Papers

Awareness and perceived value of economic information in controlling somatic cell count

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A survey of dairy farmers assessed whether they were aware of the potential production and economic benefits of adopting and implementing efficient practices to control somatic cell count (SCC), and whether providing them with additional information on projected economic losses on a regular basis might motivate them to implement enhanced control programmes. In-depth interviews revealed that the majority of the dairy farmers perceived cow-specific and herd-specific projected losses due to elevated SCCs, as not very relevant to them. Farmers considered that SCC was already monitored regularly at individual cow level, which provided them with adequate information to support decision-making. The farmers justified their actions with regard to SCC control in terms of their intention to manage the problem, and their belief in whether their efforts would be successful. Actions were rationalised in a specific context comprising the intertwined notions of intentions and efficacy beliefs.

MILK payment schemes are an important incentive in the control of somatic cell count (SCC). Dairy industries worldwide use the bulk tank SCC (BTSCC) as a quality criterion. In member states of the EU, many processing companies take a discount from milk payouts if the three-month geometric mean of the BTSCC exceeds 400,000 cells/ml; this is the most common payment scheme under discussion in this paper. In the USA, the regulatory limit for BTSCC is usually less restrictive (APHIS 2008). In general, milk processing companies are able to set more stringent penalty levels, and some dairy companies provide a bonus if BTSCC is beneath, for example, 200,000 cells/ml of milk delivered. This type of financial incentive may be an important motivator to enhance mastitis management (Valeeva and others 2007) and has been shown to be effective (Schukken and others 1992). It is well known that an elevated SCC has a negative impact on milk production and reduces farm profitability (Swinkels and others 2005, Halasa and others 2007). These production losses can also be a financial incentive to control SCC; however, an inherent problem with production losses due to increased SCC is that there may be no signs of abnormalities in the milk or udder disorders. The absolute level of production losses has been debated extensively (Seegers and others 2003). In an extensive review, Hortet and Seegers (1998) found that for every doubling of SCC above 50,000 cells/ml, there was a resultant milk production loss of 0.4 kg/day for primiparous cows and 0.6 kg/day for multiparous cows.

All Dutch dairy farms receive test results for BTSCC once every two weeks, taken randomly from deliveries to the dairy company made during that period. Dairy farmers participating in the milk production registration (MPR) system can, as well as having milk analysed for milk yield, fat and protein percentages, have milk tested for SCC at individual cow level. If BTSCC levels are elevated, the test reveals which cows are mainly contributing to it, enabling farmers to target SCC control management towards these animals. Given the relationship between SCC and milk yield, it was hypothesised that incorporating the projected production losses and the economic consequences of this in the MPR listings might motivate farmers to control SCC more stringently.

Adoption and implementation of management practices to control SCC is an action of behavioural change. However, in general, behavioural change may be difficult to achieve and sustain (Panter-Brick and others 2006). Conceptually, accomplishing this change involves awareness, intention and action. First, farmers have to be aware of the current suboptimal condition (awareness does not necessarily imply understanding, simply the ability to be conscious of the situation). Secondly, they need the intent to alter management practices. This is influenced not only by farmers' knowledge, but also by their opinion of this information (Jansen and others 2009). An opinion might be the result of a belief, for example: 'In order to prevent resistance, it is best to change antibiotics often'. Beliefs form the basis of opinions and ultimately guide behaviour (Kuiper and others 2005). Thirdly, efficient or satisfactory control strategies need to be feasible before any action can be expected, that is, belief in the efficacy of the control strategy is needed (Panter-Brick and others 2006). Farmers who are well aware of the necessity to manage SCC but who do not believe they are able to control the situation are less likely to implement control measures than farmers who feel more strongly that they might be able to manage the situation (Jansen and others 2009). Khaitsa and others (2000) analysed the relationships between herd characteristics and management practices associated with BTSCC; however, more intangible elements, such as awareness and intent, have not been so thoroughly investigated. Omitting

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the context in which farmers make choices in preventive, as well as treatment, programmes is one of the reasons why failure might not be immediately understood by the animal healthcare professionals advising them (Vaarst and others 2002).

The notion of the 'value of information' is that information adds to knowledge, and therefore to the awareness of the person receiving it, enabling him or her to make informed decisions. Within this notion, additional information will make the decision-maker more aware of an event. Although farmers may know that elevated SCC levels cause production inefficiencies, quantification of the effect might motivate them to act. In general, when considering management options, as soon as a problem is recognised, the next step is to identify any epidemiological patterns and explain why a herd is in the position it is in. In general, farmers need to compare the costs of measures intended to reduce SCC with the anticipated benefits of implementing them (Lossinger 2005). For example, cow cubicles could be in a poor state of repair, but if the majority of new infections arise during the dry period, then spending money upgrading the stalls may not be the most economical solution.

