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IMPLEMENTATION OF AN ANI MAL-BASED WELFARE ASSESSMENT SYSTEM IN BEEF BULL FARMS

Doctoral Thesis

submitted in partial fulfilment of the requirements for the award of the doctorate degree (Dr.nat.techn.) at the University of Natural Resources and Life Sciences, Vienna

by

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For all my mothers, fathers, sisters, brothers, aunts, uncles, cousins, children and friends that taught me what 'love' and 'family' means:

Thank you all for helping me finishing this!
You are gorgeous!
Without you this would not have been possible!

I'd love to thank all the people, situated in many countries and places
of the world that made this happen!
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They were patient, kind, helpful, interested, enlarging my knowledge, putting together the pieces with me
and some even might not have recognized
they did something very important!

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M.

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Ein Mensch

Es ist wichtig,
dass der Mensch
viel weiß
und viel kann.

Noch wichtiger ist,
dass der,
der viel kann
und viel weiß,
auch ein
Mensch sei.

(nach Erich Fried)

Abstract

Implementation of an animal-based welfare assessment system in beef bull farms

Farm animal welfare is of increasing interest for the public and scientific community. For these reasons, valid and robust on-farm welfare assessment systems have recently been developed. The Welfare Quality® (WQ) assessment protocols, which also refer to fattening cattle, constitute one of these approaches. Being mainly based on animal-related measures, the assessment protocols aim at providing feedback to farm managers on the welfare state of their animals and at translating this information into understandable information for consumers, e.g. for labelling purposes. In the present thesis, interviews were carried out with 90 beef farmers using straw bedded housing systems or cubicle housing with rubber mats in Austria, Germany and Italy. Subsequently, the WQ assessment protocol for fattening cattle was implemented on in total 63 of the farms. The aims were (1) to investigate perceptions and attitudes of European Beef farmers towards a welfare assessment system such as WQ, (2) to describe the welfare state of the beef bulls and evaluate the effects of different feedback strategies of results from an initial assessment and (3) to describe the consistency over time (intervals of about 1 and 6 months, respectively) at the level of single welfare measures as well as aggregated criterion and principle scores and welfare classification.

(1) About two thirds of the farmers were at least rather motivated to join a system such as WQ on a regular basis. Farmers expected the detection of deficiencies in housing and management as a basis for advice, but also regarded non-monetary benefits such as decrease in stress and workload as important. 92% of the farmers agreed to change management routines and 67% would be prepared to invest more labour. The farmers' willingness to contribute to data provision offers the possibility to reduce the total assessment costs.

(2) Farms were allocated to the categories 'Acceptable' and 'Enhanced' according to the WQ classification. Potentials for welfare improvement related to e.g. incidence of agonistic behaviours, provision of water, ease of movement, health status and dehorning procedures. After a 6-months implementation period the welfare state of farms, which had received a written report or a report plus advice on potential improvement measures did not change significantly. However, robust conclusions on the effectiveness and preferred ways of feedback of results and integration with advisory activities would require longer observation periods.

(3) Taking only farms without major changes in housing and management into account, six and two out of 27 measures showed correlations above 0.7 as well lower variance within than between farms at short and longer-term intervals, respectively. Consistency improved with aggregation level, with five and two out of 12 WQ criteria and three and one out of four WQ principles meeting these requirements, respectively. 79% and 75% of farms maintained the overall classification category. Reasons for the partly low consistency may be seen in e.g. a distinct response to normal fluctuations of farm conditions, low prevalences of some clinical measures and sample size issues. Especially if used for certification purposes, the rather low consistency across the 6-months period suggests frequent assessments and the use of rolling averages in order to reliably picture the welfare state.

In conclusion, the beef farmers' interest in animal-based assessment systems and improvement coincides with welfare issues as identified using the WQ assessment protocol thus indicating a potential for its implementation at least on a voluntary basis. Trust in the assessment system may be increased by further research with regard to reliability aspects and long(er)-term implementation studies.

Kurzfassung

Untersuchungen zur Beurteilung des Tierwohlergehens auf Stiermastbetrieben mit Hilfe eines überwiegend tierbezogenen Erhebungsprotokolls

Das Wohlergehen landwirtschaftlicher Nutztiere rückt zunehmend in den Mittelpunkt des öffentlichen und wissenschaftlichen Interesses. Daher wurden in den letzten Jahren wissenschaftlich fundierte, überwiegend tierbezogene Beurteilungssysteme wie die Welfare Quality® (WQ)-Protokolle entwickelt. Die Ergebnisse können neben der Nutzung für Zertifizierungszwecke auch zur Rückmeldung an die Landwirt/innen herangezogen werden.
In der vorliegenden Studie wurden Interviews mit 90 Landwirt/innen, die Stiermast in alternativen Haltungssystemen betreiben, in Österreich, Deutschland und Italien geführt. Anschließend wurde das WQ-Protokoll für Mastrinder in 63 der Betriebe angewandt. Ziele der Studie waren, (1) die Erwartungshaltung von Landwirt/innen gegenüber einem solchen System abzubilden, (2) den Wohlergehensstatus der Stiere darzustellen sowie den Effekt von unterschiedlichen Rückmeldungsstrategien zu evaluieren und (3) die Wiederholbarkeit von Einzelmessgrößen, aggregierten Scores sowie der Gesamtklassifizierung über unterschiedlich lange Zeiträume zu untersuchen.
(1) Zwei Drittel der Landwirt/innen waren motiviert, tierbezogene Beurteilungssysteme für Wohlergehen einzusetzen und erwarteten sich davon die Erkennung von Defiziten und Unterstützung bei Verbesserungsmaßnahmen, aber auch nicht-monetäre Vorteile wie weniger Stress und mehr Zufriedenheit bei der Arbeit. Der Großteil der Landwirt/innen würde dafür Managementpraktiken ändern und zwei Drittel einen höheren Arbeitsaufwand in Kauf nehmen. Die Bereitschaft der Landwirt/innen, selbständig Daten zur Verfügung zu stellen, bietet Einsparungspotenzial bei den Kosten der Erhebungen.
(2) Die Betriebe wurden den Kategorien „akzeptabler“ und „gehobener“ Wohlergehensstatus zugeordnet. Defizite bestanden vor allem in den Bereichen „Agonistisches Verhalten“, „Wasserversorgung“, „Bewegungsfreiheit“ und „Gesundheitsstatus“. Nach sechs Monaten hatte sich das Wohlergehen in jenen Betrieben, die Rückmeldungen und/oder zusätzliche Verbesserungsvorschläge erhalten hatten, nicht signifikant verbessert. Für eine endgültige Einschätzung der Effektivität sind jedoch vermutlich längere Untersuchungszeiträume erforderlich.
(3) Von den 27 WQ-Einzelmessgrößen wurden lediglich 6 bzw. 2 als kurz- (1 Monat) bzw. längerfristig (6 Monate) wiederholbar eingestuft (Korrelation >0,70 und geringere Varianz innerhalb als zwischen Betrieben), wenn keine maßgeblichen Änderungen in Haltungssystem und Management in den Betrieben stattgefunden hatten. Dies verbesserte sich auf 5 bzw. 2 der insgesamt 12 sogenannten WQ-Kriterien und auf 3 bzw. 1 der 4 WQ-Prinzipien. Für 79% bzw. 75% der Betriebe veränderte sich die Gesamt-Klassifizierung nicht. Gründe für die Diskontinuität werden in den kurzfristig fluktuierenden Bedingungen auf den Betrieben, niedrigen Prävalenzen von klinischen Parametern und dem Stichprobenumfang gesehen. Zur verlässlichen Klassifizierung empfiehlt sich vorerst die Verwendung rollender Mittelwerte auf der Basis wiederholter Erhebungen.
Zusammenfassend kann gesagt werden, dass Defizite im Wohlergehen mit dem Interesse der Landwirt/innen an dem Erhebungssystem und an diesbezüglichen Verbesserungen einhergehen. Das Vertrauen in das WQ-System kann durch weitere, längerfristige Studien zur Wiederholbarkeit gestärkt werden.

Content

1. Background

Increasing importance of farm animal welfare

Animal welfare in farm animals has gained increasing importance for the society in recent years, also in Europe (Eurobarometer, 2007). Since Dawkin's book 'Animal suffering' (Dawkins, 1980) the number of scientific publications per year dealing with animal welfare increased substantially. This is also the case for scientific publications on the welfare of cattle, however, with a strong focus on dairy cattle. They address to a large extent welfare problems such as lameness (e.g. Brinkmann & March, 2011; Gratzer, 2011; Leach et al., 2010; Dippel, 2009), mastitis (Ivemeyer et al., 2009; Jansen et al., 2009; Green et al, 2007) or reduced fertility and fitness (Knaus, 2010).

