The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK
www.ufaw.org.uk

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Development of a welfare assessment protocol and assessment of dairy cattle welfare in Haryana and Punjab states of Northern India

ML Kamboj*, C Kumar and V Mahla

Livestock Production Management Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India 132 001
* Contact for correspondence: kamboj66@rediffmail.com

Abstract

The aim of this study was to develop an on-farm dairy cattle welfare assessment protocol at different-sized farms in two major commercial dairy farming states in India. For developing the protocol, the basic 'Integrative Diagnostic System Welfare' (IDSW) framework was modified to include three welfare components (animal housing and other facilities; feeds and feeding practices; and animal health, performance and behaviour) and 20 welfare indicators (ten resource- and ten animal-based). Each indicator was weighed on a value scale with an aggregate welfare score of 100. The protocol was tested for feasibility, validity and reliability using Cronbach's alpha and Guttman split-half coefficient. Using this protocol, welfare was assessed on 60 commercial farms in Punjab and 50 in Haryana, divided into three adult herd sizes: small (S < 20), medium (M = 21–50) and large (L > 50). Welfare scores in L (76.60 [± 1.70]) and M (68.40 [± 2.27]) sized herds in Punjab were higher than in S herds (60.80 [± 2.77]). In Haryana these were higher in L (68.1 [± 1.18]) than in S (60.50 [± 2.74]) and M (59.35 [± 2.17]) sized herds. The aggregate average welfare score was higher in Punjab (68.60 [± 1.49]) than in Haryana (62.65 [± 2.02]). Welfare at more than 75% of the farms in Punjab and more than 50% of those in Haryana was judged as 'acceptable.' Six welfare indicators in Punjab and eight in Haryana were most compromised. Four indicators (microclimate protection measures, availability of milking parlour, cow cleanliness and reproductive efficiency) were the most compromised indicators in both states. To improve dairy cattle welfare in these states we recommend an emphasis on improving housing and feeding conditions, especially at small and medium farms, along with heat stress amelioration measures and improving hygiene and reproductive efficiency at all farms.

Keywords: *animal welfare, dairy cattle, farm size, India, welfare assessment, welfare protocol*

Introduction

India has the largest cattle (192.4 million) and buffalo population (110 million) in the world. The cows typically show low productivity (average milk yield: 3.01 kg per cow per day) producing 83.6 million tonnes of milk and contributing 46% of total milk production of the country (Basic Animal Husbandry Statistics 2019). These cows and buffaloes are maintained by approximately 70 million households under traditional small holder extensive/semi-intensive production systems in mixed farming systems. To augment the productivity of these native cows (*Bos indicus*), the cross-breeding programme was launched in the 1950s by importing high-producing European dairy cattle breeds (*B. taurus*) such as Holstein Freisian and Jersey. These cross-bred cows have now become popular, especially with relatively large-sized commercial dairy farmers and new entrepreneurs. There are now approximately 51.2 million cross-bred cows with an average milk yield of 7.95 kg per cow per day (Basic Animal Husbandry Statistics 2019). The burgeoning demand for milk and milk products in response to the rising human population and people's income levels has necessitated a paradigm shift from traditional small-scale production to commercial (intensive) production (Kumar 2015).

Commercialisation has been facilitated by modern production technology and use of cross-bred cows to satisfy demand. The cows in intensive production systems are subjected to many stressful conditions, such as tropical heat, inadequate/imbalanced feeding, improper/inadequate housing, overcrowding and infertility. They may, therefore, suffer from many problems such as impaired reproduction, high incidence of disease, high mortality and high incidence of abnormal behaviours (Kamboj *et al* 2014). Animal welfare is severely impaired by the intensive confinement of modern production systems because in these production systems animals are unable to exercise properly and unable to express many of their important natural behaviours (Jensen & Toates 1993; Špinka 2006; Humane Society International 2012). Furthermore, restrictive housing systems, poor nutrition, overproduction of milk, repeated re-impregnation, short calving intervals and physical disorders

impair the welfare of the animals in industrial dairy operations (Humane Society of US 2009). Faster growth, higher production with greater feed conversion and utilisation for production are some of the worst animal welfare problems that exist under intensive systems (Broom 2001).

Animal welfare issues have grown in importance in recent years not only in developed countries but also in developing countries where improvement of animal welfare practices can lead to not only improved animal health and production but also increased trade opportunities. Such countries, where land and labour are cheaper than in developed countries, are likely to have a natural commercial advantage through reduced farm production costs. In developing countries, the issues of animal welfare are, thus, becoming part of the agenda for animal husbandry development, due to requirements to meet stringent export norms for dairy products as well as rising domestic concerns in the course of economic development (Grethe 2017).

Cattle are considered sacred in Hindu mythology (Fox 1999; Kennedy 2018) and, therefore, their slaughter is banned in most Indian states (Constitution of India 1950; art 48), including Haryana (Haryana Gauvansh Sanrakshan and Gausamvardhan Act 2015) and Punjab (Punjab Prohibition of Cow Slaughter Act 1955). There is religious sanctity to take good care of the cattle throughout their natural life even after their productive life (Lodrick 2005; Sharma 2019). In spite of huge numbers of cattle and religious sanction for their well-being, there is a paucity of scientific studies regarding the welfare problems they face and mitigation measures. In a general appraisal on welfare problems of dairy animals in India by the Federation of Indian Animal Protection Organisations (FIAPO 2012), an NGO, identified housing of animals in tie-stalls with inadequate floor space, concrete floors and limited availability of green fodder as major animal welfare problems at commercial dairy farms. Recently, Mullan *et al* (2020) carried out an on-farm assessment of welfare challenges of dairy cows on 38 farms (2–150 animals) in the state of Kerala based on a number of animal- and resource-based assessments. The main welfare issues identified were the behavioural restrictions associated with the use of tie-stall systems (close-tied cows), limited access to water and quality feed and fodder, heat stress, poor hygiene and hair loss. They recommended that further studies which expanded on sample size and geographic scale were needed and future work should focus on carrying out welfare assessments more regularly using a validated protocol and rectifying the causes of poor welfare. The welfare of cattle in Gaushalas (stray cattle shelters) in India was assessed (Sharma 2019) using assessment protocols based on animal, resource and management indicators following the guidance of the Welfare Quality® protocol (Canali & Keeling 2009). The status of dairy cattle welfare under different commercial farming systems has not been studied, nor the husbandry practices that jeopardise welfare identified for developing mitigation strategies.