In this study, in-depth interviews were used to examine the awareness, intentions and stated actions of farmers in reducing SCC. It was thought that by analysing the three prerequisite steps to establish behavioural change (awareness, intention and efficacy belief), the inhibitory step (if present), causing observed reluctance to change, would become apparent. In addition, the hypothesis of whether economic information (presented in the form of an 'information tool') would make farmers more aware of the importance of SCC, and whether it is an incentive for them to alter their intent with respect to applying SCC control strategies, was tested.

Materials and methods

Participants

A stratified sample of 100 dairy farms was taken from the Royal Dutch Cattle Syndicate (NRS) database. The NRS provides herd recording services for Dutch dairy farmers and maintains a historical database of production and other herd-specific variables. The sample was stratified by BTSCC to ensure that different levels were represented. Letters were sent to farmers asking them to take part in the survey, and to obtain permission to analyse their historical herd records. In an aim to enhance participation, it was explicitly mentioned that during the interview, innovative information about farm-specific projected losses would be presented. In total, 19 dairy farmers submitted the enclosed response card and were subsequently interviewed. The farms were located throughout the country, representing a broad spectrum of farming systems (for example, intensive versus extensive production, and production on sandy versus clay soils).

Information tool

During the farm visit, an information tool was presented, comprising three successive spreadsheet folders (produced in Excel [Microsoft]). The first spreadsheet was the standard coversheet of the MPR list, which contained the key rolling herd statistics as well as the absolute level of BTSCC. Projected production losses (kg milk/farm/year) and their resultant economic impacts (€/farm/year) were appended, as they were not part of the standard MPR listings. In the second spreadsheet, the impact of a hypothetical reduction in BTSCC on production losses and its economic effects were displayed graphically with a range of 50,000 cells/ml to 400,000 cells/ml. The third spreadsheet focused on cases of elevated SCC in the current lactation. In the Netherlands, cows are classified as 'new attention' if primiparous cows exceed a SCC of 150,000 cells/ml or if multiparous cows exceed 250,000 cells/ml. The 'attention' status is also declared if two out of the three previous MPR recordings of SCC level for the animal exceeded the threshold.

The additional farm-specific and cow-specific information that was revealed focused on the previous MPR period. The interval of subsequent recordings varied between farms (at three-, four-, five- or six-week intervals). Recalling these most recent events enabled the farmer to focus on the specific actions that had been undertaken. Projected annual farm losses were based on the BTSCC average for the past year.

A log-linear relationship between SCC and decreased milk production was modelled as follows (Halasa and others 2009):

$$Y = \sum_{j=1}^{J} -1*(0.72 + \ln[SCC_j]*-0.22) + \sum_{k=1}^{K} -1*(1.90 + \ln[SCC_k]*-0.47)$$

$$SCC \geq 100$$

where Y is the reduction in daily yield at farm level as a result of elevated SCC (x1000 cells/ml at a level of ≥100,000 cells/ml; below 100,000 cells/ml it is assumed that there is no loss in milk production); j represents primiparous cows; and k represents multiparous cows. It was therefore assumed that milk yield decreased by 0.29 kg/day at a level of 100,000 cells/ml for primiparous cows, and by 0.45 kg/day, 0.53 kg/day and 0.60 kg/day at levels of 200,000 cells/ml, 300,000 cells/ml and 400,000 cells/ml, respectively. Given these SCC levels, for multiparous cows the milk yield would be reduced by 0.26 kg/day, 0.59 kg/day, 0.78 kg/day and 0.92 kg/day, respectively.

