Veterinary Record Open

OPEN ACCESS

Preference of veterinarians to select an udder health programme for milk producers

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► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/vetreco-2018-000313).

To cite: Vissio C, Richardet M, Chaves J, *et al*. Preference of veterinarians to select an udder health programme for milk producers. *Veterinary Record Open* 2019;**6**:e000313. doi:10.1136/vetreco-2018-000313

Received 27 September 2018
Revised 25 September 2019
Accepted 01 October 2019

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ABSTRACT

Background This investigation was carried out to gain more insight about the preference of veterinarians on the implementation of an udder health programme (UHP) in a dairy farm.

Methods A choice experiment was designed to elicit the preferences of the participants. The study population consisted of 36 veterinarians from Argentina specialised on milk quality. The choice experiment offered several UHPs, which were combinations of some of the interventions included in the so-called five-point plan. To reduce bias among the participants, the UHPs offered were unlabelled and considered two farm contexts: one was on a pasture system and the other was on a dry-lot with pasture access system. The basic criteria (the so-called attribute) to describe veterinarians' preferences for each UHP proposed were efficacy on clinical mastitis (CM) and bulk milk somatic cell count (BMSCC) reduction, cost and technical support. The data collected were analysed using conjoint analysis.

Results UHP cost and UHP efficacy on BMSCC and CM had a significant influence on veterinarians' ranking decisions under both dairy production contexts. The efficacy on CM was the most important attribute to prefer a particular UHP, while technical assistance was the least important attribute considered. The attributes related to efficacy on both BMSCC and CM explained over 60 per cent of the total importance of all attributes.

Conclusion To the authors' knowledge, this is the first research in South America focused on studying veterinarians' preferences to suggest a UHP. The cost and efficacy attributes were the veterinarians' top priority attributes to decide the best UHP.

INTRODUCTION

Bovine mastitis is the production disease of greatest impact on dairy herds worldwide. Different studies carried out in Argentina have revealed the magnitude and variation of economic losses among producers due to mastitis.[1 2] In consistency with another report, losses due to subclinical mastitis are the most relevant,[3] and there is a great deal of variation regarding the adoption of a systematic udder health programme (UHP) among dairy farmers.[4]

Regarding mastitis control, there are tools to deal with the disease which are very well known and accepted.[5] These tools are grouped in the so-called five-point plan,[6] which has been very efficient to reduce the prevalence of contagious mastitis and the bulk milk somatic cell count (BMSCC).[4 7–10] The bovine mastitis epidemiology evolves according to the degree of adoption of a control scheme and according to the level of intensification of the herd.[11 12] Because of this, the five-point plan has been expanded to ten-point for the National Mastitis Council (https://www.nmconline.org) to address issues related to farm hygiene and adequate housing, especially to deal with mastitis caused by environmental pathogens.

The research effort in mastitis control has been oriented not only to design novel and better interventions but also to understand the decision-making rationality involved in the application of the control programme in the herd.[13] Research focused on producers' decision-making rationale applied to the udder health management has been the subject of different investigations.[13–15] However, few reports have taken into consideration veterinarians' preferences as motivators for the producer to proceed with the control. Previous studies in Argentina have identified two clusters of dairy farmers among small-sized and medium-sized farms: those who were very diligent to have a comprehensive UHP in their farms in comparison with those who did not apply a systematic UHP in their farm.[4] Among those farms with good practices in mastitis control, veterinary assistance was more frequently required, although the scope of the research did not allow the authors to show more evidence to better explain the findings.

