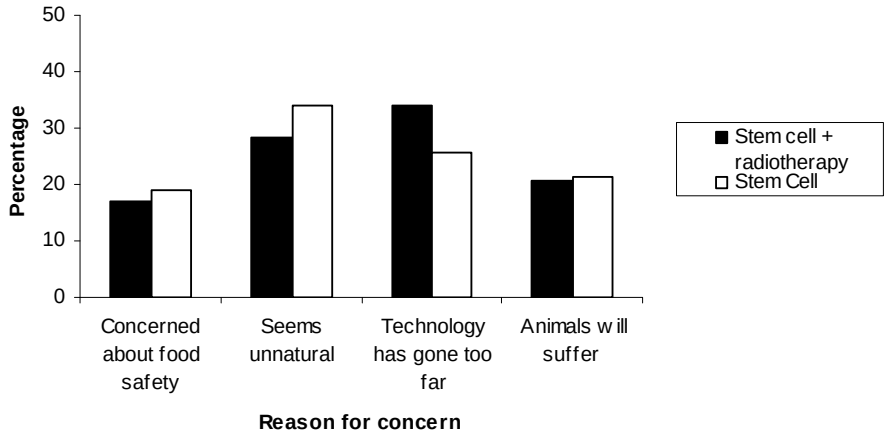


Figure 4: The number of respondents who selected a reason for why they had concerns associated with the technology, by description of that technology (note each respondent could select more than one reason).

Whether respondents were given the description of a reproduction technology with reference to stem cells or not, all were asked if they had heard about stem cells. A quarter indicated that they have heard about the use of stem cells in food production. The questions for the main survey were reviewed as a consequence to collect data pertaining to respondents' understanding of stem cells with and without prior information.

2.3 Conclusion

In this project the focus groups provided valuable information that contributed to the design of the questionnaire for the main experiment. Questions were restructured and additional ones added to improve data collection. The technology description was refined and key words that might change how people value the technology were identified from responses given by participants. The survey design was expanded to include four different questionnaires to differentiate between reactions to the key words. The questionnaire pre-test results indicated that the on-line procedure was an efficient means to collect the survey data. The results provided an indication of what we expected to find in the main survey.

3. Part II: The choice experiment

3.1 Methodology

The main survey was conducted as for the on-line pre-test. The data collection was conducted in mid-December 2008. Potential respondents were invited to complete the questionnaire and when the required sample size was reached the survey was closed. As for the pre-test, the experimental design was made up of four treatments with the questionnaire for each having a unique description (Versions, A, B, C and D as in Appendix 2). Again each of the technologies was related to the way steak is produced and respondents were then asked to consider a choice set and make choices between the steak they eat after considering the 'attributes'. The purpose of consumers making these choices was to find if respondents have particular preferences with respect to any of the attributes and if so, why. For example, do they prefer steak produced using conventional technology or the alternative technology and is price the most important factor in their decision to buy steak? In making these

choices the respondents are implicitly trading off between these attributes. Again, respondents were also asked to consider attitudinal, behavioral and knowledge questions.

To achieve efficiency gains in the design, research completed by Scarpa and Rose (2008) was considered in designing the choice. The design software allows one to make an estimate of the minimum sample size needed to obtain statistically significant results, given a set of prior values for the parameters. The latter were provided by models estimated using the data collected from the on-line pretest. In all cases the minimum estimated sample size was less than 30 respondents. So that the results obtained were robust to statistical design of the survey, the plan was designed to have 200 responses for each version of the questionnaire (i.e. for each version of the technology descriptions).

3.2 Results and discussion

The target sample realized was greater than the minimum identified with a total of 1,077 people completing a questionnaire within a week of making it available on-line (Table 1).

Table 1: The total number of people completing each version of the questionnaire.

Treatment	Completed questionnaire
Version A	266
Version B	263
Version C	274
Version D	274
Total	1,077

The demographic profile of the survey sample appeared to represent the general population, with respondents from all Australian States and Territories (Figure 5), of all age (Figure 6) and education (Figure 7) groups, and with an even distribution of gender (Figure 8).