The impact of milk yield losses could subsequently be transformed into monetary units. Under a milk quota system, economic efficiency should be expressed in terms of the most limiting restriction, and the appropriate criterion to apply in this situation is maximisation of net return/kg of milk produced (Kristensen 1989). In countries where production is well below quota and extra quota can be obtained relatively easily and cheaply, farmers may be free to benefit fully from extra milk produced through improved SCC control. Resources other than the quota may limit 'expansion' in response to better SCC control and so reduce the marginal benefits. In the Netherlands, herd and national milk quotas are fully exploited and are a restrictive resource. Huijps and others (2008) showed that, given this criterion, SCC losses differ substantially between Dutch dairy herds and depend mainly on the intensity of production. Given a very intensive farming system, which is quite common in the Netherlands, losses are approximately €0.15/kg (Huijps and others 2008). Cost components taken into account are, among others, the purchase of additional concentrates and roughage (for example, maize silage) and manure disposal costs (Berentsen and Tiessink 2003). Assumed costs decrease at lower intensity levels, and are set at €0.12/kg for an intensive farming system, €0.10/kg for an extensive farming system, and €0.08/kg for a very extensive farming system. The different classes of intensity of production, based on yearly milk production per hectare, were >15,000 kg/ha, 12,000 to 15,000 kg/ha, 10,000 to 12,000 kg/ha and <10,000 kg/ha.

Procedure and data analysis

Values for awareness, intention and efficacy belief were obtained using Likert scales (Table 1). A more elaborate and time-consuming interview approach was preferred to a wide-scale mailed questionnaire. Because the objective of the study was to identify whether farmers were aware of the current situation with regard to SCC in their herd and whether the enhancements to the MPR data were of value, face-to-face interviews were preferred to ensure that the new variables quantifying losses were comprehended. Interviews were approximately 1.5 hours in duration and were conducted in the first quarter of 2008. The interviews were structured by a number of thematic questions.

The perceived deviation from the average national BTSCC level was expressed on a five-point Likert scale (Likert and Hayes 1961) to evaluate farmers' awareness of the current BTSCC level of their herd compared with that of other herds. Subsequently, the information tool revealing projected losses was presented. The information focused on yield and monetary losses, at both whole-farm and individual-cow level. The perceived value of information for these four approaches was rated in accordance with how much it was appreciated. In addition, how much the projected amounts deviated from the farmers' beliefs was determined. Open-ended questions focused on the impact that these projections would have on the preferred control strategy. This part of the dialogue therefore concentrated on understanding the action/behavioural change of the farmer in specific situations, for example, how had cases of elevated SCC been dealt with after they had been identified in the previous MPR period; would the farmers' actions alter if objective projected losses

TABLE 1: Evaluation by 19 dairy farmers of an information tool, scoring several aspects to provide information on economic losses due to elevated somatic cell count (SCC)

	All herds (n=19)	Low BTSCC (<175,000/ml) (n=9) (mean [sd])	High BTSCC (≥175,000/ml) (n=10) (mean [sd])
Perceived values			
Perceived value of information at farm level*	2.32	2.44 (1.23)	2.20 (1.47)
Perceived value of information at cow level*	1.84	2.11 (1.45)	1.60 (0.84)
Awareness			
Deviation from perceived production loss†	2.74	2.67 (0.71)	2.80 (0.42)
Perceived deviation from other farmers‡¥	3.00	3.89 (0.60)	2.20 (0.79)
Actual absolute deviation of SCC from herdbook average (x1000 cells/ml)¥	−1	−65 (36)	36 (87)
Intention			
Aspiration SCC level, absolute (x1000 cells/ml)¥	149	116 (24)	178 (48)
Difference between actual SCC and aspiration (x1000 cells/ml)¥	49	28 (28)	68 (46)
Efficacy belief			
Perceived probability of penalties§	2.55	2.22 (0.87)	2.85 (0.88)
Perceived efforts made to control SCC#	3.26	3.44 (0.68)	3.10 (1.19)

* 1 Not valuable, 3 Somewhat valuable, 5 Valuable
† 1 Much lower than expected, 3 In line with expectation, 5 Much higher than expected
‡ 1 Much higher than other farmers, 3 In line with other farmers, 5 Much lower than other farmers
§ 1 Never occurs, 2 Very unlikely, 3 Unlikely, 4 Possible
# 1 Much less than other farmers, 3 In line with other farmers, 5 Much more than other farmers
¥ Statistically significant difference between subsamples (P<0.10)
BTSCC Bulk tank somatic cell count

were available to them; and what were their motivations for the stated behavioural change or lack of change.

Farmers were questioned about the BTSCC they aspired to achieve from their herd, to clarify their motivation to change management practices to control SCC. The farmers' perceived probability of a penalty being incurred was ascertained, as this is an important motivator for farmers to prevent too high a BTSCC (Huijps and others 2008). It was self-rated on a four-point scale describing qualitatively the probability of occurrence. Additionally, the perceived managerial efforts made to control SCC by the farmer were self-rated, by comparing the farmers' efforts with those of colleagues.