Also the perception of citizens towards animal welfare was investigated (Sørensen & Fraser, 2010; Verbecke, 2009; Vanhonacker et al., 2008; Bock & vanHuik, 2007). Studies showed that consumers have ethical concerns with products coming from animals with poor welfare (Eurobarometer, 2007; Miele & Parisi, 2001). To some extent the public is not aware of or ignores on-farm conditions and practices within certain production sectors and lost somehow contact to the origin of the food (Harper and Henson; 2001). There were also a few studies that investigated the farmers' view on animal welfare which revealed that they also acknowledge the importance of animal well-being (Vanhonacker et al., 2008; Vaarst et al., 2007; TeVelde et al., 2001). Results of these studies were of special interest for scientists because they are additionally influenced by the normative framework as set by the society (Fraser, 1994). More and more it was common understanding that animal scientists alone can not improve the situation, but it had to be a combined effort of natural scientists and social scientists, producers, consumers, administration and many more (Bracke et al., 2004, 1999; Webster, 2001). This increasing demand was highlighted by the implementation of trans-disciplinarity of animal welfare in large research projects involving multiple stakeholders of the food chain to work on improvement of farm animal welfare (Keeling, 2005; Blokhuis et al., 2003). In this situation where on the one hand demand for more sustainable livestock farming in terms of respectful treatment of the animals and on the other hand increasing problems in health and welfare of the animals were recognized there was great need to find solutions that would fit for all stakeholders interested in.

Welfare of beef cattle

With the exception of veal calves production, cattle housing and management has not been explicitly regulated at EU level. There is still no Council directive or special European legislation that adopts the recommendations of the Scientific Committee on Animal Health and Animal Welfare (SCAHAW, 2001) or other relevant scientific literature (Wechsler, 2011; Tuyttens, 2005). However, national legislation may lay down specific requirements for other cattle categories such as dairy cows or fattening cattle, as e.g. done in Austria with the 'Bundestierschutzgesetz' (TschG, 2004).

The production systems for fattening cattle in Europe are rather diverse regarding breed, age and sex of animals, but also housing and management provided. Although entire males form nearly the half of all slaughtered beef cattle in the EU27 (Eurostat, 2010), also heifers (21%), calves (17%) and steers (13%) are fattened for beef production. Largely simplified, on a European level beef production takes place either extensively, pasture based and/or at least with large amounts of roughage but less concentrates in the diet and is characterized by slow(er) growth of the animals (Nielsen & Thamsborg, 2005). On the other hand there are intensive beef production systems, which are mainly run indoors and predominantly characterized by limited space allowance and minimum lying comfort in hard-floored fully-slatted housing systems and low suitability of feed rations for fully developed ruminal digestion (Wechsler, 2011; Cozzi et al., 2009; SCAHAW, 2001). The main welfare concerns for intensive beef cattle that have been addressed in scientific studies relate to claw and leg disorders (Mülleder et al., 2008; Platz et al., 2007), tail-tip alterations (Wechsler, 2011; Platz et al., 2007; Schrader et al., 2001) abnormal and disturbed behaviour (Absmanner et al., 2009; Gygax et al., 2007), limited space at the feedrack (Gottardo et al., 2004) and concentrate-rich diet leading together with a lack of fibre to a continuously acidotic ruminal environment (Oetzel, 2000; Martens, 2000) or stressful situations through limited space allowance, mixing and transport (Gupta et al., 2007[ab]; Mounier, 2006). However, besides one study in a certain region in Italy (Gottardo et al., 2009) field studies evaluating the current welfare states of intensively kept beef bulls across countries and housing systems on European farms to our knowledge are lacking. Also with regard to the epidemiology of risk factors and welfare improvement strategies, other cattle production systems than beef fattening have received more attention. This is for example the case for gastrointestinal disorders and calf losses in veal calves (Brsic et al, 2011; Bähler et al, in press). Practical approaches to welfare improvement have most often been studied in the dairy sector, e.g. 'Herd health and welfare planning' (Brinkmann & March, 2011; Gratzer, 2011; Bell et al., 2009; Huxley et al., 2004), 'Cow comfort' (Keyserlingk & Weary, 2011; Cook & Nordlund, 2007); 'Stable schools' (Gratzer, 2011; Leeb et al., 2011; Vaarst et al., 2007).

Approaches to on-farm animal welfare assessment

Comprehensive, integrated welfare assessment systems have repeatedly been called for as the preferred way to measure animal welfare (Sørensen & Fraser, 2010; Keeling, 2005; Bracke et al., 1999). This is based on the understanding of animal welfare as a multidimensional concept (Vanhonacker et al., 2008; Botreau et al., 2007). In order to adequately address welfare, assessment systems have to take these different dimensions into account. This means the integration of several types of animal-based parameters (Whay et al., 2003), e.g. regarding health status, behaviour (Dawkins, 2003) or physiological states and not least emotions (Boissy et al., 2007). A further requirement is that such assessment schemes comprise only valid criteria that actually reflect the animals' welfare state (Whay et al., 2003). Once evaluated, results of evaluation should picture the animal welfare state over a certain period (Blokhuis, 2008). Last but not least the measures taken should be feasible and the system applicable in several different housing systems and under diverse management conditions across Europe to ensure possibilities for comparison (Knierim & Winckler, 2009). Outcomes can not only be scientifically used for determining the welfare state of the beef bulls across Europe but also to inform the consumers about the welfare state of the animals from which they buy products (e.g. retailer labels) and to promote improvements through different approaches (e.g. legal requirements, quality assurance schemes).
The European research project Welfare Quality® aimed at providing such valid, robust and feasible on-farm welfare assessment protocols for different farm animal species and categories including fattening cattle (Blokhuis et al., 2003). This included in the early phases studies with regard to feasibility, validity and reliability of the candidate measures (Knierim & Winckler, 2009; Welfare Quality, 2009b). Prototype protocols were then pre-tested on farms in several countries and additionally scoring systems were developed based on expert opinion that could integrate several single measures to aggregated scores of animal welfare (Botreau et al., 2007, 2009). The final protocols for cattle including scoring system have been published by the Welfare Quality® consortium (Welfare Quality, 2009a).

The present thesis deals with the last phase of the project, when the fully developed protocols (here: the protocol for fattening cattle) were implemented on-farm at a larger scale. It focuses on the use of the welfare assessment system by the farmers to improve the welfare status on their farms (Chapter 2 and 3) and, as results could be used for quality assurance schemes or animal welfare labelling, on methodological issues related to the consistency of measures and aggregated welfare scores derived from these measures (Chapter 4).

The objectives were as follows:
1) To investigate perceptions and attitudes of 90 beef farmers in Austria, Germany and Italy towards a welfare assessment system such as Welfare Quality® (Chapter 2);
this chapter addresses perceptions and attitudes of farmers as future users and beneficiaries towards the Welfare Quality® scheme and its application.
2) To describe the welfare state of beef bulls on 63 farms in Austria, Germany and Italy applying the Welfare Quality® assessment system and to evaluate if different feedback strategies of outcomes from the assessment can be used to successfully initiate implementation of welfare improvement strategies (Chapter 3).
3) To analyse the consistency over time (intervals of about 1 and 6 months) at the level of single welfare measures as well as aggregated criterion and principle scores and welfare classification (Chapter 4) in order to support future strategies for application of the protocol required for reliable judgements of welfare.

Farms investigated in this study carried out intensive bull fattening, but operated housing
systems with straw bedding or at least rubber mats in the lying area (cubicle houses). They had been chosen because such systems were expected to be more easily modified in order to improve the welfare state than fully slatted floor systems and farmers to be more open to animal welfare and its assessment.

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2. Attitudes and expectations of European beef farmers towards the Welfare Quality® assessment system

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Abstract

Farmers' attitudes and expectations towards mainly animal-based welfare assessment tools such as the Welfare Quality® (WQ) protocol are regarded important for successful implementation. The objectives of this study with beef farmers in Austria, Germany and Italy were to investigate farmers' willingness to join such a comprehensive assessment system and their expectations towards expected benefits, practicalities of the assessment procedure and respective feedback mechanisms. For this purpose, questionnaire-guided interviews were carried out with in total 90 beef farmers with alternative housing conditions for beef production, i.e. straw bedding or soft rubber mats at least in the lying area. 65% of the beef farmers were motivated to join a system such as WQ on a regular basis. About three quarters of all farmers considered as important, that the system is able to detect deficiencies in housing and management. Further benefits were expected in terms of profitability, state of animal welfare as well as personal job satisfaction. Regarding the willingness to implement measures to improve the welfare state, 92% of farmers agreed to change management routines and 67% would invest more labour. Only few objections were raised which mainly addressed the fear of new regulations, higher production costs and the reliability of the results. Nevertheless farmers agreed to a large extent to the practicalities of the protocol and would be willing to contribute to data provision. In conclusion, apart from the use for labelling purposes, beef farmers in this study regard a welfare assessment system such as WQ as a valid basis for advice. Beyond assessing the animals' state, information needed for improvement strategies may therefore be considered. Farmers' trust in the assessment system may be increased by further research with regard to reliability aspects.