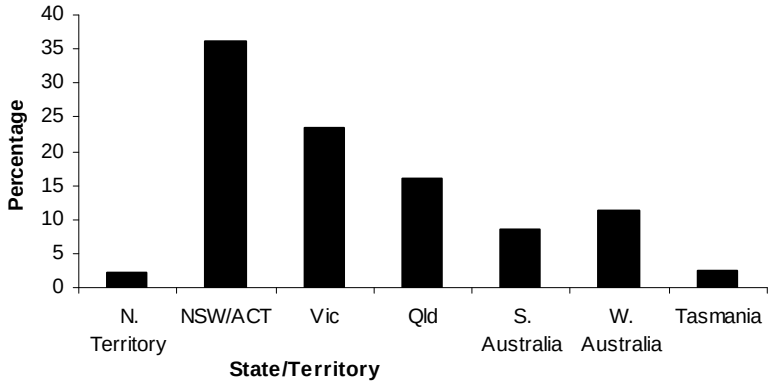


Figure 5: Percentage of respondents from each State/Territory

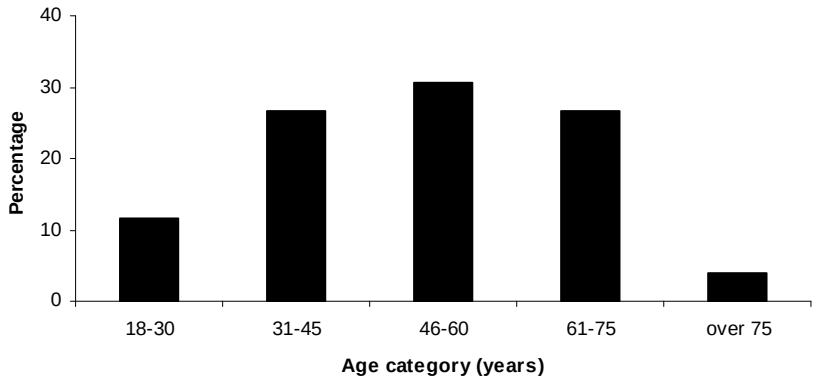


Figure 6: Age of respondents

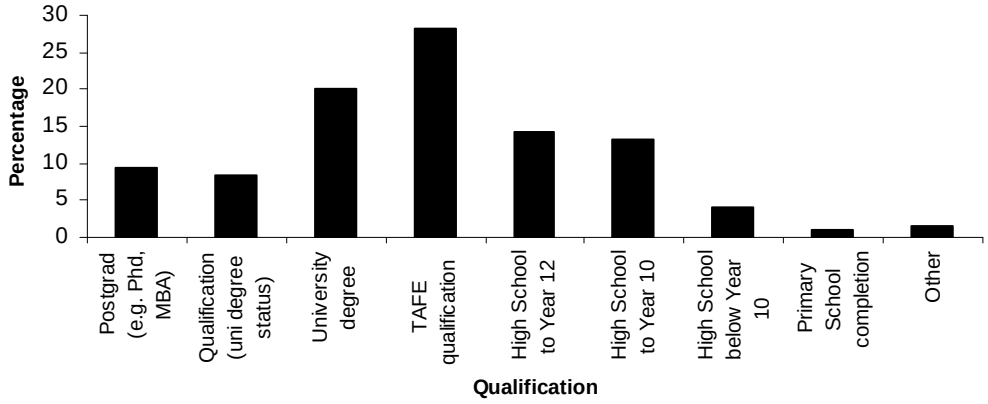


Figure 7: Level of education completed by respondents

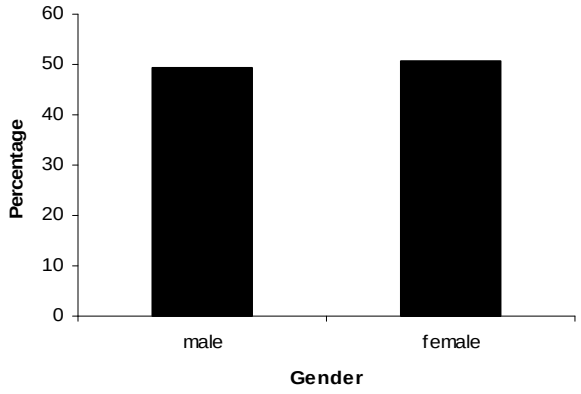


Figure 8: Gender of respondents

Results for the conditional logit models estimated for the survey responses for each version of the technology descriptions are presented in Table 2. The estimated coefficients represent the marginal utility associated with a unit change in each of the attributes, alternative technology to the 'conventional', place of origin, cattle production in a feedlot or on pasture and price of steak.