Several methods for assessing animal welfare have been tried in many countries and various frameworks suggested keeping in mind the prevailing farming systems and socio-economic conditions (Main *et al* 2003). However, it is widely accepted that welfare is best assessed with different measures which may include a description of the housing system and management (indirect indicators) and data recording on how the animals react to the system (direct indicators) (Bertoni *et al* 2003). Many of these existing models place great emphasis on resource availability and animal records, such as indexing methods, eg Animal Needs Index (ANI 35L), Tier-gerechtheits-index (TGI 200), assessment scheme for loose litter housing systems of dairy cows (ALD) and Welfare Quality® protocol (2009) of the European Union. Welfare Quality® (WQ) protocols focus mainly on animal-based measures or outcome measures, which reflect the interaction between the animal and its environment (Veissier & Evans 2007). However, application of the WQ protocol is time-consuming and expensive and may not be practically feasible for on-farm assessment at all farms (Knierim & Winckler 2009). The TGI 35L system developed in Austria (Bartussek 1999) and the TGI200 developed in Germany (Sundrum 1994) are based on environmental conditions where compliance with guidelines on animal housing systems is mainly assessed.

Among the large number of animal welfare assessment methods, the most favoured are integrative numeric systems. These methods combine physiological, ethological and ecological welfare indicators (animal housing condition) into a unique output, that is the animal welfare level (Winckler 2014). The greatest advantage of numeric assessments is their objectivity which minimises observer bias. Integrated Diagnostic System Welfare (IDSW) is one such model, described by Calamari *et al* (2003) and validated by Calamari *et al* (2004). It is based on many environmental factors grouped into two clusters: (i) life conditions and feeding; and (ii) animal responses to the previous factors with specific indicators of behavioural, physiological, performance and health.

Much concern has been expressed regarding the perceived poor welfare level of dairy animals in India. Little research effort has, however, been made to understand welfare issues specific to different commercial production systems and to identify appropriate indicators for assessment. Furthermore, there is a lack of suitable methodology for commercial dairy farms in India where animal performance, pedigree or other farm records are negligible, and the resource endowments of farmers and animal management practices are highly variable. We hypothesised that animal welfare problems may differ between relatively small-sized farms with limited means and large farms with access to better resources and technology. These problems may still be apparent at farms which are in the process of transitioning from small to large size. With this in mind, the aims of this study were to: (i) develop a methodology for assessment of dairy cattle welfare specifically suited to Indian conditions; and (ii) undertake an on-farm animal welfare assessment of different-sized dairy farms in two major dairy farming states in India.

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Materials and methods

Development of welfare assessment protocol

The basic framework of the Integrative Diagnostic System Welfare (IDSW) model (Calamari & Burtoni 2009) was selected and modified as per the prevailing farming conditions in the study area. This model suggested three major clusters (two input- and one animal-based) which have different components, each of which has different aspects represented by 40 welfare indicators. We simplified this into three major welfare components comprising two input-(housing and other facilities [A], and feeds and feeding practices [B]) and one output-based (animal performance, health and behaviour [C]) with a total of 20 indicators. The welfare scores were assigned to the three components in the same way as in the original model, based on the relative supposed relationship with welfare as indicated in the original model and as per Scott *et al* (2001).

Welfare indicators

The welfare indicators were selected based on previously described criteria (Calamari *et al* 2003) of reliability, validity and feasibility. The identified indicators had several patterns (occurrence of all possible situations from worst to the best which were described) and each pattern was weighted on a numerical scale with regard to the consequences of the pattern for the satisfaction of animal needs. Ordinal measurements were used for the resource-based indicators where responses are ordered and categorical in nature with 3–5 or more levels. Interval level measurement has been applied to the animal-based indicators characterised by continuous variability. A list of 30 draft welfare indicators was prepared as per these criteria and sent to 100 experts in the field of cattle production management for their feedback and suggestions on the suitability, definitions and weight of the selected indicators. A total of 40 responses were received from these experts. The indicators on which at least 80% experts agreed were retained in the final scale. A total of 20 indicators (6, 4 and 10 from components A, B and C, respectively) were finally retained for the development of the scale. The scores assigned to individual indicators after assessment of a farm were pooled into a single overall welfare score of 100. Farms that scored at least 60% on a welfare indicator were rated as 'acceptable' on that indicator. The original model, however, proposed a higher (75) acceptable welfare score with a total of 40 indicators. We consider this score to be high given the overall resource availability, poor knowledge regarding high welfare husbandry practices and lack of marketing or milk price advantage accruing to the farmers on account of improved animal welfare Farms obtaining a total welfare score of more than 80 were categorised as'enhanced'; farms with a score from 60 to 80 as 'Good'; farms with a score of 40 to 59 as 'average/moderate' and farms obtaining a score of less than 40 were identified as 'poor.'