Introduction

The European research project Welfare Quality® (WQ), aimed at developing a European standard for product information on animal welfare in order to address consumers' concerns for welfare friendly animal products (Blokhuis, 2008). On-farm assessment systems were developed which allow an evaluation of animal welfare of livestock kept under diverse production conditions in a reliable way based on science. Focussing on animal-based measures, but also including a limited number of resource and management parameters, the welfare state is assessed and finally expressed in scores of different integration levels (Botreau et al., 2007). Such information can be fed back to the farmer for advisory purposes. For the latter, it is essential that the outcomes of the assessment are useful for the improvement of welfare on farm. However, the usefulness of such information does not only depend on the assessment system itself, but also on the farmers' view of animal welfare and their perception of this approach. Interest in animal welfare and expected benefits from welfare improvements are likely to increase farmers' motivation and chances for effective welfare improvements on farm.

Danish dairy, pig and mink farmers described animal welfare as an area of interest in addition to productivity (Vaarst, 2003). British pig producers (Hubbard, 2006) as well as French cattle, pig and poultry farmers (Dockès and Kling-Eveillard, 2006) stated a strong link between economic performance and animal welfare issues. The latter farmers regarded animal welfare as part of professional ethics, but viewed it dominated by the duty to produce food for the society. Therefore producers tend to view animal welfare in terms of basic needs such as provision of food, water and hygiene, as well as health and productivity. For example, Dutch livestock farmers largely equated welfare with good health (Te Velde et al., 2002) and European pig producers emphasized food and water provision and climate, health and productivity (Bock and van Huik, 2007). In a more recent study with Flemish farmers (Vanhonacker et al., 2008), human-animal relationship was additionally mentioned as an important aspect of animal welfare. Farmers participating in organic or animal welfare schemes emphasized the animals' opportunity to express natural behaviour (Bock and van Huik 2007, Lund et al., 2004). Dockès and Kling-Eveillard (2006) showed that the chosen production systems were linked to the farmer's definition of animal welfare. This is in concordance with Waiblinger et al. (2006) showing that positive attitudes to animal welfare relate to animal-friendly housing systems and enjoyment of work.

Producers' views on and definitions of animal welfare are therefore diverse and appear to be fractional (Vaarst, 2003), leaving it mostly unclear, how farmers would perceive a holistic comprehensive welfare assessment system such as Welfare Quality®. Furthermore rather little is known about farmer's opinions on the assessment

procedure, the feasibility and usefulness of animal-based assessment systems. To our knowledge only one study investigated Danish dairy, pig and mink farmers' perceptions with regard to an animal welfare assessment system which involved multiple assessments over time using qualitative interviews (Vaarst, 2003). The farmers viewed the system as too complex and expensive but potentially useful as a decision support tool if adapted to the local farm conditions.

The present study focused on intensive beef fattening farms in Austria, Germany and Italy. Using questionnaire guided interviews, socio-demographical data, expectations towards the Welfare Quality® assessment system, the practicalities of such an assessment procedure and respective feedback mechanisms were investigated. The study was performed on farms with alternative housing systems for beef cattle, i.e. straw bedding or soft rubber mats at least in the lying area. The reason for investigating this comparatively small sector of the beef industry was the hypothesis, that farmers running these potentially animal-friendly systems would be more likely the future users of such welfare assessment systems. Furthermore they were expected to be more flexible for adaptations in their housing systems.

Materials and Methods

Selection of farms

In total 90 interviews were carried out in three countries (Austria: 30, Germany: 31, Italy: 29 farmers). All beef farms were visited in February and March 2008 by one person per country. Depending on the location of the farms and the availability of the farmers, one to three interviews were carried out on the same day. Farms were recruited from earlier projects with the help of organisations, such as agricultural chambers or farmer groups. Farmers were either first contacted by phone or at farmer meetings. The project was briefly explained and subsequently they were asked if they would accept an interview as well as three more visits within a period of one year, during which WQ on-farm assessments including behaviour observations, clinical scoring of the animals and an interview on management practices would be carried out. From a broader list of potential participants, farms were randomly selected and contacted again for arranging an interviewdate. If farmers were not available during this phase, they were replaced by another candidate.

Farms included in the study had to fulfil the following criteria:

- Housing systems with littered lying area or cubicles with soft rubber mats.
- At least three pens with finishing bulls (>350kg live weight) in order to allow for a minimum number of replicates at pen level within a given farm during the WQ on-farm assessment.

Development of questionnaire

A draft questionnaire was designed based on literature and similar questionnaires (e.g. Kirner, 2001, Stangl, 1997). It was amended after a review by an expert in qualitative research (co-author C. Vogl) and pre-tested with one beef farmer. The questionnaire was then further revised taking applicability issues in the different countries into account.

The final questionnaire contained in total 94 items organised in three main parts:

In the first part, information on the farm was collected such as herd and farm size, housing system and marketing strategies (50 items). It also included items covering the educational background of the farmer and source of knowledge on animal welfare. Only closed answers were used in this part.

The second part was designed to assess the farmers' expectations towards an animal welfare assessment system such as Welfare Quality® (32 items). Items covering the WQ assessment system including questions on the motivation to join Welfare Quality® in future, consisted of open questions, yes/no-questions as well as Likert scales with six levels (ranging from 'very important(6)' to 'very unimportant(1)' or from 'very high(6)' to 'very low(1)').

The third part focused on the feasibility of the assessment system such as evaluation of the practicalities of the on-farm assessment protocol, preferences regarding the way of feedback or willingness to pay for such a system (12 items). This part was only carried out with farmers that had shown interest in part 2 of the questionnaire to apply the Welfare Quality® on-farm assessment system. It included closed as well as open questions.

Interviews

The English version of the final questionnaire was translated into German and Italian. To avoid bias due to the translation, background and aim of all items were clarified in a joint meeting of the three interviewers. The interviewers introduced the farmer to the questionnaire by summarizing the aim of the project and informing about the confidential treatment of the data. The questionnaire was read out by the assessor; in some cases the sheets were handed over to the farmer during the first part (i.e. technical information on the farm, closed questions). In the second part of the questionnaire the open questions had a (planned) narrative provoking function. All answers given by the farmers were written down by the assessor. Prior to the part of the questionnaire regarding the WQ assessment system, farmers were briefly presented the WQ approach and assessment system using a standardized text.

Data Analysis

Layout of the questionnaire, data entry masks and basic descriptive statistics were carried out using GrafStat (Version 3.4.7 and international version; www.grafstat.de).

Quantitative analysis

Descriptive statistics were performed at country level. In order to ensure ordinal treatment, percentages of total numbers of answers for each category of the Likert scales were calculated (Göb et al., 2007). Due to very low responses in some categories of the Likert scales, the upper (4-6; 'high' or 'important') and lower half of the categories (1-3; 'low' or 'unimportant') were merged. Testing for differences between countries was performed using Chi-Square followed by pair wise comparisons in SPSS (PAWS-Statistics Editor) applying Bonferoni-Holm correction for multiple testing.

Qualitative content analysis

The answers in the open questions were analysed following a 'Qualitative Content Analysis' approach (Mayring, 2000). This procedure was carried out for each open question separately. In a first step, categories within a start subset of statements (all data from Austria) were inductively developed. This can be understood as an abstraction of the statements and allocation to possible higher categories. After completion of this step, the procedure was applied to the statements from all countries and every single statement was allocated to one of the previously built categories. To ensure reliability because of new statements added to the start subset, in a revision step the categories were modified or renamed if necessary. After all statements had been allocated, a final control step took place, where all statements were checked again for their correct and reasonable assignment to a category. Following this inductive category development, frequencies of answers in the different categories were determined. In order to correct for unbalanced numbers of answers of a farmer per item, the number of farmers who gave responses in the respective categories was taken into account. Thus, statements by farmers, which pertained to one category, were only counted once.

Chi-Square Tests, followed by pair wise comparisons if an effect was found, were performed to test for possible differences between countries (PAWS-Statistics Editor) followed by Bonferoni-Holm correction for multiple testing.

Results

Socio-demographic information on farms and farmers

Farms

There was a clear country effect on farm size as well as on the number of fattening bulls raised per farm (Table 1). German farms were markedly larger in mean size (167 ha) than the other two countries. The average total number of bulls per farm was 306 animals, but there was a large variation and a country effect with lowest numbers in Austria and highest in Italy (Table 1). Estimated mean daily weight gain of bulls was similar in all countries. Bull fattening was almost the only source of income in the Italian farms (95%), whereas in Germany and Austria on average around 35% of farm income originated from other activities than bull fattening. In Italy, family tradition was the main motivation to keep fattening bulls, while in Austria and Germany farmers mainly switched from the former dairy milk to the beef production. Median number of stockpersons involved in bull fattening was two (range 1-6); in about 74% of the farms they were family members in all countries (Table 1).

