

Negative attitudes of Danish dairy farmers to their livestock correlates negatively with animal welfare

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Abstract

Positive stockperson attitudes to his or her animals is associated with a positive behavioural response in the animals and in other indicators assumed to reflect a high level of welfare as well as increased productivity, eg in milk yield. Conversely, negative attitudes have been found to have the opposite effect. However, so far, no attempt has been made to link the attitudes of stockpersons to outcomes of comprehensive protocols assessing animal welfare at farm level. In the study reported here, attitudes of Danish dairy farmers are compared with the on-farm welfare of dairy cows as assessed by the Welfare Quality[®] (WQ) protocol. In 35 dairy herds the welfare was assessed, and the farmers filled in a self-report questionnaire on their attitudes to dairy cows and how they should be handled. The farmers on the farms with the lowest total welfare score could, according to the self-report questionnaire, be characterised as those with a negative attitude to the handling of cows (eg less strongly disliked to kick a cow or use a stick, when necessary). As expected, farmer behavioural attitudes regarding different situations correlated: for example, farmers who liked more to work with and have positive interactions with the cows also agreed more on patient handling and the importance of regular positive contact. Furthermore, farms where farmers gave cows a positive characteristic were found to score highly on the WQ principle 'Appropriate behaviour'.

Keywords: animal welfare, dairy cows, farmer attitude, human-animal relationship, milk yield, Welfare Quality[®]

Introduction

Dairy cattle and other domesticated animals rely on their caretakers, and their welfare is dependent on how well they are taken care of. Management decisions regarding housing and production systems have an impact on the animals; and several studies have indicated that the system can influence the animal, including, in the case of the dairy cow, its body condition score, lameness, integument alterations and somatic cell count (Bowell *et al* 2003; Regula *et al* 2004; Mattiello *et al* 2005; Trevisi *et al* 2006). However, practical experience suggests that the effects of the farmer and stockperson go far beyond this and, in a study conducted in 1972, another level of management influence was documented. The results indicated that the farmer's personality and behaviour affected milk yield in dairy cows (Seabrook 1972). This finding launched a new research area which looked into the effect human personal factors, including attitudes, and behaviour, might have on animals, reviewed by Adler *et al* (2019).

Interaction between humans and animals can involve visual, tactile, olfactory or auditory contact. The reaction elicited in the animals in response to the contact can be either positive or negative (Waiblinger *et al* 2006a).

Several studies, conducted on different species, have found that negative human behaviour towards an animal can cause both physiological and behavioural stress responses in that animal which, in turn, lead to reduced welfare and decreased production (Hemsworth *et al* 1993; de Passillé *et al* 1996; Breuer *et al* 2000, 2003; Boivin *et al* 2003; Ceballos *et al* 2018). Attitudes are important determinants of human behaviour (Waiblinger *et al* 2006a; Hemsworth & Coleman 2011) and may therefore also affect animal welfare. Attitudes are described as externally directed predispositions acquired through experience (Ajzen 2005; Hanna *et al* 2009). Self-report questionnaires, with different statements connected to Likert scales which invite the person questioned to state how strongly he or she agrees with a statement, are most often used to assess attitudes towards, for example, animals.

Literature revealed that most of the questionnaires used to assess human attitudes to farm animals resemble each other. Questionnaires often include a section about attitudes toward animals (here, cows; statements included are, eg 'Dairy cows are friendly', 'Dairy cows are intelligent' and 'Dairy cows are aggressive') and other sections about the handling of cows.

Further, the data retrieved are often handled using Principal Component Analysis (PCA) (Breuer *et al* 2000; Hemsworth *et al* 2000; Waiblinger *et al* 2002; Coleman *et al* 2003), which is a multivariate statistical method used to reduce data by finding underlying structures in a data matrix (Hair *et al* 1998). Using an attitude questionnaire containing a 25-item section on the characteristics of cows and a 57-item section on attitudes to working with cows, Hemsworth *et al* (2002) found seven factors describing the farmers' attitudes, including 'Negative attitudes', 'Good behaviour' and 'Little effort to handle'. Factors resembling these were found by Waiblinger *et al* (2002).