Table 2: Conditional Logit results for steak choice, by breeding technology description

	Version A	**Version B**	**Version C**	**Version D**
Technology	-0.647 (14.45)**	-0.437 (9.87)**	-0.523 (11.97)**	-0.309 (6.86)**
Place of origin	-0.505 (11.19)**	-0.322 (7.46)**	-0.349 (7.77)**	-0.559 (13.05)**
Feedlot or pasture	-0.751 (15.83)**	-0.693 (15.29)**	-0.794 (17.32)**	-0.811 (16.83)**
Price	-0.093 (15.07)**	-0.072 (13.62)**	-0.099 (16.39)**	-0.087 (15.29)**
Observations	2423	2904	2568	2556
Estimated amount to avoid the alternative technology ($/kg)	$6.90 (10.79)**	$6.08 (9.09)**	$5.28 (10.01)**	$3.57 (6.42)**

Absolute value of z statistics in parentheses
*significant at 5%; ** significant at 1%
observations is number of choice questions completed

The results for all attributes were significantly different from zero, and negative. The restriction that the parameters are the same across technology descriptions is not accepted at better than a one per cent level for technology, place of origin and price. However, for the '*feedlot or pasture*' parameter, there isn't any difference across the descriptions. Focusing on the impact of the alternative technology across descriptions, the use of both stem cell and radiotherapy in the description (Version A) has the greatest impact. Although the description that did not mention any key words (Version C) is numerically greater than that for the description mentioning stem cells (Version B), statistically they are not different. However, they are greater than that for the technology description detailing AI (Version D). Moreover, the AI technology description induces an adverse effect, even though this is a commonly used existing technology. Whether this is a considered aversion to the technology or an experiment specific response to the inclusion of any 'alternative' technology in the choice experiment, is an issue that will be explored in further studies. In summary, the findings are in-line with the literature as discussed previously in the introduction of this paper, with beef production using the alternative technology, importation from other states, finishing the cattle on feedlots and raising steak price all reducing welfare.

A common method of interpreting these choice experiments is by estimating the maximum that respondents would be willing to pay to avoid a change in an attribute (Table 3). Respondents were willing to pay almost $7.00/kg to avoid the technology when described using the key words, stems cells and radiotherapy (Version A) but just over $5.00/kg when neither words were mentioned in the description (Version C). They were also willing to pay in excess of $3.50 to avoid technology associated with AI (Version D). These findings indicated relatively high levels of economic aversion to the technology. Gamborg *et al.* (2005) also reported that most survey participants thought that animal breeding, livestock production and the ethical[4] aspects of animal breeding were important

[4] The exact definition of 'ethical' was not defined in the paper.

consumer issues. Reproduction techniques such as artificial insemination and freezing of semen were considered acceptable for most participants but techniques such as heat induction, embryo transplantation, cloning, sperm sexing and triplodisation were not seen as acceptable by survey respondents (although many respondents did not know what the techniques and their implications were) (Gamborg *et al.* 2005).

To explain the aversion to technology, as in the pre-test, respondents presented with technology versions A and B (descriptions that explicitly included "stem cells") were questioned about their attitudes towards the use of stem cell technologies to enhance cross breeding cattle in the Australian beef industry. For those respondents given the technology description that included the terms 'stem cell' and 'radiotherapy', 56 per cent of respondents expressed some concern, while 49 per cent of respondents who where given the description containing stem cells only indicated that they had some concern with the technology (Figure 9). However, but there is no statistical difference between the two (pr=0.388). These findings (Figure 9) are slightly different to those of the pre-test (Figure 3) in that slightly fewer people in the main survey appeared to be worried about the technology when described as '*stem cell + radiotherapy*'. Again comparing the pre-test and main survey, attitudes also did not differ by so much in terms of level of concern about the technology when given either description. Further studies will focus on this difference.