In Italy, marketing to a local slaughterhouse or butcher was most prevalent (75%), followed by marketing companies (24%). Local slaughterhouses played a lesser role in Germany (57%), where additionally cattle merchants bought the bulls (52%). Austrian farmers preferred to sell their animals to a contractual partner within a label programme (55%), followed by local slaughterhouses and butchers (multiple answers possible; Table 1).

As mentioned above, farms were only selected if bulls were housed in other systems than fully slatted floor pens. In 55 farms, pens with a littered lying area were the only housing system. These straw yard systems consisted of either 2-area systems with a straw bedded lying area and a solid or slatted loafing area along the feed bunk or outside the barn or of an “one - area sloped floor systems”. On three farms both straw systems and cubicles equipped with rubber mats were present. On three other farms animals were only cubicle housed. 29 farmers had at least one littered system and ran other barns with fully slatted floor pens on their farms. On 14 farms, bulls had access to an outdoor loafing area with concrete or soil flooring or straw litter. Housing systems were not equally distributed among countries: cubicles were only found in Austria, farms with additionally fully slatted floor pens mainly in Germany and farms with only straw bedded systems mainly in Italy (Table 1).

Table 1: Characteristics of the farms studied in Germany, Italy and Austria (country means/medians as well as overall mean/median, standard deviation (SD) and *minimum (min) and maximum (max)* values across all farms)

	Austria	**Germany**	**Italy**	**Total**	**SD**	***min - max***
N	30	31	29	**90**		
General information						
Mean farm size (ha)	72	167	74	**106**	118.0	*14 - 750*
Average number of bulls (n)	141	289	492	**307**	376.5	*40 - 2500*
Mean daily weight gain (g)	1,239	1,245	1,226	**1,236**	200	*656 –1,913*
Mean proportion income from bull fattening	0.68	0.64	0.95	**0.76**	0.28	*0.05 – 1.00*
Median number and range of number of stockpersons (n)	3	4	3	**3**	-	*1 – 16*
Median number and range of number of stockpersons working with the bulls (n)	2	2	2	**2**	-	*1 – 6*
Proportion of farms where only family members work with bulls	0.77	0.74	0.72	**0.74**	-	-
Background of farming						
Years of bull fattening as production branch since …… years	39	33	36	**36**	20.5	*1 - 100*
Main motivation for bull fattening[1]	Switch from milk production		Tradition	**-**	-	-
	0.36	0.23	0.79			
Housing systems					-	-
(Deep) littered/sloped floor (n)	17	16	22	**55**	-	-
Both pens with deep litter/sloped floor and concrete fully slatted floors (n)	7	15	7	**29**	-	-
Cubicles or both deep litter/ sloped floor and cubicles (n)	6	0	0	**6**	-	-
Market channels – bulls are sold to…[1] (proportion of answers)						
Local slaughterhouse or butcher	0.38	0.57	0.75	**0.56**	-	-
Contractual partner within a label programme	0.55	0.17	0.04	**0.25**	-	-
Marketing company	0.03	0.19	0.24	**0.15**	-	-
Cattle merchants	0.21	0.52	0	**0.24**	-	-

[1]: multiple answers possible; values for countries are expressed as proportion of answers per category out of all answers within a country; the mean proportion was then calculated from the three country values

Farmers

The median age of the farmers was 43 years (24-66); only four interviewees were women. In Austria, agricultural skills had mainly (97%) been obtained in agricultural technical schools, in combination with additional courses (60%). In Germany, vocational training dominated (81%), also combined with additional courses (58%). Italian farmers gained professional competence mainly through courses (48%) and in agricultural schools (31%). Only in Germany and Italy some farmers had an academic degree (13.5%). Most farmers mentioned two or more sources of professional skills, since multiple answers were possible. Health management was most frequently mentioned as a topic being addressed during basic training in all countries (>80%). In contrast, animal behaviour, animal welfare legislation and indicators for well-being did not follow a clear pattern in how often they were mentioned in the three countries (Table 2).

Regarding sources of information on animal welfare related topics after completion of basic training, state agricultural organisations were most important in Italy (38%), but played a minor role in the other countries (12.5%). Italian farmers were also informed by farmers' press (25%) as well as by animal health services and by the farm veterinarian (both 15%). In Germany, farmers' press (23%) and events such as meetings and fairs (20%) dominated, followed by the local veterinarian and other sources (15%). In Austria the animal health service (21%), followed by farmers' press and veterinary surgeons (both 19%) were most frequently consulted concerning animal welfare topics. Events such as fairs and meetings were a source of information in 16% of the farmers. Active information seeking using the internet was mentioned by single farmers only (on average 6%).

Table 2: Topics addressed during basic training concerning animal welfare, well-being and animal health in the three countries (ranked by frequency of answers, multiple answers possible)

Frequency	Austria n=30	Germany n=30	Italy n=25
>80 %	Health management 0.83	Health management 0.90	Health management 0.92
60-80%	Animal behaviour 0.77	Animal welfare legislation 0.67	Animal behaviour 0.68
	Animal welfare legislation 0.70		Animal welfare legislation 0.68
	Indicators for well-being 0.60		Indicators for well-being 0.64
<60 %		Indicators for well-being 0.47	
		Animal behaviour 0.47	

Farmers' expectations towards the Welfare Quality® assessment system

Motivations of farmers to join Welfare Quality® and willingness to regularly participate in an assessment scheme

On average 65% of the interviewees ranked their motivation to apply a welfare assessment system as at least 'rather high'. Some minor country differences (χ^2=7.597; p=0.022) (Figure 2a) occurred with more German farmers being at least rather highly motivated than Italian farmers (p=0.018)

Farmers in Italy would join the WQ system mainly to increase animal welfare, but they would not consider the assessment system as a tool to improve animal performance thus differing from farmers in the other two countries (χ^2=21,242, p=0.000) (Figure 1). Austrian farmers focused mainly on welfare and performance improvements and reduction of medicine use but expected least to improve management using WQ. Answers of German beef farmers were rather balanced between all categories with the highest agreement regarding improvement of performance. They were significantly more willing to join WQ in order to fulfil label requirements as compared to the other countries. 'Other reasons' were given by 3% of the farmers only and 6% were not interested in the scheme at all (data not shown).

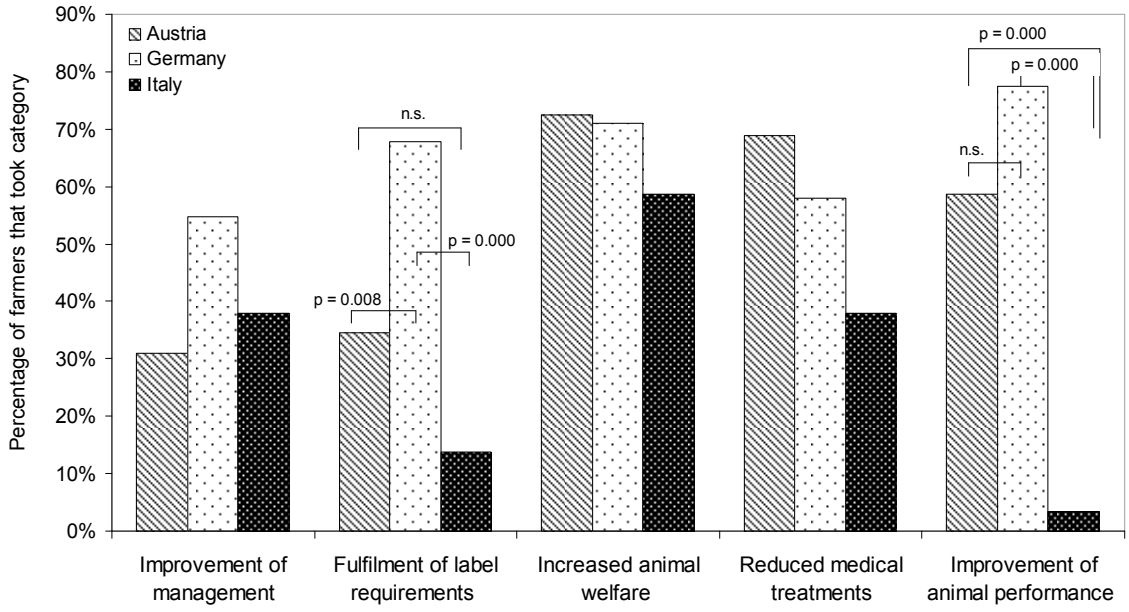
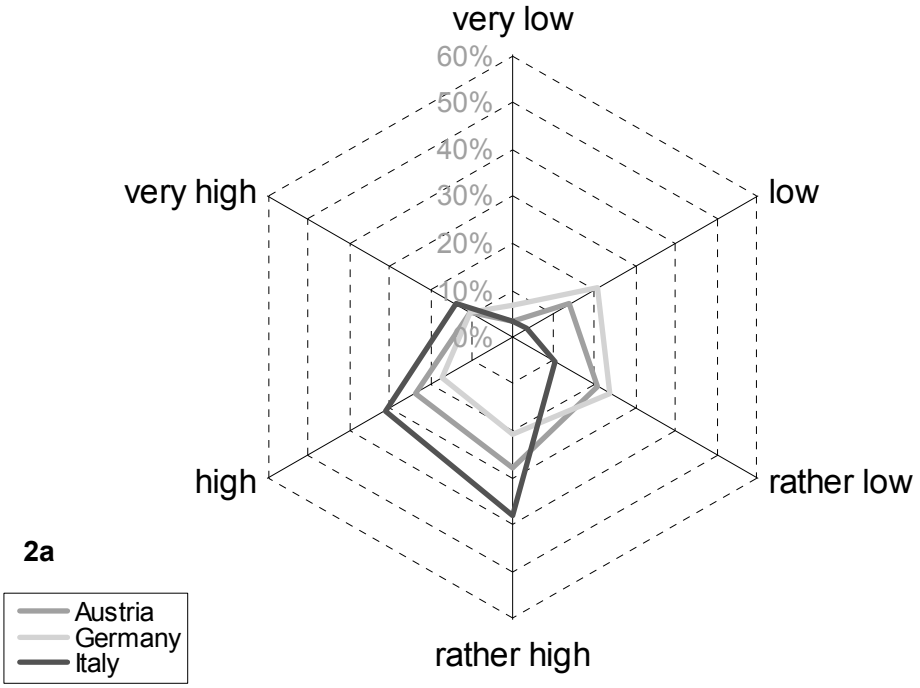