Studies investigating the relationship between human attitude and human behaviour in relation to animals have found that negative handler attitudes are correlated with negative handler behaviour. A study conducted on dairy farms found that the less positive the attitude of the stockperson, the more aversive the person was found to be; and that stockpersons with more positive attitudes used a calmer voice to address the cows (Breuer *et al* 2000). Similarly, abattoir personnel with a positive attitude to pigs tended to use an electric prod with the power turned off, while those with a negative attitude to pigs tended to use the prod with the power on (Coleman *et al* 2003). Further, it has been found that positive behaviour during milking corresponds with a willingness to give a more positive characterisation of working on a dairy farm (Maller *et al* 2005).

Associations between negative human attitudes, negative human behaviour, and animals' reaction to humans, and animal productivity, have been shown in studies of cows, poultry and pigs (Hemsworth *et al* 1993, 2000; Breuer *et al* 2000). Further, studies have shown that positive human attitudes elicit positive human behaviour which influences productivity in a positive way (Hemsworth 2003). Several studies have linked the farmer's or caretaker's attitude and behaviour to various measures of animal health, production and welfare. In veal calves, positive human behaviour was found to be associated with higher daily weight gain and lower mortality rate (Lensink *et al* 2000). In a case-control study conducted in New Zealand, the patience of the stockperson was found to be the most important factor for explaining the prevalence of lameness in dairy cows with 20% of the variance explained by this factor (Chesterton *et al* 1989). Similarly, a study of 80 dairy herds in Austria found a high prevalence of lameness to be associated with negative attitudes to the handling of cows (Rouha-Mülleder *et al* 2009). In the same study, a generally positive attitude, among milkers, to the cows was related to a lower somatic cell count (SCC), while a generally negative attitude was related to higher SCC (Waiblinger *et al* 2006b). Similarly, a study has found that the prevalence of mastitis was negatively associated with the proportion of positive interactions by milkers and positively associated with the number of cows showing high avoidance distance (Ivemeyer *et al* 2011).

As attitudes are acquired, the possibility of changing them is real (Hemsworth & Coleman 2011). Interventions to improve the stockperson's attitude and, hence, behaviour

toward cows have been successful: the stockpersons showed a more positive attitude, the flight distance of animals decreased, and milk yield increased, after an intervention (Hemsworth *et al* 2002).

Thus, the studies previously conducted indicate that handler attitude influences handler behaviour which, in turn, influences the animals, and hence their welfare. However, the studies are fragmented in the way they conceive of animal welfare. They consider different elements of animal welfare, such as fear of humans, stress, or health status, but not overall welfare measured by a validated protocol. To make up for this deficit in the existing literature, the objective of this study was to find out how farmer attitudes relate to dairy cattle welfare as measured by the European Welfare Quality® protocol — a protocol that uses a primarily animal-based approach for measuring animal welfare and that is divided into 12 criteria and four main principles (Blokhuis *et al* 2013). This enabled us to study whether or not farmer attitudes influence the overall level of welfare on-farm or whether it only influences specific aspects of animal welfare. Furthermore, it was investigated whether milk yield was affected by the level of welfare on-farm and by the farmer's attitudes to livestock.

The novel approach taken in the current study is to link farmer attitudes with an outcome-based measure of animal welfare that distinguishes different components of animal welfare defined in the light of different principles.

Materials and methods

The data used in this study were collected as part of a larger cross-sectional observational study (Andreasen *et al* 2013). Data were collected during the autumn and winter of 2010/2011 (October–March) in Denmark. In all, 44 farms participated in the larger study; of these, 35 farmers agreed to participate in the present study. The data presented and discussed here concern these 35 farms. Each farm was visited once by the same observer (SNA).

Farms and farmers

The farms used loose-housing, and the cows were all Danish Holstein-Friesian. The mean (\pm SD) number of cows per farm was 180 (\pm 73); (range: 101–452). Two of the farms were organic. Two used deep bedding, but the rest used cubicles; 22 of the farms milked in a parlour, while 13 used automatic milking. All cows were in the facility during data collection, and primiparous, multiparous and dry cows were included. Cows housed in sick pens were excluded.