Testing the reliability of the scale

The reliability of the welfare scale was tested for its internal consistency by Cronbach's alpha (Cronbach & Meehl 1995). The Cronbach's alpha was computed based on the number of items on the survey (k) and the ratio of the average inter-item covariance to the average item variance as $\alpha = k$ (cov/var) $1+(k-1)$ (cov/var). Under the assumption that the item variances are all equal, this ratio simplifies to the average inter-item correlation as Standardised item alpha. Reliability coefficient of scale was tested by Guttman split-half method on five dairy farms by measuring the Pearson correlation coefficient ($r = 2 \times r_{hh}/1+ r_{hh}$) between scores of two halves. The scale was considered reliable if the correlation coefficient between the two halves was positive and significant.

Testing the validity of the scale

The content validity of the scale was tested by expert judgment. The welfare indicators for which at least 80% experts agreed were retained for inclusion in the final scale.

Assessment of dairy cattle welfare at commercial dairy farms

The protocol developed as above was utilised for the assessment of dairy cattle welfare in two adjoining states of Northern India: Haryana and Punjab which have witnessed the greatest transformation towards commercialisation in dairy farming with high-yielding, cross-bred cows.

Description of study area

Both states of the study area are landlocked plain regions with soil, water and climatic conditions naturally suitable for dairy farming. Haryana is located between 27°39' to 30°35' N latitude and between 74°28' and 77°36' E longitude and Punjab extends from the latitudes 29.30° N to 32.32° N and longitudes 73.55° E to 76.50° E. Altitude varies from 200 to 1,200 m above sea level. The area lies in the sub-tropical belt with three major types of climates: arid, semi-arid and sub-humid. The states experience three distinct seasons, hot (April to June), rainy (July to September) and winter (October to March). The highest temperature (between 44.2 and 44.7°C) is recorded in the month of June and the lowest (between 0 and 2.2°C) in December. The normal annual rainfall in the regions varies from 450 to 500 mm.

Selection of farms

A total of 50 farms (Table 1) were selected from Haryana from four districts (Karnal, Kurukshetra, Panipat and Sonipat) where most of the commercial dairy farms in the state are concentrated. From Punjab, 60 representative farms from five districts (one each from five agro-climatic zones) which had a maximum number of dairy farms were purposely selected. The farms were categorised into three

Table 1 Number of dairy farms selected from different herd size categories from Haryana and Punjab.

Farm size category	Adult herd size	Farms selected (n)	
		Haryana	Punjab
Small	10–19	20	20
Medium	20–49	20	20
Large	≥ 50	10	20
Total	**–**	**50**	**60**

adult herd sizes: small (S = 10–19 animals), medium (M = 20–49 animals) and large (L ≥ 50 animals). If the herd size was less than 30 then all cows were selected for scoring of animal-based welfare indicators. If the herd size was more than 30 adult cows, a sample of animals were selected for scoring against the animal-based measures, as per the Welfare Quality® (2009) protocol for dairy cows. The selected farms maintained mostly cross-bred cows which had a mixed genetic lineage of native (*B. indicus*) low-producing, but heat-tolerant and disease-resistant cows (Sejian *et al* 2018) with high-producing European (*B. taurus*) Holstein Friesian. The level of foreign genetic inheritance ranged from 50 to 75%.

Statistical analysis

For each welfare indicator, mean (± SEM) values were calculated and the differences among means of different variables tested using one-way analysis of variance and Duncan's Multiple Range Test at confidence intervals of 0.01 and 0.05 as per the procedure described by Snedecor and Cochran (1994). Statistics were undertaken using SPSS Version 22 (SPSS Inc Chicago, Illinois, USA).

Results

A list of 20 welfare indicators along with weighted scores finalised after seeking expert opinion is presented in Table 2. Detailed descriptions of the patterns of each indicator and their relative weightings is provided in Table S3 in Supplementary material.

Reliability of scale

The reliability statistics as per Cronbach's alpha and Guttman split-half coefficient are presented in Table 4. The value of Cronbach's alpha was 0.828 and the value of Cronbach's alpha based on standardised items was 0.825 which indicated high correlation for the 20 indicators selected confirming the reliability and internal consistency of the scale. Coefficient value of Part 1 (0.798) and Part 2 (0.775) were highly correlated and thus had strong relationships. The value of Guttman split-half coefficient was 0.535 indicating a substantial relationship between the two parts. The scale thus was found to be moderately to strongly reliable.

Validity of scale

A total of 100 experts were consulted for this purpose, out of which 59 responded. A total of 55 experts were in general agreement with the contents of the scale, three were in disagreement and one had mixed opinion. Overall, 93.22% of the experts agreed with the appropriateness of items included in the scale. The validity of the scale was, thus, confirmed.

Welfare assessment

The mean (± SEM) scores of welfare component A were 14.55 (± 0.94), 16.10 (± 0.87) and 20.05 (± 0.88) in Punjab (Table S5) and 15.35 (± 0.74), 15.00 (± 0.66) and 20.40 (± 0.78) in Haryana (Table S6) out of a maximum score of 30 in S, M and L farms, respectively. These values were higher ($P < 0.05$) in L than in S and M farms in both the states. The overall average welfare score across farm size categories in this component was 16.90 (± 0.54) in Punjab and 17.13 (± 1.64) in Haryana. The mean (± SEM) average welfare scores of component B out of a maximum score of 30 were 21.90 (± 1.23), 25.65 (± 0.74) and 27.40 (± 0.29) in Punjab and 20.30 (± 1.12), 20.70 (± 1.12) and 23.40 (± 0.78) in Haryana for S, M and L farms, respectively. These values were higher ($P < 0.01$) in L and M than S farms in Punjab and higher ($P < 0.05$) in L in comparison to S and M farms in Haryana. The overall average score of this component across farms was 24.98 (± 0.56) in Punjab and 21.47 (± 0.97) in Haryana.