The adoption of the UHP would be favoured by factors which are beyond knowledge about good dairy farming practices. Issues such as the farmer's motivation[16–18] and premium and penalty payments relative to the base milk price are relevant to induce the producer a change in their attitude

towards mastitis control.[17 19 20] The influence of different sources of information on the producer's decision-making process would be relevant.[21 22] In relation to this, the advice received from veterinarians has been highly qualified for the producer to adopt a UHP in his or her farm.[21 23 24]

Any approach focused on studying the decision-making process may involve the description of the preferences of the person who makes the decision. In this sense, different studies employing socioecological and conjoint models have been published in the veterinary public health field[25 26] and also applied for udder health management.[20] Conjoint analysis (CA) is a quantitative method that allows to study situations in which several factors influence the final decision of a person. CA is a stated preference method where respondents are asked to choose between hypothetical goods or services with different levels of a limited number of attributes (criteria); a UHP would be a hypothetical good or service. CA makes two assumptions: that UHP can be described according to their attributes and the value of a UHP (to an individual) is a product of these collective attributes. This means that the individual's utility (preference) for a multiattributed UHP can be expressed as a sum of part-worth utility values for its attributes. It has the advantage of simultaneously estimating the overall utility for a good/service (UHP) and also identifying the relative importance of different attributes.

This research has been carried out to measure the preference of veterinarians when a UHP is suggested to producers in different dairy production contexts. It also pursued the estimation of the relative importance of different technical and economic criteria to choose a particular UHP.

METHODS

Participants

The participants involved in this study were veterinary practitioners who attended the annual udder health scientific meeting of APROCAL (Asociación Argentina Pro Calidad de Leche y sus derivados). The inclusion criterion was veterinarians specialised in udder health and/or milk quality with a minimum experience of 5 years in dairy farming. All veterinarians invited who met the inclusion criterion agreed to carry out the survey. From 80 veterinarians attending the conference, 36 met the inclusion criteria. In addition, participants were asked to provide data about their age, gender, years of experience on field and also about the type of production system where they frequently worked.

Survey design

The survey design was based on all the interventions included in the regular protocol to control mastitis, usually called the five-point plan.[6] Additionally, the survey also contained other points added to the new version of the plan, now called as the ten-point plan (https://www.nmconline.org). Thus, the survey included the six following points: proper maintenance and use of milking equipment, postmilking teat disinfection, treatment of clinical mastitis (CM), blanket dry cow therapy, culling of chronically infected cows, and maintenance of a clean, dry and comfortable environment.

Establishing the attributes and levels

Mastitis control programmes should have the following characteristics: (1) practical, (2) economical, (3) subject to easy modification and (4) effective under most management conditions. In this study, the attributes were defined based on a literature search and a discussion among experts, as suggested by Huijps and others.[27] Four critical attributes of UHP were defined: cost, efficacy in reducing CM level, efficacy in reducing BMSCC and technical support. Before the survey administration, five veterinarians were asked to fill a draft to check the clarity of the statements.

The attribute in relation to cost involved the monetary resources needed to implement the UHP in a herd with 100 milking cows. Three possible levels were considered: (1) the application of the complete UHP (£36/day), (2) the implementation of a UHP that included only maintenance of a clean, dry and comfortable environment (£22/day), and (3) the implementation of a UHP with an intermediate cost (£29/day).

The attributes in relation to efficacy referred to the possible reduction of CM incidence and BMSCC. Three levels were defined for CM: (1) reaching a percentage of monthly cases between 10 and 20 per cent, (2) between 5 and 10 per cent, and (3) below 5 per cent. For BMSCC, two levels were defined: (1) reaching a BMSCC between 300,000 and 500,000 cells/ml, and (2) below 300,000 cells/ml.

The attribute in relation to technical support involved extra labour and veterinary assistance to ensure a successful UHP implementation. The three levels were quantified summing up the cost of veterinary advice and those related to extra labour: (1) basic advice (£2/day), which involved the monthly visit of a veterinary medical adviser; (2) full advice (£4/day), which involved the biweekly visit of a veterinary medical adviser; and (3) full advice plus extra labour (£11/day).

The attributes and levels are shown in table 1.

Table 1 Attributes and levels used in the survey

Cost (£/day)	Efficacy in reducing BMSCC (cells/ml x 1000)	Efficacy in reducing CM level (%)	Technical support (£/day)
22	300–500	10–20	2
29	<300	5–10	4
36		<5	11

BMSCC, bulk milk somatic cell count; CM, clinical mastitis.