All of the 35 participating farmers were trained as farmers, had the main responsibility for the animals and handled the cows on a daily basis. Thirty-four of the farmers were male; one was female. The age of the farmers ranged from 26 to 65 years (mean 43.5 years). The mean number of years of experience in working with cattle was 31 years (range: 5–55). Thirty-three of the farmers grew up on a farm with dairy cattle; two did not. Numbers of employees on-farm ranged from one to eight, with a mean of 1.7 (\pm 1.4). General data concerning the farms (eg kg of energy-corrected milk per year [ECM per year]) were obtained through the Danish database

Table 1 Outline of the Welfare Quality® protocol for dairy cattle.

	Principle	Criteria	Number and type of measure	
Overall assessment	Good feeding	Absence of prolonged hunger	1 animal-based	
		Absence of prolonged thirst	4 resource-based	
	Good housing	Comfort around resting	4 animal-based	
		Thermal comfort	No measure	
	Good health	Ease of movement	2 resource/management-based	
		Absence of injuries	2 animal-based	
		Absence of disease	10 animal-based	
	Appropriate behaviour	Absence of pain induced by management procedures		2 management-based
		Expression of social behaviours		1 animal-based
		Expression of other behaviours		1 resource-based
		Good-human animal relationship		1 animal-based
			Positive emotional state	1 animal-based

‘Dyrregistrering’, which is a tool used in management. The mean yield was 10,373 kg; the minimum yield was 8,116 kg, and the maximum yield was 12,116 (\pm 932.3) kg.

Data acquisition

Welfare assessment

As part of the larger study, all farms were assessed using the European Welfare Quality® protocol (WQ) for dairy cattle. The WQ protocol for dairy cattle consists of 29 measures, of these 20 are animal-based, the remaining nine measures are either resource- or management-based. The WQ protocol is based on measures that relate to the experiences of the animal and therefore primarily use animal-based measures (Botreau *et al* 2007; see Table 1). None of the measures are based on observation by the farmer. The protocol assigns farms’ scores on three levels: on 12 criteria (eg Absence of prolonged hunger, Comfort around resting, Absence of injuries and Good human-animal relationship), on four principles (Good feeding, Good housing, Good health and Appropriate behaviour) and on one overall assessment (‘Not classified’, ‘Acceptable’, ‘Enhanced’ or ‘Excellent’) (Welfare Quality® 2009). The data were collected using the recommended sample size on all farms. The mean number of cows assessed on each farm was 69 (\pm 8.7); (range: 51–87); Welfare Quality® (2009).

Farmer attitude questionnaire

The participating farmers received a questionnaire assessing their attitudes to cows and their handling of cows. The farmers were asked to fill in the questionnaire on the day of the farm visit, only two failed to do so, but they returned the questionnaire no later than a week after the visit. The questionnaire, which comprised two parts, was developed and validated by Waiblinger *et al* (2002) and was translated into Danish. Part one, concerning the farmers’ general attitudes to cows, comprised 29 statements, such as ‘Cows are curious’,

‘Cows are intelligent’ and ‘Cows are often nervous’. Part two dealt with behavioural attitudes and was subdivided into four sections. The first two sections concerned the farmers’ behavioural attitudes when moving the cows to and from milking, and when milking the cows, respectively. The third section concerned the farmers’ beliefs on the importance of contact with their cattle (eg how important the farmer believed it to be to talk to the animals when approaching them and how important to go through the herd regularly). Finally, the fourth section concerned the affective attitudes to working with and having different kinds of contact with the cows; here, the farmers needed to indicate how much they like or dislike contact with cows in different situations, eg physical contact during milking. The farmers’ response was given on a seven-point Likert scale, ranging from ‘Strongly agree’ to ‘Strongly disagree’ or from ‘Very important’ to ‘Completely unimportant’ for part one and the first to third section of part two, and from ‘Like very much’ to ‘Dislike very much’ for the fourth section of part two. Part two, sections one and two were only filled in by the 22 farmers who milked in-parlour.

In addition, the farmers were asked to fill in a questionnaire about their personal details, including age, years of experience and educational background. At no point was the actual behaviour of the farmers observed.

Statistical analysis

For statistical analysis, the software SAS JMP® 10 (SAS Institute Inc, SAS Campus Drive, Cary, NC, USA) was used.

The Welfare Quality® protocol

The Welfare Quality® calculations were conducted according to the outline in the WQ protocol (Welfare Quality® 2009) and were performed by INRA (Institut National de la Recherche Agronomique), France. The outcome of the WQ protocol for each farm was, as mentioned, stated in terms of 12 criterion scores, four principle scores and one overall score.