Figure 1: Potential reasons for joining Welfare Quality® of German, Austrian and Italian beef farmers; data are given as percentage of farmers choosing out of five different categories; multiple answers possible ($n_{farmers}$ = 85, $n_{statements}$ = 232)



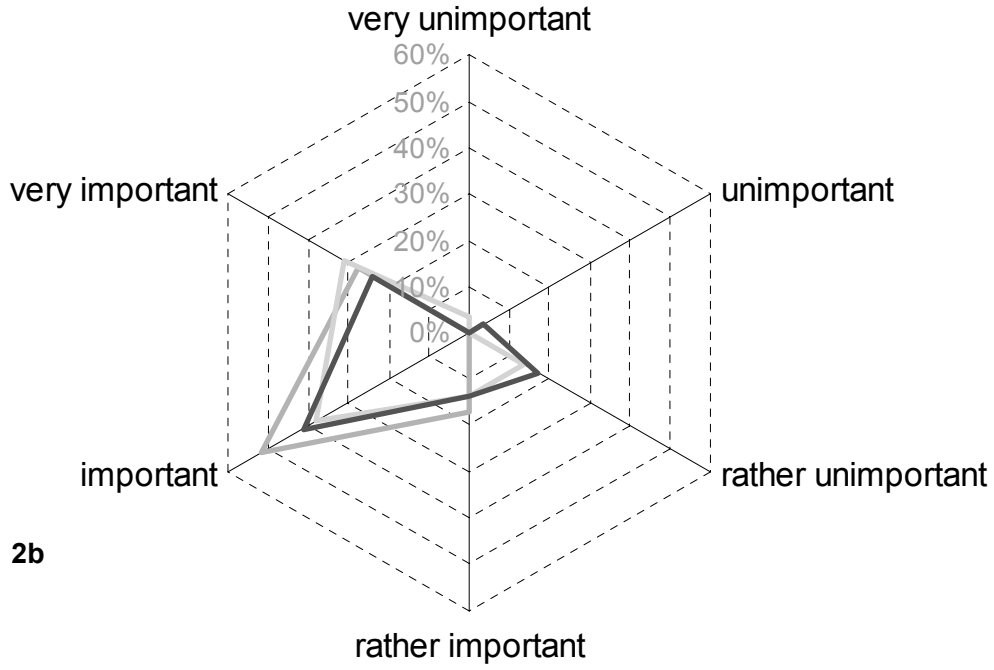


Figure 2 a+b: Motivation to join the Welfare Quality® scheme (1a) and Importance of detecting deficiencies within Welfare Quality® (1b) by Austrian, German and Italian beef farmers. Data are given as percentage of statements allocated to the six levels on a Likert scale in case of (a) from 'very low (1)' to 'very high (6)' with $Median_{total}=4$ or in case of (b) 'very unimportant (1)' to 'very important (6)' with $Median_{total}= 5$. Stated values refer to different numbers of farmers (a): $n_{Germany}=31$, $n_{Austria}=30$, $n_{Italy}=27$, in case of (b): $n_{Germany}=31$, $n_{Austria}=30$, $n_{Italy}=29$

Importance for the farmer for Welfare Quality® to detect deficiencies in housing, management and health monitoring and importance of getting advice with regard to problems identified during the Welfare Quality® assessment

Although on average only 41% of the farmers would join WQ in order to improve management, 72% ranked the detection of deficiencies in housing and herd management at least as 'important' (Figure 2b). This aspect was regarded 'unimportant' or 'rather unimportant' by a minor proportion of Italian and German farmers only. Assistance of the farmer or the farm veterinarian in herd health monitoring through WQ was rated 'important' by 40% of the farmers (in total 73% 'rather important to 'very important'). Advice related to deficiencies detected by the assessment scheme was considered 'important' (42% of all answers) or 'very important' (39% of all answers) but without significant differences between the three countries.

Expected further benefits from Welfare Quality®

52% of German and Italian farmers and 30% of Austrian farmers expected better prices for their bulls, more economic success in bull farming and better marketing options. About 42% of German and Austrian farmers also expected professional information and support regarding welfare problems and their solutions. Better health and welfare was also mentioned, but less frequently (about 10%). On average nearly one third of the farmers did not expect more benefits than the ones mentioned in earlier stages in the questionnaire (Figure 1).

Expected benefits for animals and for farmers from an increased animal welfare

Farmers' statements regarding advantageous effects on the animals were clustered in four categories. Within three of them there was a significant country effect (Figure 3). In comparison to Austria and Germany a significantly higher percentage of Italian farmers did not expect an effect at all after implementing the WQ assessment system (37% vs. 10% and 7%, χ^2=12.020 p=0.002). Compared to Italian farmers, more Austrian and German farmers expected improvements in animal welfare to result in better weight gain, meat quality and product price (χ^2=26.487, p=0.000). A similar picture was obtained for benefits on herd health state (χ^2=7.615, p<0.022). A general increase in quality of the animals' life was mentioned by about 25% of the German and Austrian farmers and 40% of the Italian farmers though differences were not significant.

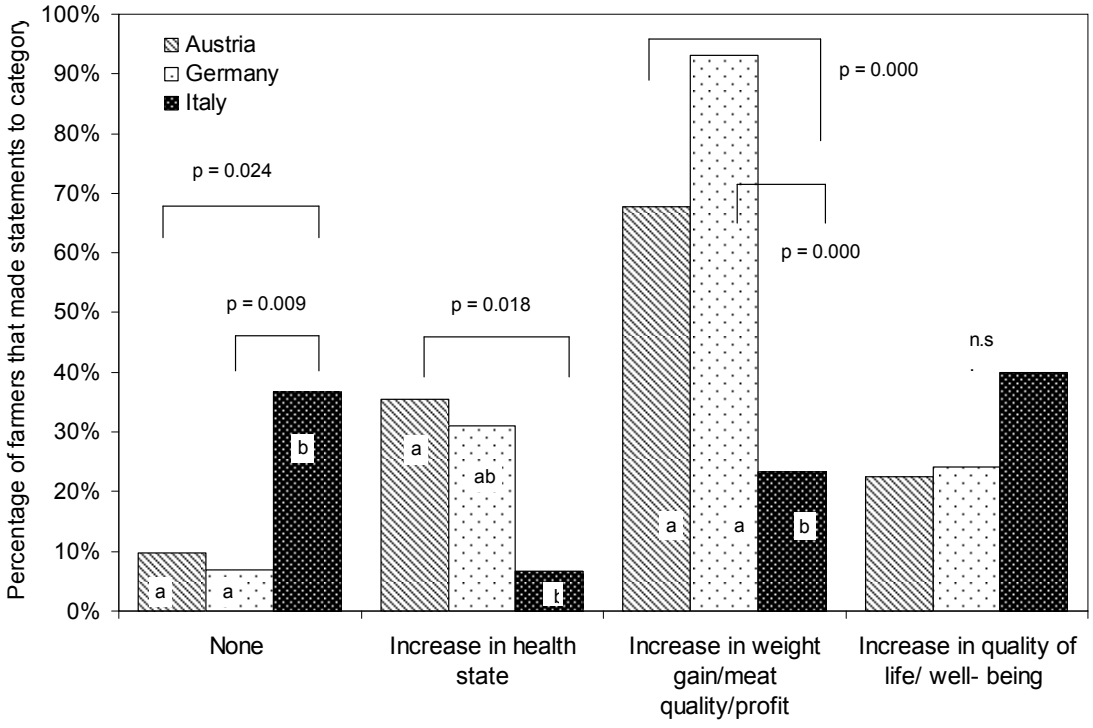


Figure 3: Content analysis of benefits for the animals after implementing Welfare Quality® expected by 90 Austrian, German and Italian beef farmers; data are given as percentage of farmers providing statements allocated to four different categories; multiple categories possible ($n_{statements\ benefits}$ = 103, n_{none}=16).