Table 2 Cards used for the choice experiment

Card identification	Cost (£/day)	Efficacy in reducing BMSCC (cells/ml x 1000)	Efficacy in reducing CM level (%)	Technical support (£/day)
A	36	300–500	<5	4
B	22	<300	5–10	4
C	22	300–500	>10	11
D	22	<300	<5	2
E	29	<300	>10	4
F	36	<300	5–10	11
G	29	300–500	5–10	2
H	29	<300	<5	11
I	36	<300	>10	2

BMSCC, bulk milk somatic cell count; CM, clinical mastitis.

Presentation of questions

Elicitation of veterinarians' preference to rank different UHPs was investigated using CA. The number of profiles used in a conjoint study depends on the number of attributes and levels of each attribute that are used. In this study, 54 possible UHP profiles were available in a full factorial design. In order to reduce the number of profiles presented in the survey, an orthogonal array was used.[28] This resulted in a random selection of nine UHP profiles (table 2).

The respondents were asked to rank profiles offered under two dairy production contexts: (1) dry-lot system and (2) dry-lot with pasture access during six to eight hours/day. All decision contexts were set for a dairy farm of 100 milking cows with an average of 20 per cent of CM and a range of BMSCC between 500,000 and 600,000 cells/ml during the last year. The nine UHP profiles were ranked on a scale from 1 to 9, where 1 meant the most desirable and 9 the least desirable UHP. Previous to this task, the first author described to all participants each attribute and explained the meaning of each level. The questionnaire is available as online supplementary data appendix 1.

Data analysis

In the implementation of CA as applied, a good or service, in this case a UHP, can be decomposed into a set of attributes. Then, the person, by sorting the UHPs, evaluates the value or utility of a UHP by combining the separate amounts of utility provided by each attribute (part-worth). As CA is an additive model, the overall evaluations (total utility) are formed by the sum of separate part-worth utility values.[28]

Ordinary least squares regression (OLS) was used to estimate the part-worth utility values of attribute levels and the relative importance of the attributes. Data were analysed with OLS, with the independent variables being the attributes and the dependent variable being the ranking of UHP from 1 to 9. Considering the four attributes (cost, efficacy in reducing CM and BMSCC, and technical support) evaluated in this study (table 1), the additive utility model to determine the total utility is expressed as follows:

$$R_{UHP} = \beta_0 + \sum_{i=1}^{3} \beta_{1i} X_{1i} + \sum_{j=1}^{3} \beta_{2j} X_{2j} + \sum_{k=1}^{2} \beta_{3k} X_{3k} + \sum_{l=1}^{3} \beta_{4l} X_{4l} + \epsilon$$

where R_{UHP} represents ranking from 1 to 9 of the nine UHPs, and β_{1i}, β_{2j}, β_{3k} and β_{4l} are the coefficients associated with the characteristics of each attribute, i=cost (£22/day, £29/day and £36/day), j=efficacy in reducing CM (10–20 per cent, 5–10 per cent, <5 per cent), k=efficacy in reducing BMSCC (300,000–500,000 cells/ml and <300,000 cells/ml) and l=technical support (£2/day, £4/day and £11/day), while ε is the error term.

The authors chose the simple OLS method of generating utilities because OLS is suitable for the rankings-based data as they were collected. In addition, this technique could easily be implemented in available statistical software (eg, Excel, Stata or SPSS).

The part-worth utility values provide a quantitative measure of the preference for each factor level; thus, the larger the value, the greater the preference. Part-worth utility values are expressed in a common unit, allowing them to be added together to give the total utility, or overall preference, for any combination of factor levels. The relative importance for each attribute was estimated as the ratio of the part-worth range for that particular attribute and the sum of all the part-worth ranges. Therefore, the relative preference (RP_i) of each attribute (A_i) was subsequently derived according to:

$$RP_i = Range\ A_i \Big/ \sum_{i=1}^{n} Range\ A_i * 100\%$$

where $Range\ A_i$ represents the difference between the highest and the lowest part-worth utility values of attribute i, with n being the number of attributes. The ratio provides an indication of the attributes that respondents valued most highly.[29]

The analysis was performed separately for each of the two dairy production contexts using IBM SPSS Conjoint V.20 (SPSS, Chicago, Illinois, USA).