Table 2 Components found when conducting Principal Component Analysis on the data collected using the questionnaire (Part one) on the farmers' attitudes to cows. Some components were found to be described by more than three statements. However, only three are reported. Using the statements describing the component the component was labelled.

Questionnaire	Component	Three descriptors (loading)	Farm score (range and median)	Name of component
Part I General attitude to cows (35 farms)	1	Cows are friendly to humans (0.86)	-1.88–2.43	PosA Positive Attitude
		Cows are intelligent (0.75)	-0.30	
		Cows are calm (0.75)		
	2	Cows enjoy being brushed by humans (0.80)	-2.64–1.41	PosC Positive Characteristic of cows
		Cows are sensitive to being talked to (0.68)	0.21	
		Cows are sensitive to contact with their caretaker (0.56)		
	3	Cows are hardly sensitive to pain (0.80)	-1.64–3.04	NegC Negative Characteristic of cows
		Cows are unpredictable (0.75)	-0.14	
		Cows are difficult to handle (0.74)		

Farmer attitude questionnaire

As mentioned, all questions were answered using a seven-point Likert scale. To obtain summary variables for all sections the answers were processed using Principal Component Analysis (PCA) with Varimax rotation for each section separately. For variables to be descriptive of a component, a criterion of them having to load ≥ 0.55 was used. In addition, the variables should not fulfil the loading criterion on any of the other components. For decisions about the number of components, scree plots were used. Component scores for each farm were found by weighting and summing the actual scores of the questionnaire.

Correlation

Correlations between general farmer attitudes and behavioural attitudes, between attitudes, milk yield and the WQ protocol (criteria, principles and the overall score), and between milk yield and the WQ protocol, were tested using Spearman Rank Correlation.

Results

Farmer attitude questionnaire

The results regarding components extracted by PCA and variations between farmers are shown in Table 2 (Parts one and two shown separately).

Part one – farmers' general attitudes to the cows

When PCA with Varimax rotation was applied to part one of the questionnaire on the farmers' attitude to the cows for all 35 farms, the scree plot indicated that three components with a cumulative percentage of 49.3% accounted for most of the variance. Eight items were found on component one, all of which described a positive attitude to cows, and the component was labelled 'Positive attitude' (PosA). On component two, six items were found. The six items all reflected a positive characteristic of cows, and the component was labelled 'Positive characteristics of cows' (PosC).

Component three was described by five items, which were all negative toward cows, and the component was labelled 'Negative characteristics of cows' (NegC). For these components, see Table 2, part 1.

Part two, section one – farmers' behavioural attitude to handling cows when moving them in the dairy

Only the 22 farms using the parlour when milking were considered. Three components with a cumulative percentage of 54.8% of explained variance were identified. The items describing component one all concerned a negative attitude to handling cows when moving them in/out of the dairy, and the component was labelled 'Negative handling moving in/out of the dairy' (NegHMD). On component two, the items indicated a patient attitude to moving cows out of the dairy, and the component was labelled 'Patience during moving in the dairy' (PatMD). Component three was described by items that all concerned an attitude to calm moving of cows, and the component was labelled 'Calm moving' (CM). For these components, see Table 2, part 2, section 1.

Part two, section two – farmers' behavioural attitude to milking the cows

Only the 22 farms using the parlour when milking were considered. Three components with a cumulative percentage of 61.2% accounted for most of the variance. Three items were found on component one; these items concerned a patient attitude during milking, and the component was labelled 'Patience during milking' (PatM). Component two was described by two items, both of which concerned a negative attitude to physical handling during milking, and the component was labelled 'Negative handling during milking' (NegHM). The third component was also described by two items; these items concerned the farmers' attitude to culling if problems occur during milking, and the component was labelled 'Culling if problem during milking' (CPM). For these components, see Table 2, part 2, section 2.

Table 2 (cont) Components found when conducting Principal Component Analysis on the data collected using the questionnaire (Part two) on the farmers' attitudes to cows. Some components were found to be described by more than three statements. However, only three are reported. Using the statements describing the component the component was labelled.