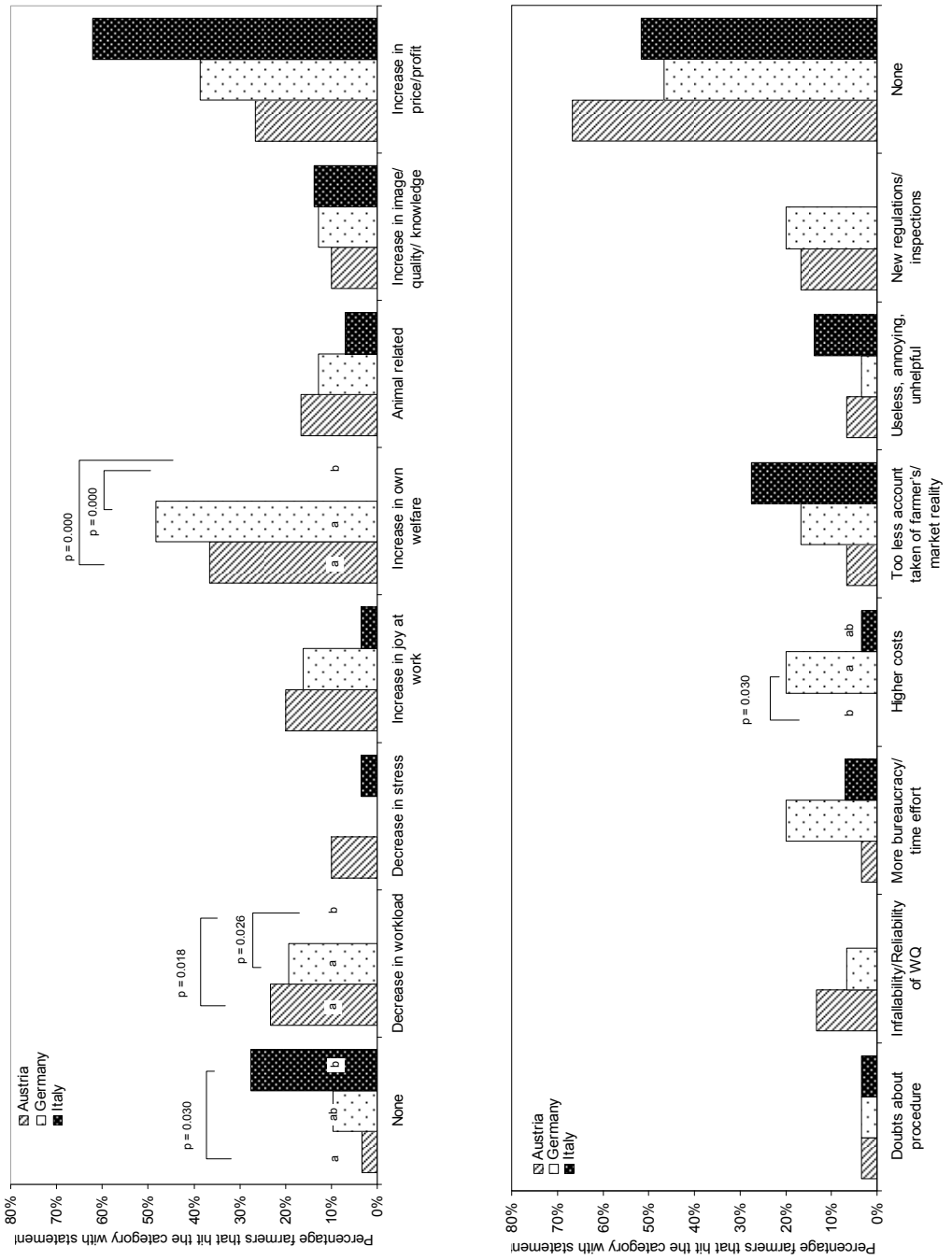
Expected personal benefits were assigned to eight categories (Figure 4). German and Austrian farmers never differed significantly in their expectations, whereas Italian farmers expected more economic benefits than Austrian farmers (χ^2=7.815, p=0.020). Contrary to Austrian and German farmers (23% and 19%, 37% and 48% respectively) Italian farmers never mentioned 'Decrease in workload' or 'Rise in their own welfare' as personal advantages (χ^2=7.419, p=0.024 and χ^2=18.402, p=0.000, respectively). However, German farmers did not expect a 'Decrease in stress'. The number of statements regarding 'Increase in joy at work' and 'Animal related' decreased, however not significantly, from Austria to Germany to Italy. Improvements in terms of 'Image and Knowledge' were mentioned by around 10% of the farmers in all countries. To a larger extent Italian farmers did not expect any personal advantage from joining a WQ monitoring program (28% vs.3% in Austria and 10% in Germany; χ^2=8.053, p=0.018).

Willingness to implement measures to improve the welfare state

Regarding the farmers' willingness to modify the housing system or management procedures or to spend more time with the animals in order to improve the situation, no significant differences were found. The lowest willingness in a single country for such modifications was expressed by farmers of Germany (67%) regarding a higher labour effort. The least accepted area across all countries was 'Increase in workload' with an overall of 75%, followed by changes of the housing conditions (80%). Management changes were best accepted (92%). Whereas Italian farmers showed no clear preference for one of the areas suggested, German and Austrian farmers appeared to be more willing to accept modifications in herd management activities. More than two thirds of the farmers were prepared to accept higher costs if balanced with revenues. About one quarter demanded an increase in net income as a condition for their willingness to improve animal welfare (about 10% increases in income per year) and 8% of farmers would not at all spend more money in order to achieve higher welfare states. None of the interviewees was willing to spend money for improving welfare, if it would not pay back in terms of monetary benefits.

Figure 4: (left) Content analysis of which personal benefits after implementing Welfare Quality® are expected by 90 Austrian, German and Italian beef farmers; data are given as percentage of farmers providing statements allocated to eight different categories of personal benefits; multiple categories possible (n statements $_{none}$=12; n statements $_{benefits}$=115).

Figure 5: (right) Content analysis of objections against Welfare Quality® by 90 Austrian, German and Italian beef farmers; data are given as percentage of farmers providing statements allocated to eight different categories of objections; multiple categories possible (n statements none=49; n statements objections=58).



Objections against the Welfare Quality® assessment system and acceptance of technical details of the Welfare Quality® protocol

A slight majority of farmers had no objections against the assessment system as outlined to them (67, 47 and 52% of farmers in Austria, Germany and Italy, respectively; Figure 5). The main concerns with some country differences were related to upcoming new welfare regulations (less in Italy, χ^2= 6.060, p=0.030) as well as increasing production costs (more in Germany; χ^2=9.080, p=0.011). Doubts in the enforceability in the market and on the reliability and validity of the assessment system were also expressed.

Farmers interested in joining WQ would on average accept a farm visit of 8 hours (median; range 0.75-24 hours) and being available for 1.5 hours for questionnaires (e.g. on management procedures and farm records) (range 1-8 hours). 82 of the 90 farmers would assist in collection/provision of data. On average 2.4 farm visits/assessments per year (range 0-12) were suggested. The preferred form of feedback of the results of the welfare assessment was a written report in combination with oral advice with the veterinarian being an external person they would like to include into the process (Table 3).