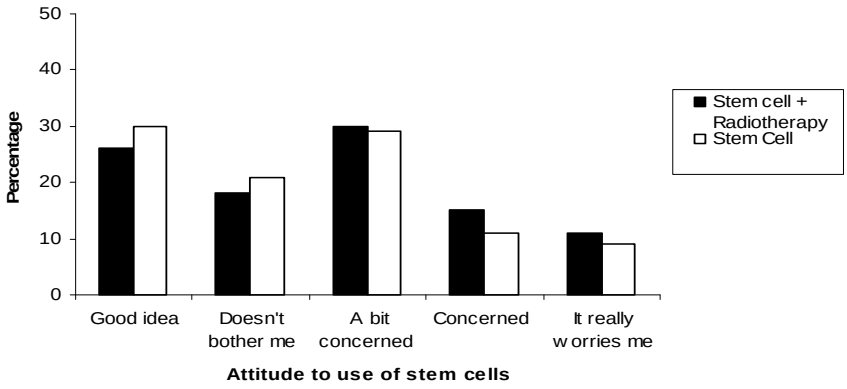


Figure 9: The percentage of respondents who were concerned or not about the use of stem cells in cattle breeding given the different descriptions that they received

Furthermore, respondents who expressed concerns about the use of the technology were invited to a select from a number of reasons that might explain their concerns. Of those replying to this question, there seemed to be little difference in the causes for concern across the two groups (Figure 10).

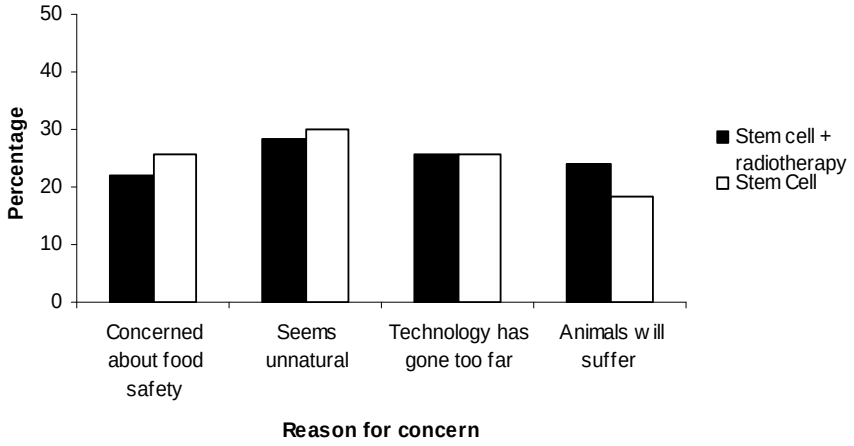


Figure 10: The percentage of respondents who selected a reason for why they had concerns associated with the technology, by description of that technology (note each respondent could select more than one reason).

For respondents given the description with stem cells only, it can be concluded that these findings are similar to those of Frewer *et al.* (2005) who found that consumers rated animal welfare as less important than food safety. However, once radiotherapy was included in the description, respondents may have been more concerned about animals suffering than about food safety. However, given that participants in the focus groups linked radiotherapy and cancer, survey respondents may also have been considering food safety. This notion will be explore in future studies.

When respondents considered each choice set they made their decisions based on all of the attributes, or if they considered an attribute to be unimportant to them they may have decided to disregard it when they made their choices. In this sample, 29 per cent of respondents said that they ignored at least one attribute and some ignored more than one. The most ignored attribute was the technology option and the least ignored was price (Figure 11).

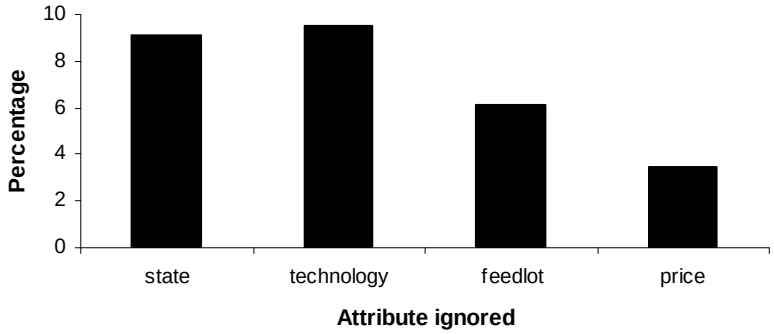


Figure 11: The percentage of respondents who ignored an attribute

Recent studies suggest methodology to deal with respondents ignoring attributes and the implications on the estimation process. Hensher *et al.* (2005) and Saelensminde (2001) proposed a method whereby