Questionnaire	Component	Three descriptors (loading)	Farm score (range and median)	Name of component	
Part 2, Section 1 Farmers' behavioural attitudes to moving cows to and from milking (22 farms)	1	When a cow stops while moving into the dairy I would move her with a stick/pipe (first-calf heifer 0.86; cows 0.81)	-1.42–2.0	NegHMD	
		When a cow stops while moving out of the dairy I would shout at her loudly (first-calf heifer 0.85; cows 0.81)	-0.13	Negative Handling moving in/out of Dairy	
		When a cow stops while moving into the dairy I would shout at her loudly (first-calf heifer 0.77; cows 0.78)			
	2	When a cow stops while moving out of the dairy I would move her with a touch by the hand (first-calf heifer 0.91; cows 0.92)	-2.58–1.55	PatMD	
		When a cow stops while moving into the dairy I would move her with a touch by the hand (first-calf heifer 0.72; cows 0.61)	0.29	Patience during Moving in the Dairy	
	3	It is important to give first-milking cows time when moving them into the dairy (0.83)	-1.91–2.05	CM	
		When a first-calf heifer stops while moving into the dairy I would talk to her calmly (0.66)	-0.19	Calm Moving	
		It is important to teach the cows not to stop when entering the dairy (0.63)			
	Part 2, Section 2 Farmers' behavioural attitudes to milking cows (22 farms)	1	When a first-calf heifer kicks during milking I would try to calm her down by talking to her (0.94)	-2.66–1.14	PatM
When an older cow kicks during milking I would try to calm her down by talking to her (0.90)			0.12	Patience during Milking	
Important to calm a first-calf heifer by talking when she kicks during milking (0.61)					
2		When a first-calf heifer kicks during milking I would hit her with the hand to stop her (0.89)	-1.80–1.88	NegHM	
		When an older cow kicks during milking I would hit her with the hand to stop her (0.87)	-0.22	Negative Handling during Milking	
3		When an older cow kicks during milking I would cull her soon even if she is high-yielding (0.97)	-1.57–2.23	CPM	
		When a first-calf heifer kicks during milking I would cull her soon even if she is high-yielding (0.76)	-0.12	Culling if Problem during Milking	
		It is important to go through the herd regularly – calves, young stock, first-calf heifers and cows (0.86; 0.86; 0.91; 0.91)	-4.60–1.00	IPC	
Part 2, Section 3 Farmers' behavioural attitudes to contact with animals in general (35 farms)		1	It is important to stroke calves, young stock, first-calf heifers and cows (0.87; 0.85; 0.87; 0.81)	0.10	Importance of Positive Contact
	It is important to talk to the animals when you go through the herd – calves, young stock, heifers and cows (0.85; 0.86; 0.86; 0.85)				
	During working with the cows I stay calm no matter the situation (0.74)		-2.71–2.25	CA	
	2	Important for easy handling that the animals are confident in humans (0.58)	0.11	Confident Animals	
		Important that animals keep calm when they are touched (0.56)			
	Part 2, Section 4 Farmers' behavioural attitudes to working with cows (35 farms)	1	Likes petting and stroking cows when dry (0.72)	-2.0–1.46	LWC
			I like my cows (0.69)	0.03	Like Working with Cows
			Likes working with cows in general (0.69)		
		2	No strong dislike kicking cows if necessary to move them (0.75)	-1.81–2.25	NegPC
No strong dislike moving cows with a stick if necessary (0.67)			-0.10	Negative Physical Contact	
3		Like treating cows (0.65)	-1.97–2.23	LikeTC	
			0.06	Like Treating Cows	

Table 3 Significant correlations between variables found using Spearman Rank Correlation Significant correlations between variables found using Spearman Rank Correlation.