In component C, these scores were 24.35 (± 1.33), 26.65 (± 1.08) and 29.15 (± 0.88) in Punjab and 24.85 (± 0.40), 23.00 (± 0.40) and 24.30 (± 0.38) in Haryana against a maximum assigned score of 40 in S, M and L farms, respectively. These were higher ($P < 0.01$) in L than S but there was no significant difference between L and M as well as between S and M farms. In Haryana, however, these average scores were statistically similar at all farms. The overall average sum of these scores of three components was higher ($P < 0.01$) in L (76.60 [± 1.70]) than S (60.80 [± 2.77]) farms in Punjab but did not vary between L and M (68.40 [± 2.27]) and between S and M farms. In Haryana, however, this score was higher ($P < 0.05$) in L (68.1 [± 1.18]) than in S (60.50 [± 2.74]) and M (59.35 [± 2.17]) farms. The aggregate average welfare score was higher in Punjab (68.60 [± 1.49]) than in Haryana (62.65 [± 2.02]).

Welfare ranking

In Haryana, the level of welfare was more than the threshold acceptable welfare score of 60 (welfare level from good to enhanced) at the majority of farms (54%) (Table 7). Most of the large farms (80%) had 'acceptable' welfare whereas at small and medium farms the ratio of 'acceptable' and 'unacceptable' welfare levels was almost 50:50. In Punjab, the percentage of farms with enhanced, good, average and poor welfare were 10.00, 66.67, 21.67 and 1.66%, respectively. An overwhelming majority of the total studied dairy farms (76.67%) had an 'acceptable' welfare level. The percentage of farms falling in the 'acceptable' welfare category in large farms was as high as 95%, medium farms 80% and small farms 55%.

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Table 2 Selected welfare indicators and their weighted scores.

Component (score)	Indicator	Weighted score
Animal housing and other facilities (30)	Housing system and availability of floor space	10
	Type and height of roof	3
	Type of floor	2
	Microclimate protection measures	5
	Feeding and watering space, availability of feed and water, and frequency of provision	5
	Availability of milking parlour/separate milking place, water for bathing cows, udder washing, cleaning of milking utensils and availability of lighting	5
Feeds and feeding practices (30)	Availability of feed and fodder	10
	Availability of feed and fodder storage space	5
	Feeding practices of different categories of animals	10
Animal health, performance and behaviour (40)	Colostrum and feeding of milk to calves and heifer feeding	5
	Average productivity	8
	Body Condition Score	4
	Cow comfort index	5
	Cow cleanliness index	4
	Hock injury scoring	3
	Human-animal interaction	3
	Lameness scoring	4
	Mastitis incidence	4
	Reproductive efficiency	3
	Abnormal behaviours	2
	Total score	**100**

Table 4 Reliability statistics of Cronbach's alpha and Guttman split-half coefficient.

Cronbach's alpha	Part 1	Value	0.798
		Number of items	10[a]
	Part 2	Value	0.775
		Number of items	10[b]
	Total items (n)		20

Guttman split-half coefficient: 0.536

[a] The 10 items in this part were: Housing system and availability of floor space, type and height of roof, type of floor, microclimatic protection measures, feeding and watering space availability, availability of milking parlour and other amenities for milking, availability of feed and fodder, availability of feed and fodder storage, feeding practices, colostrum/milk feeding to calves.

[b] The 10 items in this part were: Body Condition Score, average productivity, lameness score, cow comfort index, cow cleanliness score, abnormal behaviours, hock injury score, mastitis incidence, reproductive efficiency and human-animal relationship.

Table 7 Welfare ranking of dairy farms.

Welfare category	Welfare score	Small	Medium	Large	Overall
			Percent of farms in Haryana		
Enhanced	≥ 80	–	–	10	2
Good	60–79	50	45	70	52
Average	40–59	50	50	20	44
Poor	< 40	–	5	–	2
			Percent of farms in Punjab		
Enhanced	≥ 80	–	–	30	10.0
Good	60–79	55	80	65	66.6
Average	40–59	40	20	5	21.6
Poor	< 40	5	–	–	1.6

Discussion

A simple and easy-to-use, on-farm dairy cattle welfare assessment protocol was developed with a total of 20 indicators. This protocol enabled valid and reliable 'on-farm' assessment of welfare.

Welfare assessment

Housing and other facilities

The welfare scores for housing and other facilities at large farms were greater than at small and medium farms both in Haryana and Punjab. This may be attributed to greater resource availability, in terms of land for animal housing, and capital for the construction of climate-resilient animal shelters and installation of separate milking parlours, within large farms. Farmers at large farms were better trained and exposed to modern production technology (some of them from Punjab were even trained from Israel and other foreign countries) and thus were able to create better housing and ancillary facilities for the improved production and welfare of animals. Samer (2010) also reported that small and medium dairy farms in hot climates encounter several problems caused by poor housing. The indicator 'housing system and floor space availability' was identified as unacceptable at small and medium farms in Punjab and at medium farms in Haryana. Cows were predominantly stall-fed in both states, and not provided access to pasture for grazing. However, some small and medium farmers in Haryana were practicing partial grazing at unused community lands. Loose-housing with cubicles (Figures 1 and S2) was more prevalent at large farms whereas tethering and loose-housing were more common at small (Figure S3) and medium (Figure 4) farms. In most other indicators in this component, large dairy farms performed better than either small or medium dairy farms. Mullan *et al* (2020), in an on-farm welfare assessment in different regions of Kerala, also observed poorer dairy animal welfare due to a lack of proper housing and other facilities. The overall mean scores of the 'housing and other facilities' component were 'acceptable' only at large farms in both states. This indicates that small and medium farmers need to change the system of housing from predominantly tethering to loose-housing whilst adhering to recommended feeding and watering space availability. More emphasis should be placed on heat-stress alleviation measures and creation of separate milking facilities. Overall mean welfare score for housing component across all three categories of farm size was also found to be 'unacceptable' both in Punjab and Haryana, highlighting the need for substantial improvements to housing systems and creation of associated facilities for the comfort of animals. The physical conditions in which animals live have ramifications for welfare (Johnsen *et al* 2001), nevertheless, commercial considerations take precedence over behavioural and welfare needs of the animals (Bertoni *et al* 1998).

