Analysing hidden patterns of farmers' preferences for farm performance characteristics that may be related to tail-docking practice decisions

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Abstract

We investigated how multivariate statistics can be used to determine the different patterns of preferences that may exist within a farmer population. As a case study, we used adaptive conjoint analysis to analyse farmers' preferences for nine farm performance characteristics that may be related to tail docking practice decisions. As expected, at the whole population level, farmers' preferences for these traits were found to be highly heterogeneous, with only the most important issues and least important issues being able to be statistically differentiated. Using Cluster Analysis and Principal Components Analysis we found some hidden relationships and identified the existence of four groups of farmers that had greater preferences for different characteristics; group one preferred having less dags and less costs associated with dagging and crutching, group two preferred to reduce euthanasia from uterine prolapse and rectal prolapse, group three preferred to avoid stressing lambs at the time of docking and group four preferred to have less fly-strike and greater weaning weights. We discuss how the use of multivariate statistics allowed a deeper interpretation of preference studies in a context of importance to NZ farmers.

Keywords: farmers' preferences; preference heterogeneity; tailing; 1000Minds

Introduction

The analysis of peoples' preferences has been used for many different purposes including consumer research (Green & Srinivasan 1990), environment valuation (Martin-Lopez et al. 2007), analysis of farmers' reasons and concerns in relation to farming practices (Barnes & Toma 2012), and determination of animal breeding goals (Byrne et al. 2012). There are several methods to analyse peoples' preferences but all of them are based on confronting people to make choices among alternatives from which ranking and/or relative weights are derived.

On many occasions the relative importance that people give to different alternatives is compared for the whole sampled population (Ndumu et al. 2008; Scarpa et al. 2003). However, in general, people's preferences are known to be heterogeneous and interrelated and therefore the analysis of preferences in populations as a whole can be insufficient to fully understand the issue being analysed. This seems to be the case for many farming issues, where it has been shown that farmers' preferences can be highly heterogeneous (Barnes & Toma 2012; Valbuena et al. 2008) and it is reasonable to expect that farmers' preferences on different issues might be interrelated. Translated into mathematical terms this means that the variables, when analysing farmers' preferences, have high variance and are correlated, to a greater or lesser extent, among each other.

One approach to analyse this heterogeneity is looking at differences in preferences among predefined groups, for example farming systems (Tano et al. 2003), or looking at interaction between preference levels and other variables (Zander et al. 2013). However, this approach gives no information about the relationship among preferences for different issues that might be very informative to the problem under study. Furthermore, the models set for these approaches usually do not account for correlations among variables which, if they exist, might be causing unaccounted-for collinearity problems (Tormod & Bjorn-Helge 2001). Another approach is to look at the relationships among preferences themselves and try to identify patterns of preferences that are not shown when analysing the sampled population as a whole. This approach has the strength of not being hypothesis driven since no *a priori* assumptions are made about the factors affecting preference, and therefore, might allow unexpected but true patterns to be revealed.

There are several ways to analyse peoples' preferences, one of them, the PAPRIKA method implemented in 1000Minds software (Hansen & Ombler 2009) has proven to be an accurate method for reflecting preferences. This is because the adaptive conjoint analysis approach employed by the software ensures that the elicitation burden on the respondent is minimised (Beshears et al. 2008).

In this paper, we explore the use of multivariate statistics to understand patterns of preferences that might exist in a community of farmers. As a case study, we analysed New Zealand (NZ) sheep farmers' preferences for farm performance characteristics that may influence tail docking practice decisions. Detailed background of this specific study has been reported in Kerslake et al. (2015).

Material and methods

1000Minds® software was used to analyse farmers' preferences for farm performance traits that influence decisions relating to their tail docking practices. 1000Minds® software uses a method called PAPRIKA to transforms people's pairwise ranks of a given set of alternatives (formed by different criteria) into relative weights (Hansen & Ombler 2009). Specifically, we determined farmers' relative preferences for farm characteristics that may influence decisions relating to tail docking practices. These included 2 less fly-strike related deaths per 100 lambs, 1 less dagging event per lamb, 50% reduction in costs due to dagging time, 50% reduction in costs due to crutching time, 0.5 kg increase in weaning weight, 1 less uterine prolapse related euthanasia per 100 ewes, 2 less rectal prolapse related euthanasia per 100 lambs and no stress at the time of docking.