Variable	Variable	r_s	P-value
<i>Inter-relationship between general attitudes and behavioural attitudes</i>			
PosA - Positive Attitude	NegHMD - Negative Handling moving in/out of Dairy	-0.499	0.018
	CA - Confident Animals	0.384	0.007
	LWC - Like Working with Cows	0.454	0.006
	NegPC - Negative Physical Contact	-0.361	0.033
PosC - Positive Characteristics of cows	CM - Calm moving	0.479	0.024
<i>Inter-relationship between behavioural attitudes</i>			
NegHMD Negative Handling moving in/out of Dairy (22 farms milking in parlour)	NegHM - Negative Handling during Milking	0.464	0.03
	LWC - Like Working with Cows	-0.451	0.035
	NegPC - Negative Physical Contact	0.601	0.003
CM - Calm moving (22 farms milking in parlour)	LWC - Like Working with Cows	0.52	0.013
PatM - Patience during milking (22 farms milking in parlour)	LWC - Like Working with Cows	0.424	0.049
IPC Importance of positive contact	CA - Confident Animals	0.448	0.007
	LWC - Like Working with Cows	0.477	0.004
CA - Confident Animals	LWC - Like Working with Cows	0.626	< 0.0001
<i>Attitudes and the Welfare Quality® protocol</i>			
PosC - Positive Characteristic	Principle 4 - Appropriate behaviour (Welfare Quality®)	0.398	0.018
NegPC - Negative Physical Contact	Overall score (Welfare Quality®)	-0.425	0.011
LikeTC - Like Treating Cows	Criterion 2 - Absence of prolonged thirst (Welfare Quality®)	0.373	0.027

Part two, section three – farmers' attitude to the importance of contact to cattle

All of the farms were considered. Two components with a cumulative percentage of 61.9% were extracted. The first component was detailed by items describing attitudes toward regular, positive contact with the animals, and the component was labelled 'Importance of positive contact' (IPC). The second component was described by items which concerned the importance of confident animals, and the component was labelled 'Confident animals' (CA). For these components, see Table 2, part 2, section 3.

Part two, section four – farmers' affective attitude to contact with the cows

All of the farms were considered. When PCA with Varimax rotation was applied to the results of this part of the questionnaire, the scree plot indicated that three components with a cumulative percentage of 55.5% accounted for most of the variance. On component one, eight items were found; these concerned the joy of working with cows, and the component was labelled 'Like working with cows' (LWC). Component two was described by two items both of which concerned negative physical interactions with cows, and the component was labelled 'Negative physical contact'

(NegPC). The third component was described by one item and was labelled 'Like treating cows' (LikeTC). For these components, see Table 2, part 2, section 4.

Correlation between variables

As mentioned, Spearman Rank Correlation was used to explore the correlation between variables. The significant results are presented in Table 3.

Farmer attitude questionnaire – inter-relationships

Inter-relationships between a farmer's general attitude and his/her behavioural attitude was found. Thus, for example, farmers who had a general 'positive attitude' (PA) towards cows liked working with cows (LWC) and believed that confident animals (CA) are important. Further inter-relationships between a farmer's behavioural attitudes were found; having a 'negative attitude to handling cows when moving them in and out of the dairy' (NegHMD) was negatively correlated to 'like working with cows' (LWC). 'Like working with cows', on the other hand, correlated positively with 'calm moving' (CM), 'patience during milking' (PatM), and the beliefs that positive contact (IPC) and confident animals (CA) are important. For significant correlations see Table 3.

Welfare Quality® scores, milk yield and attitudes

When the relationship between attitudes and the WQ protocol was examined, less aversion to using negative physical contact (NegPC) (ie less dislike expressed regarding the statements of kicking or hitting cows with a stick if necessary to move them) was significantly related to a poorer overall WQ score. ‘Positive characteristic’ (PosC) was positively correlated with Principle 4 in the WQ protocol (‘Appropriate behaviour’). Farmers with a positive attitude to treating cows (‘like treating cows’ [LikeTC]) scored high on criterion 2 — ‘Absence of prolonged thirst’ in the WQ protocol. For specific correlations, see Table 3.

When correlations involving milk yield (energy corrected milk per year [ECM per year]) were examined, no significant correlations were found nor as regards WQ or farmer attitude.

Discussion

This study is the first that has investigated and found an association between negative farmer attitudes and poor overall on-farm levels of welfare in Danish dairy herds as measured by the Welfare Quality® protocol. The study could not reveal correlations between negative attitudes and low milk yield as found in previous studies (Rushen *et al* 1999; Breuer *et al* 2000; Hanna *et al* 2006, 2009; Fukasawa *et al* 2017).

Farmers who scored higher on ‘negative physical contact’ (NegPC) (ie who less clearly expressed a dislike of kicking and/or hitting cows with sticks if necessary to move them) were found to obtain poorer overall welfare results in the WQ protocol.