Table 3: Agreement of farmers with the practicalities of the Welfare Quality protocol

	Mean or percentage agreement	n farmers
Duration of the protocol on farm	7.1h (0.75-24h); median 8h	59
Time available for conducting the questionnaire	1.5h (1 – 8)	77
Price willing to pay for a Welfare Quality® Assessment when offered on a commercial base	100€ (n=32: 1-1,000€; n=31: 0€)	63
Support in collection of management, housing and animal health related data by the farmer (percentage of farmers)	79%	82
Number of Welfare Quality® assessments accepted per year	2.4/year (0 – 12)	59
Written feedback plus oral advice during a visit Only written feedback Written feedback and oral advice per telephone	60% 30% 10%	82
Preferred external persons who should be included in the process	Veterinarians (60%) Farmer colleagues (21%) Feeding experts (20%)	75

Discussion

Beef production in the three countries included in this study is characterised by predominantly intensive bull fattening but with significant differences in the average number of animals kept per fattening unit, with Austria having the smallest and Italy the largest herds. However, all farms investigated in this study operated housing systems with straw bedding or at least rubber mats in the lying area (cubicle housing). Farmers running these housing systems had been chosen based on the assumption that an option to receive welfare-related rewards might be attractive to them, and, furthermore that in these systems there would be greater scope for welfare improvements compared to fully slatted floors. Exact prevalence data regarding alternative types of housing systems in the three countries were not available. However, the fully slatted floor system is the main housing system for intensive fattening in all three countries (e.g. Cozzi, 2007). The decision to run a straw bedded housing system can be based on a number of different motivations. One of them may be the desire to provide animal friendlier conditions. However, about one quarter of the farmers additionally ran a system with fully slatted floor pens. Partly, littered pens are used to finish bulls slaughtered at higher live weights (Cozzi et al., 2009). This if often the case for Charolais bull fattening since this breed is more sensitive to lameness and soft bedding helps to reduce leg and claw lesions (Cozzi et al., 2005). In agreement with Ingram (2008), farmers in Germany and Austria also regarded manure from bedded systems advantageous for soil fertility and crop production during the interviews. Farms and farmers included in this study therefore belong to a rather small segment of the (intensive) bull fattening industry, but farm and herd sizes as well as level of intensity of production can be regarded to be similar to the average beef fattening industry in the respective countries (e.g. Cozzi, 2007). However, running an 'alternative', presumably more welfare friendly housing system may influence views on animal welfare and it may also affect the propensity to aim at welfare improvements. Even if the results have been obtained from a small segment of the beef industry, at least practical aspects of the assessment are likely to apply to all production systems. The majority of the interviewed farm managers in our study were highly interested in the topic 'animal welfare assessment'. This is in contrast to Te Velde et al. (2002) describing Dutch broiler chicken, pig and veal farmers as feeling confident with the status quo of animal welfare in their farms and not actively searching for more knowledge about animal welfare. However, professional training with regard to animal welfare provided by agricultural schools, state agricultural organisations or animal health services in all three countries was mostly restricted to 'Animal Health'. Welfare indicators or animal welfare legislation is much less commonly dealt with during basic training. On the other hand, the beef farmers of this study also appeared to be actively

seeking information on animal welfare. Sources of information regarding animal welfare were state agricultural extension services, farmers' press, fairs and veterinary services (animal health services), whilst information gathering via internet was not very common. Additionally, in 83% of the interviews the farmers were regarded as interested in completing the questionnaire (data not shown). The data collected are therefore assumed to be meaningful in relation to potential participants of an animal-based welfare assessment scheme.

Farmers' expectations of an animal welfare assessment system such as Welfare Quality®

Motivation to join a welfare assessment scheme such as WQ was only moderate. This may be attributed to the fact that farmers in the countries studied did not have previous experience with similar animal-based assessment systems and that they were only given an overview about the WQ on-farm welfare assessment procedures before conducting the questionnaire. Therefore there may have been a lack of experience and therefore confidence in such a system and farmers may not have sufficiently captured the main messages.

It was assumed that different structures of the beef industry in the different countries would affect the acceptance of the assessment system. However, differences between countries were not very pronounced. Whilst farmers in all countries would join WQ mainly to increase animal welfare and to reduce medical treatments, improvement of performance or being able to participate in a label programme was of lesser interest, especially for Italian farmers. Possible reasons for the latter may lie in the rather low interest of Italian consumers in animal welfare labels. According to Miele and Parisi (2001) about 61% of consumers stated to think rarely about housing of farm animals when buying food of animal origin and 53% in general do rarely think about the way in which farm animals are treated. Furthermore, consumers were not likely to pay a higher price for animal friendly products. In total, this may reflect a lower pressure on animal production due to societal debate about animal welfare in Italy and consequently less potential to introduce welfare-labelled beef. In all countries farmers expect the assessment system to support the identification of deficiencies of housing and management and to support monitoring the herd health status. This is in agreement with experiences made in the course of a herd health and welfare planning process in Austrian organic dairy farming, where farmers mainly expected an improvement of the health situation (Gratzer et al., 2011). In line with this Bock and van Huik (2007) found that many farmers appreciate a quality assurance scheme as a tool to reflect on their farming practices and to make adjustments when necessary. Farmers in the present study willing to participate in welfare assessment systems such as WQ obviously want to benefit from external inputs (e.g. advice on problems identified) as well.

Further advantages expected by nearly half of the farmers were higher product prices, better marketing options and more economic success. While in principle most farmers seem to be willing to implement changes in management, housing, workload and even costs to improve the assessment outcomes, they also stressed that improvements would have at least to pay off in economic terms. Financial incentives therefore appear to be crucial for welfare improvement. Also consumers believe that farmers should be compensated for higher welfare standards (Eurobarometer, 2007) with rather large differences between countries. This suggests that solutions to achieve economically viable measures for animal welfare improvement may be country specific or even regional.

In the open questions concerning the benefits of implementation of the WQ assessment system some categories contain apparently inadequate or imprecise statements (e.g. animal related statements to the question about 'personal benefits' by improving animal welfare). Nevertheless these 'off-topics' were regarded as valid because they had been given by the farmers in the context presented to them. Therefore, they were kept in the results in order to sensitively reflect what farmers associate with animal welfare or think about WQ. For example, one question was about benefits for the animals, but many farmers provided statements regarding positive effects related to the animals (e.g. meat quality, profits) which do not necessarily mean a direct advantage for the animals. Vice versa farmers mentioned animal related aspects when the question aimed at personal benefits they presume. This could be a sign of indexicality, which is understood as "the effect of a single word or expression providing a stimulus for connotations, memories, pictures or feelings which lead to answers that may appear aberrant in the context of the interview" (Kruse, 2009), especially in open questions. Another possibility is a lack of clear differentiation between personal and animal needs or that the animals' and farmers' welfare is viewed as interdependent. This has also been reported by Kauppinen et al. (2010) in a qualitative study on farmers' attitudes towards the improvement of animal welfare. In all countries farmers expected a higher quality of life, as well as reduced stress and workload when animals have better welfare. This is in agreement with findings for German farmers applying a tool concerning health and welfare plans, who found it similarly important to implement plans that improve farm income as well as general job satisfaction related to animal production (Oppermann et al., 2008). Concepts of motivation of farmers such as 'instrumental business orientated' (Kauppinen et al., 2010) or 'intrinsic welfare orientated' (Lund et al., 2004) can also be applied to this study with about 68% of farmers expecting personal and 'non-monetary' benefits. Such 'internal' motivation factors have been regarded as crucial for behaviour change related to lameness control in dairy cows (Leach et al., 2009) or reduction of clinical

mastitis in dairy cows (Valeeva et al., 2008) but would require further investigations (Gratzer et al., 2011).

A slight majority of farmers had no objections against WQ, but again the limited knowledge of the farmers about this new type of assessment system should be taken into account. Nevertheless, concerns about increased bureaucracy (mainly Germany) or additional animal welfare regulations (Austria, Germany) and lack of a real recognition by the production chain (Italy) were raised. Bock and van Huik (2007) reported that cattle farmers felt an increased administrative workload since they participated in a label scheme. Danish dairy, pig and mink farmers (Vaarst, 2003) were also concerned about 'negative' impacts of an animal welfare assessment scheme especially if carried out by external persons and not by the farmers themselves. Their concerns were mainly related to the use of results in terms of judgements made by consumers and retailers or political decisions such as the implementations of stricter rules concerning housing. Besides this they found as another disadvantage that the assessment was too comprehensive and wished it would have had a better connection with productions results. Te Velde et al. (2002) reported fears of farmers, that more consideration of animal welfare would imply returning to a more traditional way of farming and therefore worsening of working conditions. Similar to this, one farmer in our study expected a change in societal views, giving animal welfare higher priority than human (farmer) welfare.

Certainly, another important issue is potential farmers' 'Distrust in the approach' and in the reliability of the animal-based WQ assessment system. The reliability of welfare indicators in the context of welfare assessment is an important topic in the current scientific discussion. The farmers' sceptics views are in line with calls for more basic scientific work, such as tests for consistency of measures (Knierim and Winckler, 2009; Welfare Quality, 2009b; Plesch et al., 2010), inter-observer reliability (Brenninkmeyer et al., 2007, Leach et al., 2009, Mullan et al., in press), the investigation of meaningful herd samples sizes (Mullan et al., 2009) and validity testing of potential novel animal based measures (Schulze Westerath et al., 2009). Farmers are obviously very aware of the high variability of animal based data from day to day, reflected by the relatively high count of suggested visits per year.