Results

Descriptive statistics

Comparison of the rolling herd averages of a number of key parameters from farms included in the national Dutch herdbook (17,797 farms) and the 19 farms participating in the study, indicated that the sample was representative with respect to SCC levels (Table 2). Herd size and production characteristics (milk, fat and protein) were somewhat higher than the average for the herdbook farms. This was also the case for the average age of cows present on the farm, as well as the economic production result (the revenues for milk and its components).

Substantial differences in BTSCC levels were observed between the 19 farms in the study sample. The average BTSCC in the subsample comprising farms below the median was 137,000 cells ml, whereas for the farms above the median it was 276,000 cells/ml (Table 3). Because of the broad range of BTSCC levels observed, the original stratification was maintained, and was, moreover, a good representation of the actual population.

In line with observed BTSCC levels, substantial differences in production losses across farms were estimated. The estimated average annual production loss was 6218 kg milk/farm, and 83 kg milk for a cow with a SCC exceeding 100,000 cells/ml (Table 3). On average, an annual loss of 4885 kg milk/farm was estimated in the BTSCC group below the median (67 kg milk/cow), whereas for the BTSCC group above the median, this was 7417 kg milk/farm (97 kg milk/cow). Production losses on farms with a more homogeneous herd (that is, a herd in which the cows are similar in terms of their level of milk production) exceeded those of more heterogeneous herds, although BTSCC did not differ. This reflects the fact that farms with identical BTSCC and herd size can have different yield reduction levels. The average annual loss amounted to €850 per farm and €11 per cow, with substantial differences between and within groups.

Perceived value of information

The majority of dairy farmers interviewed did not perceive the cow-specific projected losses as valuable in the sense of the exploitability of this information by them; their average rating was 1.84 on a five-point scale ranging from 'not valuable' to 'valuable' (Table 1). In general, respondents did not question the validity of the estimated projections. Although projected losses were split into yield and monetary losses (both being farm-specific), farmers found it difficult to discriminate between these two alternative units of measurement and therefore always rated them identically. However, when farmers were asked to approximate the loss induced by elevated SCC levels themselves, they could express it more easily in terms of physical units (that is, in milk yield) than in monetary loss.

Farm-level projected losses were perceived to be more useful than the more comprehensive cow-level reports; however, the difference was small (2.32 v 1.84, respectively). Increasing need for improvement on a farm was not associated with an increased appreciation of the revealed information by the farmer, as can be seen by comparing the BTSCC group ratings.

Supplementary information adds to the knowledge and, therefore, the awareness of the person receiving it. Projected losses were mostly in line with the farmers' approximations (score 2.74), although farmers often lacked confidence in their predictions and were reluctant to disclose their estimates. However, there was a tendency for farmers to be relieved when shown projected losses, as these did not exceed their approximations. The difference between projected and perceived production losses was not statistically different between BTSCC groups, indicating that, in general, farmers were aware of the loss exposure. A rule of thumb often mentioned by farmers was a reduction by 2 per cent to 5 per cent, for an increase from 100,000 cells/ml to 200,000 cells/ml, which is in accordance with normal advice from veterinarians and others providing agricultural advice. Almost all farmers anticipated that there would be no losses if SCC was below 100,000 cells/ml. It was shown that farmers were well aware of their achievements compared with those of colleagues. Farmers were aware of whether their herd had a high or low BTSCC, and reported this accurately. For example, the low BTSCC group (with an actual average deviation of −65,000 cells/ml) consistently rated themselves as having better results than other farms (mean [sd] score 3.89 [0.60]) compared with the high BTSCC group (2.20 [0.79]).

A farmer who knows the impact that an elevated SCC level has on production might have a more ambitious intention to reduce it. Aspiration levels were defined by farmers as levels that were thought feasible to obtain, and differed between them. Average aspiration levels

TABLE 2: Key rolling herd averages of variables from the national Dutch herdbook and farms in the study sample

	Herdbook* (n=17,797)	Sample* (n=19)
Somatic cell count (x1000 cells/ml)†	211	210
Herd size (number of milking cows)	68	76
Milk (kg)	8127	8394
Fat (kg)	358	372
Protein (kg)	285	297
Lifetime (days)	1493	1540
Economic production result (€/cow/year)	2063	2150
Intensity of production (kg/ha)‡	12,010	16,490

* Dutch Cattle Syndicate (NRS) (2009)
† Milk Control Station (MCS) database for 16,615 dairy farms supplying to Campina and Royal Friesland Foods (MCS 2009) (to represent Dutch dairy farms)
‡ Agricultural Economics Research Institute (LEI 2005) (to represent Dutch dairy farms)