PCA was the main statistical method used in this study. PCA is used to identify underlying structures in a complex data set, and it can reduce data. For PCA, an N:P (sample size/number of variables ratio) of 3:1 is suggested (Gorsuch 1997, for a discussion, see Budaev 2010). This is not met by the current data; the ratios varied from 2.7:1 in Table 2, section 4 to 0.6:1 in Table 2, section 1. Although the formal requirements are not met, the range of ratios is not unusual in papers published using PCA (eg Feaver *et al* 1986; Phythian *et al* 2013).

The results did not show a positive correlation between positive attitude and good overall welfare. However, giving a positive characteristic of cows (PosC) correlated positively with Principle 4 in the WQ protocol, which describes ‘Appropriate behaviour’ (Welfare Quality® 2009). Furthermore, farmers with a positive attitude (PosA) found it important to have confident animals (CA) (for results, see Table 2. This is in line with previous studies which have found an association between positive human attitude and positive animal behaviour (Breuer *et al* 2000; Hemsworth *et al* 2000; Hemsworth & Coleman 2011), including reduced agonistic interactions.

Interestingly, we did not find a correlation between criterion 11 in the Welfare Quality® protocol and the results of the farmer attitude questionnaire, such as found by, eg des Roches *et al* (2016). Criterion 11 is defined as good human-animal relationship and is measured as avoidance distance (Welfare Quality® 2009). A reason for this finding could be

that only farmers were asked to fill in the questionnaire while, besides farmers, other caretakers could have an impact on the animals’ relationship towards humans and therefore have an effect on the way cows react to an unknown experimenter.

The findings of this study further indicated that there is a positive correlation between and within general attitudes and attitudes towards certain forms of behaviour — a finding also made by Waiblinger *et al* (2002). Thus, farmers who liked working with cows (LWC) agreed about being patient during milking (PatM) and saw calm moving (CM) as important. Further, LWC was found to positively correlate with having a general positive attitude (PosA) and to the belief that confident animals are important (CA).

Behavioural attitudes have been found to be quite good predictors of stockpersons’ behaviour towards their animals (eg Waiblinger *et al* 2002, for the questionnaire used in this study and Hemsworth & Coleman 2011, for a review). Therefore, more negative behaviour can be expected from farmers who score highly on NegPC and NegHMD. The above findings suggest that being more in agreement with the statements endorsing negative handling of cows is correlated with the use of negative handling which, in turn, affects the cows in a negative way (by inducing fear and behavioural and physiological stress responses, eg Rushen *et al* 1999; Breuer *et al* 2003), resulting in cows with poor welfare. This is in line with earlier results on the relationships of human attitudes and behaviour (Waiblinger *et al* 2002). Of course, correlation does not indicate causality and the direction of effect. We cannot totally exclude that health problems in the cows may have induced frustration in farmers which then is expressed in more negative handling affecting cow behaviour and feeding back on attitudes (for discussion on mutual influences of attitude and behaviour, see Hemsworth & Coleman 2011). However, due to previous on-farm as well as experimental studies where sequential relationships of human attitudes, human behaviour, animal stress, behaviour and production were shown (eg Hemsworth *et al* 2002, for a review, see Hemsworth & Coleman 2011), we argue that a directional explanation for our findings is likely — farmers having a positive attitude toward their animals enjoy working with them and thereby have an understanding of their animals and by that develop a behaviour and management style which induces better welfare (see also Waiblinger *et al* 2001, 2006c).

The self-report questionnaire used in this study was filled in by the farmers no later than a week after the WQ visit. To ensure continuity to the validated version and to previous studies, the wording of the questionnaire was retained. It could however be argued that some of the questions would not fit well in Danish settings. In many Danish farms, the number of cows and robot installations, such as robotic milking, reduces the close contact between the farmer and the cow. However, the farmer and employees typically still walk rounds each day and still have to move and handle the cows on a regular basis. How farmers and stockpeople behave during these interactions can be very different and is

crucial for the human-animal relationship (Waiblinger 2019) and the attitude questionnaire was designed to evaluate attitudes related to these behavioural differences. Accordingly, the questionnaire was successfully used in different European and non-European countries with largely different farm situations (with respect to herd size, use of employees, and husbandry conditions including robotic milking). Another point of critique concerning the questionnaire could be that farmers may not respond honestly if they assume the response would not be socially acceptable. Particularly, one might assume, in instances of receiving an honest response to the question of how strongly they dislike kicking a cow or would use a stick, when necessary, even if the wording ‘if necessary’ already implies a degree of acceptability. But one must consider that these two single items on negative behaviours are included in a battery of items that includes both neutral and positive behaviours, an important feature of attitude questionnaires. Farmers did show clear variation in the level of dislike in this and in previous studies, which is sufficient for distinguishing farmers’ attitudes towards these negative behaviours. The PCA identified components of attitudes largely similar to the ones in the previous studies and results show meaningful associations in the expected direction — all this again verifies the validity of the attitude questionnaire.