Feeds and feeding practices

In welfare component B, the large and medium farms in Punjab and large farms in Haryana farms performed better than the small and small/medium farms, respectively. The low scores for small farms might be due to not being able to feed proper balanced diets to their animals throughout the year. There was also insufficient storage space for feeds and fodder. At large farms in both states there was year-round availability of good quality fresh seasonal green fodder, dry fodder, silage, concentrate mixture and mineral mixture. Large farms were also in a position to effectively balance the daily animal rations as per their nutritional requirements (Figure 5). Furthermore, large farms had sufficient storage space for storing dry fodder, raw concentrate ingredients, finished concentrate mixture (Figure S6) and silage trenches or silo bags (Figure S7) available for storing feed stuffs, which lead

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to high scores for this indicator. Small farms had storage space mainly for concentrate mixture only and sparingly resorted to silage/hay-making or other forms of fodder preservation. Feeding practices of animals other than those lactating were compromised as lactating animals got priority when feed resources were limited (Figures 8 and 9) especially at small and medium farms. Overall welfare scores of feeds and feeding practices were, however, acceptable across all farm size categories in both Punjab and Haryana indicating that the basic needs of feeding of cows were being met. Mullan *et al* (2020), however, reported much poorer dairy cattle welfare due to inappropriate feeding practices in Kerala.

Animal health, performance and behaviour

In component C, the overall score was higher in large and medium farms than in small farms. They performed relatively better for average productivity, Body Condition Score and reproductive efficiency as compared to small farms. This may be reflective of better inputs/resources in terms of feed and feeding practices at these farms and improved genetics for milk production. The scores for most other indicators were similar. Unexpectedly, better inputs with large farmers did not translate into higher scores for this component in Haryana. This may be explained by the fact that small and medium farms were largely family owned and these farmers might have been providing better care and management through positive human animal-interactions (HAI) and a 'personal touch' with animals, whereas larger farms are largely dependent on hired labour who may not have such strong motivation to take personal care of the animals. These results partially agree with the results of Hemsworth *et al* (2002) who observed that the mean value of HAI in small dairy farms was higher than medium and large dairy farms because as the number of animals increases their HAI relationship becomes weaker. Furthermore, the human-animal relationship is reported to be better in tie-stall housing systems than in loose-housing systems (Mattiello *et al* 2009; Popescu & Borda 2011); more small and medium farms in the present study were tie-housed. Previous studies also proved that in extensive and tethered rearing systems of dairy cows the stockmanship is better than in intensive housing conditions (Popescu *et al* 2009) because of the lower number of animals and frequent intervention of humans (eg for feeding, watering, milking, barn cleaning etc). Larger farms tend to have fewer workers per animal (Bewley *et al* 2001) so are at a disadvantage in terms of providing individual care. Prevalence of mastitis was significantly greater in small and medium farms than large farms in Haryana. This might be attributed to the fact that large farmers used technology to periodically screen their animals against sub-clinical mastitis and practiced post-milking teat-dipping as a preventive measure against mastitis infection. Cow cleanliness was very poor at all farms in Punjab and at large farms in Haryana. Wet floors and infrequent cleaning may be responsible for this. This may also be one of the reasons for mastitis at these farms. The problem of poor hygiene at dairy farms leading to higher incidence of mastitis was highlighted in Kerala in India (Mullan *et al* 2020) and in Bangladesh (Islam *et al* 2020).

Figure 1

A loose house with adequate roof height, sand-bedded resting cubicles and foggers and fans for heat stress protection at a large farm.

Figure 4

Loose-housing system with brick-on-edge flooring and use of ceiling fans for protection against heat stress at a medium farm.

Overall welfare scores

Better overall scores in large farms in both states may be attributed to better resources, access to technology and training. Previously, it was argued that larger and more specialised farms would result in lower levels of welfare for farm animals (Winter *et al* 1998). But now it has been revealed (Grethe 2017) that existing empirical evidence does not support this view. The frequently voiced hypothesis that smaller and more traditional farms automatically imply higher levels of welfare has been rejected as the facilities for proper housing (loose cow sheds) and feeding may be lacking at smaller farms (Grethe 2017). Although, there was

Figure 5

Feeding practice of offering green fodder, dry fodder and concentrate mixture through fence-line feeding system at a large farm.

Figure 8

Limited availability of green fodder at a small farm.

Figure 9

Traditional dome-shaped structures made of paddy straw for storage of dry fodder (wheat straw) close to an improvised cow shed and yard at a small farm.

no consistent relationship between farm size and animal welfare (Coignard *et al* 2013; Spiller *et al* 2015; Robbins *et al* 2016), larger farms permitted more specialised and professional management of animal health. Farmers at large farms are more likely to implement science-based standard operating procedures, train their employees, and utilise technology to track and monitor animals and implement costly changes to improve welfare (Robbins *et al* 2016). Moreover, precision livestock farming technologies show strong potential for better welfare monitoring and timely interventions in case of problems which are mainly used in intensive husbandry systems (Berckmans 2014)

The results of the present study with regards to small farms are corroborated by Islam *et al* (2020) in Bangladesh who underlined the need to expose smallholder dairy farmers to training in good animal welfare practices, including appropriate housing designs and cleanliness. The medium farms were almost on par with small farms in Haryana but performed better in Punjab. They were found be to catching up with large farms on overall welfare scores. They were not too large to take full advantage of the production technology and were in a dilemma whether to invest in modern housing and mechanisation or to continue with existing practices.