estimation of random parameter logit models is adjusted so that the marginal utilities of the relevant attributes are constrained to be zero for those who ignored that attribute. Campbell *et al.* (2008) focused on the impacts on error variance for respondents who ignored attributes. Further analyses in this study will reveal if there is any difference in the estimation process between survey participants who said they ignored an attribute and those who did not and the subsequent implications on this process.

3.3 Conclusion

Over 1,000 people responded to the main survey, with the population being from a wide range of demographics. Generally respondents were willing to pay to avoid any alternative technologies to those used to produce cattle in the 'conventional' way. Of those told about 'radiotherapy' and/or 'stem cells', around half had some level of concern about the technology. Less than a third of respondents ignored one or more attributes when considering the choice sets and implications of this action on the estimation procedure will be considered in future studies.

4. Conclusions

The process of using focus groups and pre-testing was important in this study so that the final attributes and technology descriptions used in the choice experiment were relevant to consumers. The level of detail and the use of words were also found to affect consumers' comprehension of the technologies and it was important to make sure these aspects were correct so that the effect of the 'key words' could be assessed.

While it is apparent that some consumers were not concerned about the use of stem cell technologies in animal production, generally people were willing to pay to avoid eating steak that had been produced using these technologies. Moreover, it appears that they would pay more to avoid this steak when specific key words providing additional information about the technology were used to describe the steak being valued.

FABRE (2006) and Neeteson-van Nieuwenhoven *et al.* (2006) suggested that transparency about new technological developments, clear definitions of terminology and an open dialogue with society are important for all stakeholders. However, whether this leads to greater acceptance of such technology as alluded to by IFIC (2007) would be worth exploring in future studies associated with the use of stems cells in cattle production.

References

Aldrich L. and Blisard N. (1998). Consumer Acceptance of Biotechnology: Lessons from the rbST Experience. Current Issues in Economics of Food Markets, Agriculture Information Bulletin No. 747.01, Economic Research Services, United States Department of Agriculture.

Alfnes F. (2004). Stated preferences for imported and hormone-treated beef: application of a mixed logit model. *European Review of Agricultural Economics* **31(1)**: 19-37.

Bruhn C.M. (2003). Consumer attitudes toward biotechnology: Lessons for animal-related applications. *Journal of Animal Science* **81**: E196–E200.

Campbell, D., Hutchinson, W.G. and Scarpa, R. (2008) Incorporating discontinuous preferences into the analysis of discrete choice experiments, *Environmental & Resource Economics* **41(3)**: 401-417.

Carpenter C.E., Cornforth D.P. and Whittler D. (2001) Consumer preferences for beef colour and packaging did not affect eating satisfaction. *Meat Science* **57(4)**: 359-363.

CSIRO (2008). Engineering better Australian seafood and beef: Website details for the Breed Engineering Theme of the CSIRO Food Futures Flagship. Retreived 20/01/2009 from http://www.csiro.au/science/psp8

FABRE (2006). Sustainable farm animal breeding and reproduction: A vision for 2025. The Farm Animal Breeding and Reproduction European Technology Platform. Paper prepared for the FABRE Technology Platform, February. Retrieved 8th November 2007 from: www.inra.fr

Foote R. H. (2002). The history of artificial insemination: Selected notes and notables. *American Society of Animal Science*: 1-10.

Frewer L.J., Kole, A., Van De Kroon, S.M.A and De Lauwere C. (2005). Consumer attitudes towards the development of animal-friendly husbandry systems. *Journal of Agricultural and Environmental Ethics* **18**: 345–367.

Gamborg C., Olsson A. and Sandøe P. (2005). Farm animal breeding related ethical concerns and tools for implementation. Project report 11, Danish Centre for Bioethics and Risk Assessment, the Royal Veterinary and Agricultural University, Copenhagen, September.