The components found in this study resemble those found in other studies of farmers’ attitudes (Hemsworth *et al* 2000; Waiblinger *et al* 2002; Ivemeyer *et al* 2011), and the results are believed to reflect farmer attitudes to cows. Although 32 of the 35 farms had one or more employees (a factor which can also have an impact on the cows), all farmers reported having a significant amount of contact with the cows and were therefore expected to influence the cows. Further, farmers in charge make overall decisions which could influence the cows. Also, the employees were under the supervision of the farmers. Against this background it can be argued that the results obtained when attitudes were correlated with the WQ protocol, reflect the effect of the farmers’ attitude and subsequent behaviour and decisions on the cows (for a review, see Waiblinger 2019). Previous studies have also found a connection between farmers’ attitudes, farmers’ behaviour and animal behaviour (Breuer *et al* 2000; Hemsworth 2003; Hemsworth & Coleman 2011). It is possible, that inclusion of further caretakers’ attitudes would enhance the predictive value of human attitudes on cow welfare and production.

Attitude and personality are the main determinants of human behaviour, however their relative importance is assessed differently. Five basic dimensions of human personality have been described: extraversion, agreeableness, conscientiousness, neuroticism and openness. These ‘big five’ are believed to be the core personality traits and are regarded by psychologists as important in explaining human behaviour (McCrae & Costa 1997; Hanna *et al* 2009). The present study adopted the approach of previous studies when assessing attitude and relating it to animal welfare and human behaviour. Future studies may benefit from including measures of personality in addition to measures of attitude, eg O’Kane *et al* (2017).

As mentioned, this study documented a connection between negative farmer attitude and overall poor welfare, and this supports the findings, made in other studies, that farmers are important to the animals and their welfare. However, the idea that the attitude of a farmer can be used in the assessment of welfare on-farm should be approached with caution as pointed out already by Waiblinger and Spooler (2007). The recording of attitude is easily compromised, as it depends on self-reports. With this in mind, we will argue that farmer-attitude is not suitable for use as proxy measures of animal welfare in regulatory settings where the assessment of welfare can lead to sanctions. However, attitude may perhaps be used as a proxy animal welfare measure in situations where farmers or their employees wish to explore the level of welfare on-farm and underlying factors under their own initiative.

Animal welfare implications

This study supports previous work and adds to the knowledge that farmer attitudes affect overall animal welfare when this assessed by a validated protocol. An intervention study conducted by Hemsworth *et al* (2002) found that changing stockperson attitudes so that they are more positive elicits a positive response in the cows. This result, together with the finding made in the present study, that farmer attitudes influence overall animal welfare, points to an important route to improving animal welfare by affecting farmer attitudes through education.

Conclusion

In this study, the relationship between farmer attitude and animal welfare as measured by means of comprehensive, validated indicators is studied for the first time. It was found that farms where farmers, according to the self-report questionnaire, had a negative attitude to the handling of cows were also the farms with reduced levels of welfare, as measured by the WQ protocol. On the other hand, farmers with positive attitudes to cows agreed on being patient and calm, and their farms scored highly on the WQ principle ‘Appropriate behaviour’.

These results together with previous studies — which have shown that negative human attitudes lead to negative human behaviour (eg negative tactile behaviour, such as hitting and tail twisting, or negative auditory behaviour, such as shouting), and that positive human attitudes lead to positive human behaviour (eg positive tactile behaviour, such as stroking, or positive auditory behaviour, such as soft vocalisation) — strongly suggests that farmer attitudes influence the cows mediated by behaviour and decision-making. Further, it can be argued that holding a negative attitude will increase the negative experiences of the cows, leading to poor welfare.

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