Welfare ranking

All three categories of farms in Punjab and Haryana except medium farms in Haryana had 'acceptable' levels of welfare. In Haryana, eight welfare indicators were compromised which included three input-based (microclimate protection measures, availability of feeding space, watering space and associated practices, and availability of milking parlour) and five output-based (Body Condition Score, cow cleanliness index, mastitis incidence, reproductive efficiency and abnormal behaviours). In Punjab, six indicators were most compromised which included four input-based (system of housing, type of floor, microclimate protection measures and availability of milking parlour); and two animal-based (cow cleanliness score and reproductive efficiency). Four indicators, namely microclimate protection measures and availability of milking parlour, cow cleanliness score (Figures S10 and S11), and reproductive efficiency were found to be the most compromised indicators in both the states. Behavioural restrictions associated with the use of tie-stall housing systems, limited access to water, quality feed and fodder, heat stress and poor hygiene were also the major welfare problems in dairy herds in Kerala (Mullan *et al* 2020).

Nearly all large and most of the medium farms in Punjab, and most of the large farms in Haryana had 'good' to 'enhanced' welfare. These findings are consistent with welfare level of cattle in Portugal (Krug *et al* 2015) and Mexico (Salas *et al* 2017) assessed using the Welfare Quality® protocol, and in The Netherlands (Vries *et al* 2013) assessed using the Welfare Quality® multi-criteria evaluation (WQ-ME) model and in south-eastern Romania, using an integrative numeric system (Austrian Animal Needs Index 35L/200). The cattle welfare level was, however, poorer than found in the present study and was

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unacceptable at most farms in north-eastern Transylvania (Popescu *et al* 2010), Romania (Popescu & Borda 2011) and in Algeria (Benatallah *et al* 2015).

Animal welfare implications

The developed dairy cattle welfare assessment protocol will be useful for assessing the welfare of cross-bred dairy cows managed under commercial/intensive production systems in the states of Punjab and Haryana and other regions in India with comparable husbandry practices. It can be used as an evidence-based diagnostic tool to identify major welfare problems by farmers as well as by Government agencies so that a strategy for remedial action for improvement of welfare can be prepared and implemented. Ameliorative action on the most compromised welfare indicators identified through the assessment studies using this protocol in two major dairy farming states of India has the potential to lead to substantive improvement in dairy cattle welfare in the country.

Conclusion

A simple and easy-to-use, on-farm dairy cattle welfare assessment protocol suitable for northern Indian conditions was developed based on 20 input- and output-based welfare indicators. Using this protocol, the welfare of more than 75% of dairy farms in Punjab and more than 50% of the farms in Haryana was judged as 'acceptable.' The welfare of cattle at large farms was much better than at small farms in both states. In Haryana, eight indicators, including microclimate protection measures, availability of feeding space, watering space and associated practices, availability of milking parlours, Body Condition Score, cow cleanliness index, mastitis incidence, reproductive efficiency and abnormal behaviours were the most compromised. In Punjab, the six most compromised indicators were housing system, type of floor, microclimate protection measures and availability of milking parlours, cow cleanliness score and reproductive efficiency. Four indicators, namely, microclimate protection measures, availability of milking parlour, cow cleanliness index and reproductive efficiency were common to both the states. In order to improve the welfare of dairy cattle in the states of Haryana, Punjab and other regions with comparable husbandry conditions, efforts must be made to improve the housing and feeding conditions, especially at small- and medium-sized farms along with taking suitable measures for heat stress amelioration and improving hygiene and reproductive efficiency at all farms. Further studies need to be conducted to test the reliability and validity of this protocol under different agro-climatic and husbandry conditions. The protocol is based on assessing a few of the most practicable welfare indicators by assigning them weights through knowledge from literature and expert opinion. Scores of individual indicators have been aggregated to 100 by banding into different welfare categories which may need further validation.

Declaration of interest

None.

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References

Bartussek H 1999 A review of the Animal Needs Index (ANI) for the assessment of animal's well-being in the housing systems for Austrian proprietary products and legislation. *Livestock Production Science 61*: 179-192. https://doi.org/10.1016/S0301-6226(99)00067-6

Basic Animal Husbandry Statistics 2019 *Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying*. Government of India: New Delhi, India

Benatallah A, Ghozlane F and Marie M 2015 Dairy cow welfare assessment on Algerian farms. *African Journal of Agricultural Research 10(9)*: 895-901. https://doi.org/10.5897/AJAR2015.9483

Berckmans D 2014 Precision livestock farming technologies for welfare management in intensive livestock systems. *Scientific and Technical Review of the Office International des Epizooties (Paris) 33(1)*: 189-196. https://doi.org/10.20506/rst.33.1.2273

Bertoni G, Calamati L and Maianti MG 2003 Factors of welfare status in dairy cows and the relationship with milk features. In: Greppi GF and Enne G (eds) *Proceedings of International Symposium on Milk and Research* pp 63-94. Lodi, Italy

Bertoni G, Trevisi E, Calamari L and Lombardelli R 1998 Additional energy and protein supplementation of dairy cows during early lactation: milk yield, metabolic-endocrine status and reproductive performances. *Zootecnicae Nutrizione Animale 24*: 17-29

Bewley J, Palmer RW and Jackson-Smith DB 2001 An overview of experiences of Wisconsin dairy farmers who modernized their operations. *Journal of Dairy Science 84(3)*: 717-729. https://doi.org/10.3168/jds.S0022-0302(01)74526-2

Broom DM 2001 Coping, stress and welfare. In: Broom DM (ed) *Coping with Challenge: Welfare in Animals Including Humans. Proceedings of Dahlem Conference* pp 1-9. Dahlem University Press: Berlin, Germany