TABLE 3: Statistics of rolling herd averages and production losses from subclinical mastitis due to somatic cell count in 19 Dutch dairy herds surveyed, subdivided into high and low bulk tank somatic cell count (BTSCC)

	All herds (n=19)	Low BTSCC (<175,000 cells/ml) (n=9) (Mean [sd])	High BTSCC (≥175,000 cells/ml) (n=10) (Mean [sd])
Herd statistics			
BTSCC (x1000 cells/ml)*	210	137 (29)	276 (88)
Herd size (number of milking cows)	76	73 (24)	78 (24)
Milk (kg/cow)	8394	8727 (841)	8095 (897)
Fat (kg/cow)	372	386 (43)	359 (46)
Protein (kg/cow)	297	307 (31)	288 (32)
Lifetime (days)	1540	1524 (209)	1554 (146)
Economic production result (€/year)	2150	2226 (235)	2082 (249)
Intensity of production (kg/ha)*	16,490	19,088 (6776)	14,152 (4509)
Loss projection			
Production loss at farm level (kg/farm/year)*	6218	4885 (1575)	7417 (2676)
Production loss at cow level (kg/cow/year)*	83	67 (9)	97 (24)
Economic loss at farm level (€/farm/year)	850	703 (249)	982 (432)
Economic loss at cow level (€/cow/year)*	11	10 (2)	13 (4)

* Statistically significant difference between subsamples (P<0.10)

were 149,000 cells/ml, with a difference between this and the actual level of 49,000 cells/ml. For the high BTSCC group this was 178,000 cells/ml (68,000 cells/ml difference). None of the farmers made efforts to achieve levels lower than 100,000 cells/ml.

In an open dialogue, the interviewer inquired what the farmer's justification was in aspiring to achieve a BTSCC level higher than the more production-efficient level of 100,000 cells/ml. The responses were categorised into three main areas, with declining importance, referred to as cost effectiveness, expansion plans and technical limitations. This part of the study focused on exploring and describing a spectrum of views, rather than quantifying the farmer's opinions with respect to the underlying and complex subthemes. Farmers in the high BTSCC group justified their moderate aspiration levels because alterations would affect the preferred overall farm management strategy. Moderate aspirations were also rationalised by linking projected gradual herd expansion plans to less restrictive culling strategies. Ultimately, the justification was, at least to some degree, to decrease the unit production cost (economies of scale). In the case of a large investment, expansion would require new housing facilities and milking equipment, facilitating more challenging aspiration levels. Some of the farmers with relatively high BTSCC levels pinpointed technical limitations, such as outdated housing facilities, to justify their moderate aspiration levels. Without having the intention or financial resources, strategic investments were not considered.

The farmer's belief in the efficacy of the current approach towards SCC management was discussed in relation to the perceived risk of penalties and efforts made to control SCC given the current control strategy applied. Farmers with higher SCC levels were aware of the probability of adverse outcomes with respect to milk payments. They rated the probability of penalties as unlikely (score 2.85) while the respondents with lower SCC perceived it as very unlikely (2.22). However, none of the farmers had been confronted with a penalty in the past five years. Culling of cows with consistently high SCC levels was regarded by farmers with high BTSCC levels as a last resort, but at the same time as a very effective way to avoid penalties.

The authors focused on the perceived effort needed by the farmer for their current SCC control strategy (and the farmer's belief in it), in line with the conceptual model of Ajzen (1991), and not the actual effort, as the actual time and money spent was not elicited. Therefore, the association between the perceived effort/behavioural control, given the mastitis treatment strategy applied, and behaviour could be quantified. Both groups perceived that they were more motivated to control subclinical mastitis by comparing their efforts with those of colleagues. Some farmers might have overstated their efforts either by providing socially desired answers, or because information on the efforts made by others was lacking or not appropriately valued.

In general, the perceived trade-off between the cost of measures intended to reduce SCC with the anticipated benefits differed substantially. Control practices that were considered to be successful by some farmers were felt to be too expensive or impractical to implement by others. A pervasive problem encountered was the difficulty of disentangling, at an empirical level, intentions from efficacy beliefs. Farmers might have justified their high BTSCC status because they had not considered better ways of reducing it. According to Ajzen (1991), achievement of behavioural change depends jointly on motivation (intention) and ability (behavioural control). Non-motivational factors such as opportunities and resources (for example, the time and skills available to control SCC) may have had an impact on farmers' intent. Broadly, the theory of planned behaviour is well supported by empirical evidence. This is in line with Ajzen (1991), who stated that attitudes, subjective norms and perceived behavioural control are often related to behaviour and control beliefs about the behaviour, but the exact nature of these relationships is still uncertain.