Hallman, W. K., Hebden, W. C., Aquino, H.L., Cuite, C.L. and Lang, J.T. (2003). *Public Perceptions of Genetically Modified Foods: A National Study of American Knowledge and Opinion.* (Publication number RR-1003-004). New Brunswick, New Jersey; Food Policy Institute, Cook College, Rutgers - The State University of New Jersey.

Hartman J. (2004) Using focus groups to conduct business communication research. *Journal of Business Communication* **41(4)**: 402-410

Hensher, D.A., Rose, J.M. and Greene, W.H. (2005) The implications on willingness to pay of respondents ignoring specific attributes, *Transportation* **32**: 203-222.

Herrid M., Vignarajan S., Davey R., Dobrinski I. and Hill J.R (2006). Successful transplantation of bovine testicular cells to heterologous recipients. *Reproduction* **132**: 617–624.

Hill J.R. and Dobrinski I. (2006). Male germ cell transplantation in livestock. *Reproduction, Fertility and Development* **18**: 13-18.

IFIC (2007). Food Biotechnology: A Study of U.S. Consumer Attitudinal Trends, 2007 REPORT. International Food Information Council Foundation. Retrieved 9th November 2007 from: http://www.ific.org/research/biotechres.cfm?renderforprint=1

Lagerkvist C.J, Carlsson F. and Viske D. (2006). Swedish Consumer Preferences for Animal Welfare and Biotech: A Choice Experiment. *AgBioForum* **9(1)**: 51-58.

Mireaux M., Cox D.N., Cotton A. and Evans G. (2007). An adaptation of repertory grid methodology to evaluate Australian consumers' perceptions of food products produced by novel technologies. *Food Quality and Preference* **18**: 834–848.

Neeteson-van Nieuwenhoven A.-M., Merks J., Bagnato A. and Liinamo A.-E. (2006). Sustainable transparent farm animal breeding and reproduction. *Livestock Science* **103**: 282–291.

Qin W. and Brown J.L. (2006). Consumer opinions about genetically engineered salmon and information effect on opinions: A qualitative approach. *Science Communication* **28(2)**: 243-272.

Saelensminde, K. (2001) Inconsistent choices in Stated Choice data - Use of the logit scaling approach to handle resulting variance increases, *Transportation* **28**: 269-296.

Scarpa, R. and Rose, J.M. (2008). Design efficiency for non-market valuation with choice modelling: how to measure it, what to report and why. *Australian Journal of Agricultural and Resource Economics* **52(3)**: 253-282.

van Eenennaam, A.L. (2006). What is the future of animal biotechnology? *California Agriculture* 60(3): 132-139

Appendix 1: Descriptions for the attributes used in the survey

Introduction

Many people don't think about how the meat that they eat is produced. However, in this survey we would like you to consider the steak that you normally buy and how the cattle it comes from are raised.

Modern agriculture often involves management of how animals reproduce, and in this survey we will ask you to consider 2 alternative forms of breeding technology. We will label these:

"Conventional"

And

"**Alternative"**

"The Conventional" Method
Modern agriculture often involves management of how animals reproduce. Different breeds of cattle have different characteristics. Cross breeding, which has been used for centuries, allows useful characteristics of each to be combined in a single animal.

For example, Northern bred cattle used in beef production can cope with the sometimes harsh weather conditions in the north of Australia and produce meat of lower quality (it is mostly used to produce hamburgers or mince). Other breeds, used to produce steak, are suited to Southern Australia but cannot survive conditions in Northern Australia. Cross breeding the two results in cattle that can survive in the Northern environment and be used to produce steak.

This crossbreeding method is the most commonly used currently in the production of beef, and in what follows we will describe steaks from cattle bred in this way as "conventional".

The "Alternative" method (Version A)
Although cross breeding Northern cows with Southern bulls is possible, introducing Southern bulls into the northern rangelands has not been particularly successful because the conditions are too harsh.

A new reproduction method, that meets animal ethics and welfare guidelines, is being developed by CSIRO. Using this method cross breeding can be achieved without introducing Southern bred bulls into the northern regions. Firstly, the testicle of a Northern bred bull is treated with a low dose of radiotherapy to stop him producing sperm. Stem cells removed from a Southern bred bull can then be injected into the testicle of the Northern bred bull. The effect is that it now produces sperm resembling that produced by the Southern bred bull.