Calamari L and Bertoni G 2009 Model to evaluate welfare in dairy cow farms. *Italian Journal of Animal Science 8(S1)*: 301-323. https://doi.org/10.4081/ijas.2009.s1.301

Calamari L, Bionaz M and Bertoni G 2003 A new model to evaluate the welfare status in the dairy farm. *Proceeding of fourth International Congress of European Society for Agricultural and Food Ethics* pp 77-80. Toulouse, France

Calamari L, Bionaz M, Trevisi E and Bertoni G 2004 Preliminary study to validate a model of animal welfare assessment in dairy farms. *Proceedings of Fifth International Congress of European Society for Agricultural and Food Ethics* pp 38-42. Leuven, Belgium

Canali E and Keeling L 2009 Welfare Quality® project: from scientific research to on-farm assessment of animal welfare. *Italian Journal of Animal Science 8(2)*: 900-903. https://doi.org/10.4081/ijas.2009.s2.900

Coignard M, Guatteo R, Veissier I, Roches ADBD, Mounier L, Lehébel A and Bareille N 2013 Description and factors of variation of the overall health score in French dairy cattle herds using the Welfare Quality® assessment protocol. *Preventive Veterinary Medicine 112*: 296-308. https://doi.org/10.1016/j.prevetmed.2013.07.018

Constitution of India, Article 48 2015 *Organisation of Agriculture and Animal Husbandry.* https://www.constitutionofindia.net/constitution_of_india/directive_principles_of_state_policy/articles/Article%2048

Cook NB, Bennett TB and Nordlund KV 2004 Effect of freestall surface on daily activity patterns in dairy cows with relevance to lameness prevalence. *Journal of Dairy Science 87*: 2912-2922

Cronbach LJ and Meehl PE 1995 Construct validity in psychological tests. *Psychological Bulletin 32*: 281-302. https://doi.org/10.1037/h0040957

Federation of Indian Animal Protection Organizations 2012 *Holy Cows! Research Insight into Dairies in India* pp 12-45. Federation of Indian Animal Protection Organizations: New Delhi, India

Flower FC and Weary DM 2006 Effect of hoof pathologies on subjective assessments of dairy cow's gait. *Journal of Dairy Science 89*: 139-146

Fox MW 1999 India's sacred cow: Her plight and future. *Animal Issues 3(2)*: 38

Grethe H 2017 The economics of farm animal welfare. *Annual Review of Resource Economics 9*: 75-94. https://doi.org/10.1146/annurev-resource-100516-053419

Haryana Gauvansh Sanrakshan and Gausamvardhan Act 2015 http://pashudhanharyana.gov.in/sites/default/files/documents/The_Haryana_Gauvansh_Sanrakshan_and_gausamvardhan_act_2015_-_Eng.PDF

Hemsworth PH, Coleman GJ, Barnett JL, Borg S and Dowling S 2002 The effects of cognitive behavioral intervention on the attitude and behavior of stockpersons and the behavior and productivity of commercial dairy cows. *Journal of Animal Science 80*: 68-78. https://doi.org/10.2527/2002.80168x

Humane Society International 2012 *An HSI Report: The Welfare of intensively confined animals in battery cages, gestation crates, and veal crates.* https://www.hsi.org/wp-content/uploads/assets/pdfs/welfare-of-intensively-confined-animals-international-word-sept-4-08.pdf

Humane Society of US 2009 *An HSUS Report: The welfare of cows in the dairy industry.* Humane Society of US: USA

Islam MA, Sharma A, Mazumdar A, Rudra KC and Phillips CJC 2020 Welfare assessment of dairy cows in small dairy farms in Bangladesh. *Animals 10*: 394. https://doi.org/10.3390/ani10030394

Jensen P and Toates FM 1993 Who needs behavioural needs? Motivational aspects of the needs of animals. *Applied Animal Behaviour Science 37(2)*:161-181. https://doi.org/10.1016/0168-1591(93)90108-2

Johnsen PF, Johannesson T and Sandøe P 2001 Assessment of farm animal welfare at herd level: Many goals, many methods. *Acta Agriculturae Scandinavica, Section A-Animal Science 51(S30)*: 26-33. https://doi.org/10.1080/09064700131692302 7

Kamboj ML, Prasad S, Oberio PS, Manimaran A, Lathwal SS and Gupta K 2014 *National Code of Practices for the Management of Dairy Animals in India* pp 80. ICAR-National Dairy Research Institute, Karnal and World Animal Protection: New Delhi, India

Kennedy U, Sharma A and Philips CJC 2018 The sheltering of unwanted cattle, experiences in India and implications for cattle industries elsewhere. *Animals 8(5)*: 64. https://doi.org/10.3390/ani8050064

Knierim U and Winckler C 2009 On-farm welfare assessment in cattle: validity, reliability and feasibility issues and future perspectives with special regard to the Welfare Quality® approach. *Animal Welfare 18(4)*: 451-458

Krug C, Haskell MJ, Nunes T and Stilwell G 2015 Creating a model to detect dairy cattle farms with poor welfare using a national database. *Preventive Veterinary Medicine 122*: 280-286. https://doi.org/10.1016/j.prevetmed.2015.10.014

Kumar A 2015 The changing paradigms of Indian dairy industry. *International Journal of Livestock Research 5(6)*: 19-25. https://doi.org/10.5455/ijlr.20150602041344

Lodrick D 2005 Symbol and sustenance: Cattle in South Asian culture. *Dialectical Anthropology 29*: 61-84. https://doi.org/10.1007/s10624-005-5809-8

Main DC, Kent J, Wemelsfelder F, Ofner E and Tuyttens FAM 2003 Applications for methods of on-farm welfare assessment. *Animal Welfare 12(4)*: 523-528