Discussion

Although many studies have reported substantial production and economic losses due to increased SCC, behavioural change to adopt and implement enhanced SCC control practices may be difficult to achieve. By analysing the three prerequisite steps to establish behavioural change (awareness, intention and efficacy beliefs), the restraining step causing observed inertness for change could be shown. The present study also tested whether providing farmers with additional information on economic loss due to increased SCC on a regular basis would motivate them to implement enhanced control practices. In-depth interviews revealed that providing farmers with cow-specific information on economic losses hardly altered their intent, although, as shown in the present study, they were well aware of their situation. Farmers stated that a higher SCC was due to the overall farm management strategy in place; however, in part, this statement might be merely justifying their high BTSCC status, while lower levels would have been preferable from an economic point of view.

It should be noted that the potential economic importance of BTSCC is not uniform across farms, and control measures justified in one context may not be worthwhile in another (McInerney 1996). At an economic level, the aim of disease control is to minimise the avoidable losses, that is, the total monetary value of the production losses incurred as a result of a disease plus the expenditure incurred to control it (McInerney 1996). The avoidable losses of preventive and curative approaches to the control of a disease can therefore have a similar total value, but consist of a different balance between production losses and control expenditures. Achievement of the economic objective may or may not therefore coincide with high levels of BTSCC control. Perhaps showing farmers the efficient options available to them and supporting them in their decision-making might alter their intent and ultimately their behaviour.

Besides providing production and financial incentives to encourage change, diagnosis of epidemiological patterns of individual-cow and bulk milk SCC is another approach. It could be argued that information on the reasons for changes in epidemiological patterns might also encourage farmers to alter their behaviour. Suggesting feasible enhanced strategies in addition to appending projected losses to standard MPR information might motivate farmers to act more. Knowledge of the epidemiological background of the problem in relation to knowledge of farm management and farm structure is essential to the development of feasible enhanced control strategies. In general, in providing persuasive communications, not only the emotional appeal of the overriding message, but also the man-

ner in which specific information is framed, should be considered (Levin and others 1998). However, given the requirement that context-specific factors need to be accounted for, adding possible strategies to the MPR is not likely to be a promising way forward. Ascertaining farmers' motives and beliefs is probably a more appropriate way of providing the farmer with specific advice on optimal strategies. Perhaps discussing the strategies applied by colleagues via study groups might make farmers more susceptible to behavioural change.

Farmers' choices were shown to be coherent, in the way that their actual behaviour was associated with stated intentions together with perceived behavioural control. However, their decisions often seemed to differ from the standard recommendations by veterinarians and agricultural extension workers (for example, private consultants and extension practitioners working for government agencies or cooperatively). Farmers with relatively high BTSCC levels were well aware of their situation; therefore, providing specific information on the economic consequences was unlikely to alter their actions subsequently. Farmers' actions can be rationalised in a specific context, comprising the intertwined notions of intentions and efficacy beliefs. Although farmers may have positive intentions, a feeling of not being completely in control may inhibit their capacity to deal with the situation (Jansen and others 2009). Understanding these notions is essential when advising farmers, to support them in implementing effective decisions at farm level.

Behavioural change theories and models attempt to explain the reasons behind alterations, or inertness, in individuals' behavioural patterns. In recent years, there has been increased interest in the application of these theories in the areas of health and education, with the hope that understanding behavioural change will improve the services offered in these areas. However, behavioural change is in general notoriously difficult to achieve and sustain (Panter-Brick and others 2006). This is frequently observed and analysed in, for example, human health intervention efforts to promote a healthy lifestyle or discourage poor health behaviours. In the present study, it was found that not all beneficiaries (farmers) were very responsive to indications of the benefits of changing their management practices in the context of SCC control. Behavioural change theories and models may gain interest within the broader context of the Animal Health and Welfare Strategy for Great Britain (Defra 2004) and the corresponding EU policy that 'prevention is better than cure' and that 'costs and benefits need to be understood if best practice is to be understood, accepted and adopted' (European Commission [EC] 2007). These theories and models may be of use in a whole range of behavioural interventions in animal health, and in the improvement of the services offered.

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