RESULTS

The survey was completed by 36 veterinarians specialised in dairy production and udder health management. Most respondents were male (64 per cent), with an average age of 45 years old (range: 29–63). The respondents had a mean of 15 years of experience working on milk quality and mastitis (range: 5–34), and all of them, once a year, had participated in meetings related with the subject. The respondents worked in different dairy production systems: pasture (39 per cent), dry-lot (27 per cent), dry-lot with pasture access (18 per cent) and total confinement (16 per cent) located in the main milk-producing provinces of Argentina: Córdoba (37 per cent), Buenos Aires (33 per cent), Santa Fe (15 per cent), Entre Ríos (7 per cent) and La Pampa (7 per cent).

Table 3 Median and IQR of veterinarians' preferences for UHP in different dairy production contexts

Context	UHP	Median (IQR)
Dry-lot system	D	2 (1–3)
	H	2 (1–3)
	B	3 (2–4.25)
	F	5 (4–6.25)
	A	5.5 (3–7)
	E	6 (4.75–7)
	G	6 (5–7)
	I	7 (6–9)
	C	7.5 (6–9)
Dry-lot with pasture access system	D	1 (1–2)
	H	2 (2–4)
	B	3 (2–4)
	A	6 (3–8)
	F	6 (4–7)
	E	6 (5–7)
	G	6 (5–8)
	I	7 (5–8)
	C	7.5 (6–9)

Rank of preference was from 1 (most desirable) to 9 (least desirable).
IQR, interquartile range; UHP, udder health programme.

The overall median preference for each UHP under each production context is displayed in table 3. Particularly, the respondents' preference showed the card with UHP D as the top choice (preference 1) and the one with UHP C as the last choice (preference 9) (figure 1), under both production system contexts. The UHP D was ranked as the first preference for 47.2 per cent and 72.2 per cent of the respondents under dry-lot system and dry-lot with pasture access choice context, respectively (figure 1).

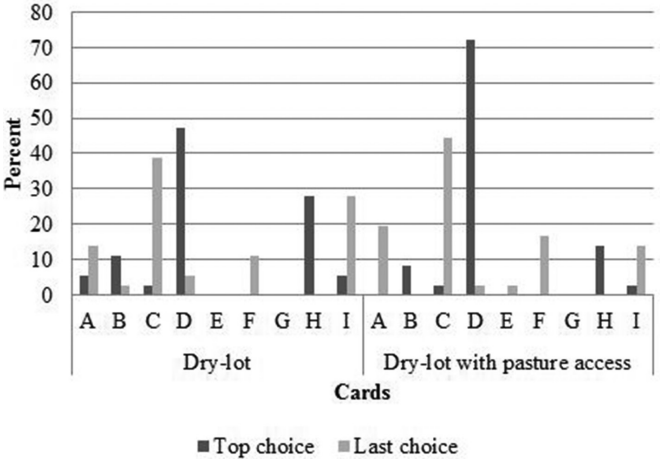

Figure 1 Most and least preferred cards in choice experiment.

The CA allowed the quantification of the relative importance of each attribute over the total utility values (preference) of a UHP. Efficacy on CM, with a relative importance around 40 per cent, was the most important attribute to prefer a particular UHP under both production contexts. Efficacy on BMSCC and cost were attributes with similar relative importance, around 25 per cent in both contexts. On the other hand, technical assistance was the least important attribute considered (table 4). The efficacy attributes together (on CM and BMSCC) explained nearly 60 per cent of the total importance of all attributes.