Mattiello S, Klotz C, Baroli D, Minero M, Ferrante V and Canali E 2009 Welfare problems in alpine dairy cattle farms in Alto Adige (Eastern Italian Alps). *Italian Journal of Animal Science 8*: 628-630. https://doi.org/10.4081/ijas.2009.s2.628

Mullan S, Bunglavan SJ, Rowe E, Barrett DC, Lee MRF, Ananth D and Tarlton J 2020 Welfare challenges of dairy cows in India identified through on-farm observations. *Animals 10*: 586. https://doi.org/10.3390/ani10040586

Napolitano F, Grasso F, Bordi A, Tripaldi C, Saltalamacchia F, Pacelli C and De Rosa G 2005 On-farm welfare assessment in dairy cattle and buffaloes: evaluation of some animal-based parameter. *Italian Journal of Animal Science 4*: 223-231

Popescu S and Borda C 2011 Microbiological air quality in tie-stall dairy barns and some factors that influence it. *African Journal of Agricultural Research 6(32)*: 6726-6734. https://doi.org/10.5897/AJAR11.1428

Popescu S, Borda C, Lazar EA and Hegedus IC 2009 Assessment of dairy cow welfare in farms from Transylvania, *Proceedings of 44th Croatian and 4th International Symposium in Agriculture* pp 752-756. Upatija, Croatia

Popescu S, Borda C, Sandru CD, Stefan R and Lazar E 2010 The welfare assessment of tied dairy cows in 52 small farms in north-eastern Transylvania using animal-based measurements. *Slovakia Veterinary Research 47(3)*: 77-82

Punjab Prohibition of Cow Slaughter Act 1955 http://www.lawsofindia.org/pdf/haryana/1956/1956HR15.pdf

Robbins JA, von Keyserlingk MAG, Fraser D and Weary DM 2016 Invited review: Farm size and animal welfare. *Journal of Animal Science 94*: 5439-5455. https://doi.org/10.2527/jas.2016-0805

https://doi.org/10.7120/09627286.31.4.008 Published online by Cambridge University Press

Salas MAS, Cardona MGT, Perez LB, Ortiz JGP and Badillo MDRJ 2017 Milk cow welfare assessment in system of small-scale production by applying the protocol proposed by Welfare Quality®. *Revista Mexicana de Ciencias Pecuarias 8(1)*: 53-60. https://doi.org/10.22319/rmcp.v8i1.4306

Samer M 2010 Adjusting dairy housing in hot climates to meet animal welfare requirements. *Journal of Experimental Sciences 1(3)*: 14-18

Scott EM, Nolan AM and Fitzpatrick JL 2001 Conceptual and methodological issues related to welfare assessment: a framework for the measurement. *Acta Agriculturae Scandinavica 30*: 5-11. https://doi.org/10.1080/090647001316922983

Sejian V, Bhalla R, Gaugham JB, Dunshea FB and Lacetera N 2018 Review: Adoption of animals to heat stress. *Animal 12(2)*: 431-444. https://doi.org/10.1017/S1751731118001945

Sharma A 2019 *Welfare assessment of cows at cow shelters (gaushalas) in India*. PhD Thesis, The University of Queensland, Australia

Snedecor GW and Cochran WG 1994 *Statistical Methods, Seventh Edition*. Iowa State University Press: Iowa, USA

Spiller A, Gauly M, Balmann A, Bauhus J, Birner R, Bokelmann W, Christen O, Entenmann S, Grethe H, Knierim U, Latacz-Lohmann U, Matenh-Lohmann J, Matinhernie-Bauhus J and Peterweingarten V 2015 Ways to a socially acceptable farm animal husbandry. *Reports on Agriculture 221*: 1-171

Špinka M 2006 How important is natural behaviour in animal farming systems. *Applied Animal Behaviour Science 100(1-2)*: 117-128. https://doi.org/10.1016/j.applanim.2006.04.006

Sprecher DJ, Hoesteler DE and Kaneene JB 1997 A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. *Theriogenology 47*: 1179-1187

Sundrum A 1994 Assessing livestock housing conditions in terms of animal welfare, possibilities and limitations. *Proceedings of Fourth International Symposium on Livestock Farming Systems*. Foulum, Denmark

University of Minnesota Quality Counts Programs 2011 SCC *Diagnostics Tool Box, W-AH-2*: Hock Injury Scorecard. https://qualitycounts.umn.edu/sites/qualitycounts.umn.edu/files/2022-01/w-ah-2.pdf

Veissier I and Evans A 2007 Rationale behind the Welfare Quality® assessment of animal welfare. In: Veissier I, Forkman B and Jones B (eds) *Assuring Animal Welfare: From Societal Concerns to Implementation* pp 9-12. Second Welfare Quality® Stakeholders Conference, Berlin, Germany

Vries MD, Bokkers EAM, Schaik GV, Botreau R, Engel B, Dijkstra T and Boer IJMD 2013 Evaluating results of the Welfare Quality® multi-criteria evaluation model for classification of dairy cattle welfare at the herd level. *Journal of Dairy Science 96*: 1-10. https://doi.org/10.3168/jds.2012-6129

Waiblinger S, Menke C and Fölsch DW 2003 Influences on the avoidance and approach behaviour of dairy cows towards humans on 35 farms. *Applied Animal Behaviour Science 84(1)*: 23-39

Welfare Quality® 2009 *Welfare Quality® Assessment protocol for cattle*. Welfare Quality® Consortium: Lelystad, The Netherlands

Winckler C 2014 On-farm animal welfare assessment and welfare improvement in dairy cattle. *AgroLife Scientific Journal 3(1)*:163-168

Winter M, Fry C and Carruthers SP 1998 European agricultural policy and farm animal welfare. *Food Policy 23*: 305-323. https://doi.org/10.1016/S0306-9192(98)00036-0