Kerslake et al. (2015) implemented a general descriptive statistical analysis of farmers' preferences and showed that at the whole population level, farmers' preferences were highly heterogeneous, and that overall, only the most important preferences (minimizing deaths from fly-strike, improving weaning weight and making more money from the processor) and the least important preferences (fewer dag events, less euthanasia from rectal prolapses and less stress for the lamb at docking) could be statistically differentiated. Based on practical knowledge in this area, groups of farmers with different patterns of preferences were expected to exist, and therefore further multivariate analyses were undertaken to see if hidden patterns of farmer's preferences could be found

We used two multivariate statistical techniques, cluster analysis (CA) and principal component analysis (PCA), to explore hidden patterns of preferences. These techniques have been widely used in many fields; CA is an approach to find structure in data by identifying grouping of observations (Fielding 2007) and PCA can help in finding patterns in highly dimensional data (Smith 2002). The procedure applied can be divided into three steps. We first explored the correlation among the preferences by building a correlation matrix. This gave a general overview of the relationships among preferences and helped in the interpretation of the results for further analysis. Then we used the two approaches to identify groups of farmers with different patterns of preferences; 1) CA of the preferences values and, 2) a PCA of the preferences followed by a CA of the calculated Principal Components (PCs). All statistical analyses applied were non-parametric, since distributions of preferences values were non-normal.

For the CA we used the k-means clustering method, since the distance measure it uses is easy to understand, is widely used, and gives good results. K-means clustering aims to group n observations into k clusters in such a way that each observation belongs to the cluster with the nearest mean. In a multivariate case, the mean would be the mean for each of the analysed variables. The optimal number of clusters was decided based on within group sums of squares, which quantifies the degree of similarity among individuals within groups compared to those of the other groups. The CA of the PCs was implemented following the same method.

Results

Farmer's preferences were found to be correlated with each other with different patterns (Table 1). Correlation values ranged from 0.33 between less crutch and dag costs preferences and -0.36 between less euthanasia for uterine prolapse and less crutch costs and less dag events.

Table 1 Spearman correlation matrix of farmers' preferences for farm performance characteristics that may be affected by tail-docking. Farm characteristics included, Less fly-strike (2 less fly-strike related deaths per 100 lambs), Greater weaning weight (0.5 kg increase in weaning weight), Less dag events (1 less dagging event per lamb), Less dag costs (50% reduction in costs due to dagging time), Less crutch costs (50% reduction in costs due to crutching time), Less euthanasia from uterine prolapse (1 less uterine prolapse related euthanasia per 100 ewes), Less euthanasia from rectal prolapse (2 less rectal prolapse related euthanasia per 100 lambs) and No stress at docking (no pain/stress at the time of docking).

Factors	Less fly-strike	Greater weaning weight	Less dag events	Less dag costs	Less crutch costs	Less euthanasia from uterine prolapse	Less euthanasia from rectal prolapse
Greater weaning weight	-0.25**						
Less dag events	-0.22**	-0.14*					
Less dag costs	-0.17**	-0.15*	0.19**				
Less crutch cost	-0.16*	-0.21**	0.14*	0.33**			
Less euthanasia from uterine prolapse	0.00	-0.07	-0.36**	-0.35**	-0.36**		
Less euthanasia from rectal prolapse	0.00	-0.20**	-0.29**	-0.28**	-0.23**	0.25**	
No stress at dock	-0.07	-0.1	-0.07	-0.16*	-0.21**	-0.15*	-0.16*

*p<0.05, **p<0.01.

Cluster analysis

A summary of the results of the CA on farmers' preferences is shown in Table 2. The solution that minimized the within clusters sum of squares was achieved when farmers were grouped in three clusters. These three clusters happened to have different preferences for all of the farm performance characteristics, except for less fly-strike and greater weaning weights, which they all considered to be of high importance (Table 2). The first group is characterized by giving high preference to less dag events and less dag and crutch costs, the second by giving high preference to less euthanasia due to uterine prolapse and rectal prolapse and the third by giving high preference to no stress for the lamb at the time of docking.

Table 2 Average farmers' preferences for farm performance characteristics that may be affected by tail-docking of the three clusters of farmers determined by k-cluster method. Farm characteristics included, Less fly-strike (2 less fly-strike related deaths per 100 lambs), Greater weaning weight (0.5kg increase in weaning weight), Less dag events (1 less dagging event per lamb), Less dag costs (50% reduction in costs due to dagging time), Less crutch costs (50% reduction in costs due to crutching time), Less euthanasia from uterine prolapse (1 less uterine prolapse related euthanasia per 100 ewes), Less euthanasia from rectal prolapse (2 less rectal prolapse related euthanasia per 100 lambs) and No stress at docking (no pain/stress at the time of docking).