The result is that the Northern bred bull, which can survive the northern environmental conditions, fathers cross bred cattle that can be raised to produce steak.

Note that these cattle and the meat from them are not classified as genetically modified or GM food.

The "Alternative" method (Version B)

Although cross breeding Northern cows with Southern bulls is possible, introducing Southern bulls into the northern rangelands has not been particularly successful because the conditions are too harsh.

A new reproduction method, that meets animal ethics and welfare guidelines, is being developed by CSIRO. Using this method cross breeding can be achieved without introducing Southern bred bulls into the northern regions. Stem cells removed from a Southern bred bull can be injected into the testicle of the Northern bred bull. The effect is that it now produces sperm resembling that produced by the Southern bred bull.

The result is that the Northern bred bull, which can survive the northern environmental conditions, fathers cross bred cattle that can be raised to produce steak.

Note that these cattle and the meat from them are not classified as genetically modified or GM food.

The "Alternative" method (Version C)

Although cross breeding Northern cows with Southern bulls is possible, introducing Southern bulls into the northern rangelands has not been particularly successful because the conditions are too harsh.

A new reproduction method, that meets animal ethics and welfare guidelines, is being developed by CSIRO. Using this method cross breeding can be achieved without introducing Southern bred bulls into the northern regions. A Northern bull can be treated so that he produces sperm resembling that produced by the Southern bred bull.

The result is that the Northern bred bull, which can survive the northern environmental conditions, fathers cross bred cattle that can be raised to produce steak.

Note that these cattle and the meat from them are not classified as genetically modified or GM food.

The "Alternative" method (Version D)

Although cross breeding Northern cows with Southern bulls is possible, introducing Southern bulls into the northern rangelands has not been particularly successful because the conditions are too harsh.

A reproduction method using artificial insemination (or AI) , that meets animal ethics and welfare guidelines, enables cross breeding to be achieved without introducing Southern bred bulls into the northern regions. Instead of the bull and cow mating in the usual way, sperm is taken from the Southern Bred bull and refrigerated. It is then transported to northern Australia and inserted by a trained AI specialist into Northern bred cows in their own environment.

The result is that Southern bred bulls don't have to be introduced into the northern environmental conditions, but can be used to father cross bred cattle that can be raised to produce steak.

Note that these cattle and the meat from them are not classified as genetically modified or GM food.

Descriptions for the other attributes

As well as the way the cattle are bred, the steaks you are going to choose between vary in terms of 3 other characteristics

Which State/Territory the cattle are from (Origin)

This identifies whether the cattle are raised in YOUR home State/Territory, or OTHER State/Territory in Australia.

Whether finished on feedlots or in the paddock (Feedlot/Paddock)

Feedlots are a confined yard area with watering and feeding facilities where cattle raised on pasture are 'finished' on a diet of grain feed prior to slaughter or live export. Cattle stay in feedlots for periods varying from about 30 days up to about 300 days depending on the weight required by the particular customer.

Approximately 97% of all Australian grain-fed beef is derived from feedlots that work under the National Feedlot Accreditation Scheme to achieve quality assurance. This form of production has been used in Australia since the 1960s, and approximately 40% of domestically consumed beef comes from feedlots.

Cattle raised in a paddock eat native and/or sown pastures for feed. They stay in this environment until they are sold. The industry doesn't have a specific code of practice but it is expected that producers monitor the condition of cattle and vegetation and maintain a sustainable production system.

The cost of the steaks in $/Kg (Price)

The price of steak was based on the price that they nominated that they pay for the steak that they usually buy. In the program hosting the questionnaire, the nominated price was copied in as the base price and alternative prices were calculated.

Appendix 2: ORU

The Online Research Institute (ORU) own and manage the largest research-only proprietary online panel in Australia with 300,000 members in addition to a SME panel with over 45,000 members and a NZ panel with 30,000 members. They comply with all local (AMSRS) and international (ESOMAR) guidelines for online panels and use industry best practice methodology at all stages of the research process from recruitment to panel management, survey execution and data delivery.