The results of the OLS regression model indicated that the attributes UHP cost and UHP efficacy on BMSCC and CM had a significant ($P<0.001$) influence on veterinarians' ranking decisions regarding both dairy production systems (table 5). There was an inverse relation (negative utility value) between cost and utility, which means that veterinarians preferred the least costly UHP. In relation to UHP efficacy, the veterinarians preferred the lower levels of BMSCC and CM (table 5). Technical support was an attribute statistically significant for veterinarians' ranking decisions only under dry-lot with pasture access during six to eight hours/day. Based on part-worth utility values, veterinarians preferred the UHP with less technical support (table 5).

DISCUSSION

This conjoint experiment was set under an endemic mastitis situation (an average of 20 per cent of CM and a range of BMSCC between 500,000 and 600,000 cells/ml during the last year) to avoid bias in respondents' preferences caused by an outbreak situation.[27] Although UHP D was the least expensive and most effective option, it was not chosen by all the respondents. This could imply that other criteria or perceptions may motivate veterinarians to prefer one UHP over the other.

The attributes related to efficacy on both BMSCC and CM explained over 60 per cent of the total importance of all attributes. To define the UHP ranking, respondents relied mainly on efficacy, which may imply that effective UHP in reducing mastitis levels would be an important attribute for them to suggest a particular UHP to producers. Previous reports have shown the importance that farmers give to the effectiveness of practical tools in udder health[30] as well as in other herd problems like detecting silent heats.[31] The estimation of efficacy and cost interventions are a very important piece of information to help in the decision-making process.[32 33]

The efficacy on CM showed a greater relative importance in comparison with BMSCC efficacy. This could be due to the fact that respondents paid more attention to CM losses (direct) than to those associated with higher BMSCC. Furthermore, in this study, the respondents worked mainly on intensified production systems, which have been reported as farms with higher CM levels.[2]

Table 4 Relative importance (%) of udder health programme attributes under both dairy production contexts

	Cost (£/day)	Efficacy in reducing BMSCC (cells/ml x 1000)	Efficacy in reducing CM level (%)	Technical support (£/day)
Dry-lot system	22.5	23.2	42.2	12.1
Dry-lot with pasture access system	26	24.4	38.3	11.3

BMSCC, bulk milk somatic cell count; CM, clinical mastitis.

Because of this, veterinarians may be more likely to give greater importance to efficacy on CM.

In this experiment, the attribute related to technical support involved extra labour plus the veterinarian's involvement to ensure a successful UHP implementation. This attribute was transferred to a comparable monetary value because of the difficulty to quantify it.[27] The respondents paid more attention to UHP efficacy and cost than to the demands of continuous technical assistance. This was an unexpected finding, mainly because the technical assistance involved the veterinary service and the respondents were veterinarians. In contrast to the present study's findings, van den Borne and others[29] showed that the veterinarians considered their contribution, together with the help of the state, as the most relevant aspect when implementing national health programmes. However, in this study, the authors could not separate the influence of extra labour and veterinary service demanded because both aspects were combined in the same attribute.

The reason why the technical support attribute was not significant may be due to the presence of outliers on some observations, missing or erroneous data, and non-normality in the distribution of attributes, which limit the usefulness of t-statistic in establishing levels of statistical significance.[28] Beyond that, this attribute may not have been statistically significant because it was not an important influence for the respondents under the dry-lot system choice context, where the management would be more standardised with less extra labour demands.

Table 5 Estimated utility values for each level of udder health programme attributes under both dairy production contexts