Factor	Cluster 1	Cluster 2	Cluster 3	*p- value
	n=94	n=77	n=77	
Less fly-strike	0.13 ± 0.005	0.14 ± 0.005	0.13 ± 0.005	0.057
Greater weaning weight	0.12 ± 0.004	0.14 ± 0.005	0.13 ± 0.005	0.011
Less dag events	0.13 ± 0.004	0.08 ± 0.004	0.10 ± 0.004	<0.001
Less dag costs	0.14 ± 0.004	0.09 ± 0.005	0.11 ± 0.004	<0.001
Less crutch cost	0.14 ± 0.004	0.08 ± 0.004	0.11 ± 0.004	<0.001
Less euthanasia from uterine prolapse	0.08 ± 0.004	0.16 ± 0.003	0.10 ± 0.005	<0.001
Less euthanasia from rectal prolapse	0.09 ± 0.005	0.13 ± 0.006	0.08 ± 0.005	<0.001
No stress at docking	0.05 ± 0.002	0.05 ± 0.003	0.14 ± 0.004	<0.001

*Kruskal-Wallis test

Cluster analysis of the principal components

Principle component analysis showed that the highest variability (27.3%) in the data can be accounted for when observations are arranged by preferences for less dag events, less dag and crutch costs with less euthanasia due to rectal prolapse and uterine prolapse (see compositions of PC1 in Table 3). The second highest source of variability in the data (PC2) was related to farmers' preference for no stress at docking. Finally, the third PC that accounted for another 14.7% of the variability of the original data set was mainly related to greater preferences for less fly-strike.

The CA of the three first PCs determined that the most suitable numbers of clusters was four. Three of the four clusters were similar to those found in the CA of the preferences (Clusters 1, 2 and 3 in Fig. 1). Also similarly to the CA results (Table 2), the size of the cluster of farmers with higher preference to less dag events, less dag costs and crutch costs was the largest. The new farmer cluster found in this analysis, gave the highest preference to less fly-strike and greater weaning weights and lower importance to the rest of the characteristics.

Table 3 Description of the first three Principal Components (PC) of the preferences for farm characteristics that may be affected by tail-docking. Farm characteristics included, Less fly-strike (2 less fly-strike related deaths per 100 lambs), Greater weaning weight (0.5kg increase in weaning weight), Less dag events (1 less dagging event per lamb), Less dag costs (50% reduction in costs due to dagging time), Less crutch costs (50% reduction in costs due to crutching time), Less euthanasia from uterine prolapse (1 less uterine prolapse related euthanasia per 100 ewes), Less euthanasia from rectal prolapse (2 less rectal prolapse related euthanasia per 100 lambs) and No stress at docking (no pain/stress at the time of docking).

Factor	PC 1	PC 2	PC 3
Less fly-strike	0.243	0.112	0.614
Greater weaning weight	-0.006	-0.017	-0.235
Less dag events	-0.588	0.138	0.002
Less dag costs	-0.641	0.291	-0.003
Less crutch cost	-0.574	0.394	0.09
Less euthanasia from uterine prolapse	0.651	0.369	0.114
Less euthanasia from rectal prolapse	0.761	0.111	-0.217
No stress at docking	0.007	-0.857	0.391
Cumulated variance accounted for	27.30%	44.70%	59.40%