Context	Attribute	Levels of attribute	Utility (part-worth)	SE	P value
Dry-lot system	Cost (£/day)	22	−0.829	0.106	<0.001
		29	−1.657	0.212	
		36	−2.486	0.318	
	Efficacy in reducing BMSCC (cells/ml x 1000)	<300	−1.639	0.184	<0.001
		300–500	−3.278	0.368	
	Efficacy in reducing CM level (%)	<5	−1.519	0.106	<0.001
		5–10	−3.037	0.212	
		>10	−4.556	0.318	
	Technical support (£/day)	2	0.074	0.106	0.490
		4	0.148	0.212	
		11	0.222	0.318	
	(Constant)		11.731	0.45	
Dry-lot with pasture access	Cost (£/day)	22	−1.074	0.071	<0.001
		29	−2.148	0.142	
		36	−3.222	0.213	
	Efficacy in reducing BMSCC (cells/ml x 1000)	<300	−1.972	0.123	<0.001
		300–500	−3.944	0.246	
	Efficacy in reducing CM level (%)	<5	−1.477	0.071	<0.001
		5–10	−2.954	0.142	
		>10	−4.431	0.213	
	Technical support (£/day)	2	−0.278	0.071	<0.001
		4	−0.556	0.142	
		11	−0.833	0.213	
	(Constant)		13.287	0.302	

BMSCC, bulk milk somatic cell count; CM, clinical mastitis.

Extra labour and changes in routines are aspects less preferred, like it was observed in dairy producers by Huijps and others.[27] The individuals have a strong tendency to remain in status quo because the disadvantages of leaving it are larger than its advantages.[34]

Overall, the results showed no difference in the relative importance of attributes in both dairy production system contexts. Two dairy production system contexts were evaluated because internal forces related to farm-specific factors have been described as components which generally affect the strategic decision-making process.[35] The authors were expecting that the respondents had a greater preference for the technical support attribute, especially under dry-lot system, because this kind of context would be more prompt to have problems of environmental mastitis. However, this was not the case because the technical support attribute was more valued under the dry-lot with pasture access system. Beyond that, under both production contexts, efficacy and cost were considered as the most important attributes.

The study population was a convenience sample, which is prone to selection bias; thus, it is not possible to generalise the findings to the entire population of veterinary practitioners in Argentina. However, this sampling design could have been a cost-effective alternative to study the preference of the veterinarians. Because of the complexity of the choice experiment, the meeting where participants were recruited allowed the authors to have a sufficient number of veterinarians specialised in udder health management, although this feature of the study design compromised the external validity. The survey administration in situ, in contrast to alternative methods as telephone, postal and/or internet survey, could have contributed to a more precise estimation of preference.

In the choice experiment, sample size is crucial. In a review about the applications of CA in health literature, the sample size varied between 13 and 1258 respondents.[36] In this study, considering the total number of levels and attributes, the sample size would be enough to represent the population adequately.[37]

In CA studies, a balance between statistical efficiency and response efficiency is sought.[38] In this sense, an orthogonal array was used to reduce from 54 to 9 the number of cards presented in the survey, seeking to enhance the quality of the results.[39] In addition, this unlabelled experiment offered different UHPs, each as a set of criteria (attributes) without identifying the points of mastitis control plan (eg, post-dipping),[28] which helped to reduce bias associated with particular interventions based on professional interests and/or personal gains.[40]

Decision-making involves choosing an alternative between several options for the purpose of solving a problem, even when there is no evidence of a latent conflict. The decision-making process is not strictly rational, and is influenced by multiple factors as emotions, personal beliefs and perceptions.[41] In this sense, the present study's scope did not include the decision-making dimension related with subjectivity, as it has recently been addressed to study the use of antibiotic in dairy farms[42] or farmers' perception of the role of veterinary surgeons in vaccination strategies.[43] Further research combining quantitative and qualitative methods (mixed research) is needed to investigate the effects of sociopsychological variables on veterinarians' decision-making in udder health management. However, to the authors' knowledge, this is the first research in South America that studies veterinarians' preferences to suggest a UHP.

CONCLUSION

The cost and efficacy were the veterinarians' top priority attributes to decide the best UHP. They left the technical assistance and extra labour demanded in second place.

Contributors All authors conceived and designed the study. CV, MR and AL were involved in survey administration. All authors analysed the data and wrote the paper. CV and MR performed the statistical analysis.

Funding This work was financially supported by Instituto de Investigación de la Universidad Nacional de Villa María.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article.

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