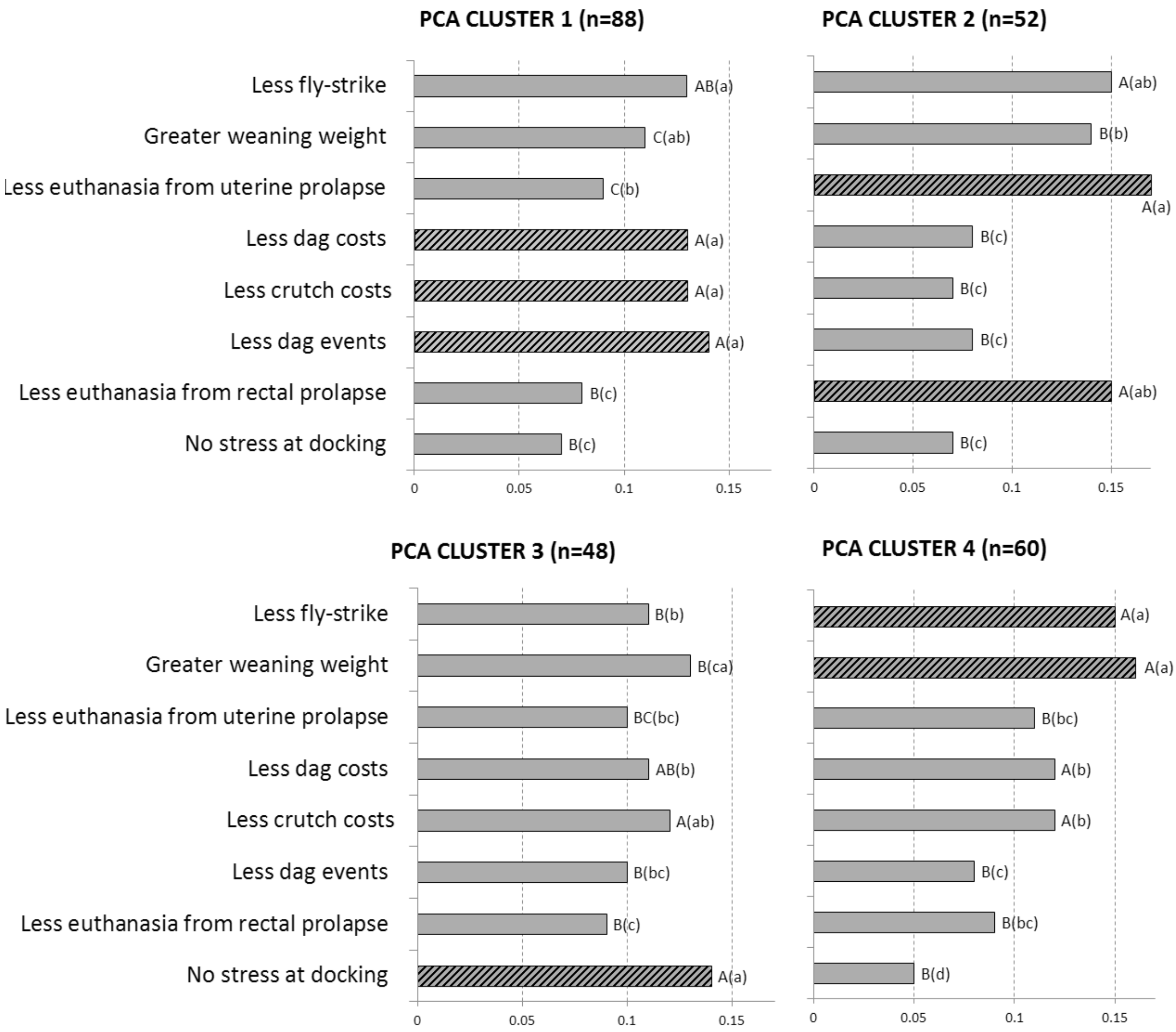

Figure 1. Average farmer preferences for farm performance characteristics that may be affected by tail-docking among the 4 clusters of farmers determined by cluster analysis of the principal components. Farm characteristics included, Less fly-strike (2 less fly-strike related deaths per 100 lambs), Greater weaning weight (0.5kg increase in weaning weight), Less euthanasia from uterine prolapse (1 less uterine prolapse related euthanasia per 100 ewes), Less dag costs (50% reduction in costs due to dagging time), Less crutch costs (50% reduction in costs due to crutching time), Less dag events (1 less dagging event per lamb), Less euthanasia from rectal prolapse (2 less rectal prolapse related euthanasia per 100 lambs) and No stress at docking (no pain/stress at the time of docking).

A-C. Bars with different capital letters differ statistically (at least $p<0.05$, K-W test) among PCA clusters. a-c. Bars with different lower case letters differ statistically (at least $p<0.05$, K-W test) within PCA clusters

Discussion

In the specific case of farmer preferences for farm performance characteristics that may be related to tail-docking practice decisions, initial analyses showed that, at the whole population level, the most important farm performance characteristic for farmers were having less fly-strike and achieving greater weaning weights, the least important was for the lamb to have less stress at the time of docking, with the remaining issues having equal importance (Kerslake et al. 2015). Using multivariate techniques, we were able to draw a more accurate picture of farmers' preferences by showing that within the whole sampled population, there were actually four different groups of farmers with different patterns of preferences for farm performance traits that may be related to tail docking practice decisions.

These different groups of farmers include those that preferred less dags, fewer costs associated with dagging and crutching, and less fly-strike; those that preferred less fly-strike and greater weaning weights; those that preferred less euthanasia from uterine and rectal prolapses and less fly-strike and those that preferred to avoid stressing the lamb at the time of docking. Overall this research highlights that there is a wide set of farm performance characteristics that farmers see as important. In terms of practical implications, these results suggest that if a change in tail-docking practice (either voluntary or regulator) was ever required, the perceived impact of making this change would not be the same for all farmers. It is likely that different education programs would be required to address the different concerns that farmers have about farm performance characteristics associated with tail docking practice decisions.

In this case study, both the CA of preferences and the CA of the PCs gave coherent results however, the CA of PCs revealed a more complete picture of the existing pattern of preferences. This fact might be related with the existence of a complex pattern of correlations among preferences and the very nature of the PCA (Smith 2002). Therefore, it seems that in studies where correlations exist among preferences, CA of PCs might outperform CA of preferences, and therefore, should be the preferred method.

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