Acceptance of technical details of the Welfare Quality protocol

The time needed for the application of on-farm welfare assessment protocols and possible alternatives have been repeatedly discussed (e.g. DeVries, 2011; Knierim and Winckler, 2009, Mülleder, 2007; Sørensen, 2007). Key issues are the costs associated with data collection per visit and - closely related to this - the number of visits needed per year or production period. On average farmers in this study would accept farm visits lasting for about 7 h, and this matches well with the time given in the WQ protocol (Welfare Quality, 2009a) for fattening cattle of 4.5 – 6.0 h, depending on the number of animals. In any case, the application of the WQ protocol would exceed the time usually taken for farm audits and previously suggested assessment protocols such as the Bristol Welfare Assessment Programme (Leeb et al., 2004), and especially with systems which are mainly resource based such as the ANI (Bartussek, 1999). However, it has to be taken into account that interviewed farmers were not informed about the potential costs of such long lasting assessments. The amounts farmers were willing to pay for the assessment varied from as little as zero to 1000 Euro. In many cases they were prepared to pay about the price of public services such as the membership fee in animal health service. Again, in all three countries similar assessment systems have not been implemented yet and therefore farmers were not familiar with it. Sørensen et al. (2007) suggested the use of already existing farm records and the involvement of the farmers in data collection as a way to reduce the costs of assessment systems. Consistent with this approach 80% of the farmers in our study were prepared to actively contribute to the data collection required within the WQ assessment scheme with regard to housing, management and animal health records, thus aiming at a potential reduction of time spent on farm by the assessor and their related costs.

A written feedback on the outcomes of the assessment was requested by all farmers and additionally an advisory visit involving external experts (mainly a veterinarian) was preferred by more than half of the farmers. This goes along with studies by Gratzer et al. (2011) and Brinkmann and March (2011). It is clear, that farmers showed a preference for an integrated approach of planning and working with the active contribution of other professionals addressing the farm animals' welfare issue like nutritionists and mainly vets.

Conclusions

Beef farmers in this study show interest in welfare assessment and labelling thus indicating a potential for implementation of an animal based assessment system such as Welfare Quality® at least on a voluntary basis. Apart from the use for labelling purposes, farmers expect the detection of deficiencies in beef cattle housing and management as a valid basis for advice. To ensure further acceptance the assessment scheme should therefore not be reduced to a certification tool only but also consider information that may be used for advisory activities. When advertising such assessment systems non-monetary benefits such as decrease in stress and workload may also be addressed.

The farmers' willingness to contribute to data provision offers the possibility to reduce the time spent on farm by the assessor and the total assessment costs; however this would need further investigation. Farmers' trust in the assessment system may be increased by further research with regard to reliability aspects (e.g. repeatability over time). Nevertheless, these issues may be tackled while applying animal-based welfare assessment schemes in practice on a broader basis using the data originating from these implementations.

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3. State of animal welfare on European beef bull farms following the implementation of the Welfare Quality® assessment system

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Abstract

Beef bull production in Europe does not underlie detailed regulations regarding housing and management. However, welfare concerns have been raised especially for intensive beef production, but on-farm welfare assessment studies are rare. In recent years, a Welfare Quality® (WQ) on-farm welfare assessment system for fattening cattle has been developed. This assessment system is mainly based on animal-related measures and provides an aggregated evaluation of welfare using so-called criterion and principle scores as well as an overall welfare classification. It may be used for certification purposes but also in order to support welfare improvement measures on the farms. It was aim of this study to implement this assessment system on farms in order to evaluate the state of welfare at the level of WQ measures and of aggregated scores as well as overall classification. Additionally the purpose was to evaluate two ways to feed back information to the farmers resulting from the assessment in terms of possible welfare improvements on the farms. The study was performed in Austria, Germany and Italy on in total 63 beef bull fattening farms with deep littered and cubicle housing systems. Assessments and score calculations followed the WQ protocol for fattening cattle and took place three times (1 month and 6 months apart form the initial visit). In every country farmers were evenly assigned to two treatment groups (feedback from initial visit as written report/F, written feedback plus oral advice/FA) and a control group (C), which did not receive any feedback. Effects of treatment were analyzed using a linear mixed effects model. On criterion level, the highest average scores were obtained for 'Absence of prolonged hunger' (94/100) followed by 'Absence of pain induced by management procedures' (88/100) and 'Comfort around resting' (77/100). Most welfare concerns became evident for criteria such as 'Absence of disease' (40/100), 'Expression of social behaviour' (44/100) and 'Positive emotional state' (48/100) thus indicating room for improvements also in the housing systems investigated in this study. Regarding the overall classification, two thirds of the farms achieved the 'Enhanced' level, and one third was judged 'Acceptable'. After six months

there was no significant welfare improvement in both treatment groups compared to the control group. Reasons for the lack of effect may mainly be seen in the short monitoring period and a lack of external motivating factor such as incentives. Longer-term studies as well as investigations of alternative ways of transferring outcomes of on-arm welfare assessment back to farmers should be carried out in future.

Introduction

Beef production systems are widespread in the European Union, and exhibit a great diversity across countries, ranging from extensive more or less pasture-based fattening of steers and heifers to intensive indoors-based bull fattening systems (SCAHAW, 2001). There is no EU legislation in force concerning the welfare of fattening cattle. Although in 1988 the Council of Europe Standing Committee of the Convention on the Protection of Animals Kept for Farming Purposes adopted a recommendation concerning cattle including beef cattle, so far this had only limited effect on farming practices. On European level, only for beef originating from organic production specific regulations have come into effect ((EC) No. 834/2007 and 889/2008), setting out among others requirements for housing and management that are welfare relevant. At the national level, welfare legislation may however address minimum requirements for beef cattle, as it is the case e.g. in Austria (TSchG, 2004).

The limited legal standards concerning beef production contrast with numerous welfare concerns, as reviewed for example by the Scientific Committee on Animal Health and Animal Welfare (SCAHAW) (2001). They were mostly based on current practices regarding housing, feeding and management in intensive beef fattening. More recently, Wechsler (2011) reviewed scientific evidence regarding the effects of floor quality and space allowance on the welfare of finishing beef cattle and concluded that SCAHAW's recommendations from 2001 are still valid. Other studies in the recent years regarding welfare aspects in beef bulls were focussing on problems arising from feeding facilities (Gottardo et al., 2004), cleanliness (Tessitore et al., 2009; Schulze Westerath et al., 2007; Cozzi et al., 2005), skin lesions (Platz et al., 2007; Schrader et al., 2001; Schulze Westerath et al., 2007 & 2009b), agonistic and socio-positive behaviours (Laister et al., 2009; Platz et al., 2007; Schulze Westerath et al., 2009a) or human-animal relationship (Windschnurer et al., 2009). Besides these mainly experimental studies nearly no larger-scale on-farm welfare assessments in intensive beef farming have been carried out to our knowledge, and if, restricted to Italy (Gottardo et al., 2009; Tessitore et al., 2009).

In this contrasting situation in beef bull farming where growing welfare concerns face a lack of minimum legal requirements in many countries, the application of an overall welfare assessment protocol on a wider scale could help to determine the state of animal welfare. At the same time, farmers may use the monitoring system as a tool to

improve the welfare state on their farm. Such a tool has been developed in recent years (Welfare Quality, 2009a) involving scientists, citizens and stakeholders from the industry. One scope was to develop valid and robust assessment protocols that can be easily applied on-farm. The information gathered can be processed into integrated welfare scores (Botreau et al., 2007). The scoring therefore has the potential to be the basis of a European-wide standardized labelling for products coming from animal welfare friendly production systems (Blokhuis, 2008). Another important aspect is the feedback of the assessment results to the farmer, pointing out strengths and weaknesses in terms of animal welfare and aiming at initiating improvement processes.

It was therefore the aim of this study to describe the welfare state on beef bull farms in Austria, Germany and Italy regarding the different levels of the Welfare Quality® (WQ) assessment system for fattening cattle: single measures, criterion and principle scores and overall classification. Secondly it was the aim to evaluate the WQ welfare assessment system with regard to the implementation of welfare improvement measures and the actual effect on the welfare state, again on the above mentioned different levels. For this purpose two types of feedback of information resulting from the assessment were used (i.e. feedback by written report, written feedback plus advice).

The study was carried out in three countries with predominantly intensive bull fattening, but with significant differences in farm size (on average rather small in Austria, medium in Germany and large in Italy). Investigations were performed on farms with straw bedded housing systems or cubicle housing with soft rubber mats in the lying area. The reason for investigating this comparatively small sector of the beef industry was the assumption that modifications intended at improving welfare would be easier to implement in such systems and that farmers running these potentially animal-friendly systems would more likely be the future users of such welfare assessment systems. Furthermore they were expected to be more flexible for adaptations in their housing systems.

Materials and Methods

Farms and allocation of farms to treatments

In total 63 beef fattening farms (21 farms each in Austria, Germany and Italy) were included in the study. These farms were selected from a total of 91 farms that had been recruited at an earlier stage of the project (29-31 farms per country; Chapter 2). The farms included in the implementation study had to fulfil the following criteria:

1) Housing systems with littered lying area or cubicles with soft rubber mats.
2) At least three pens with finishing bulls (>350kg live weight) in order to ensure a minimum number of replicates at pen level within a given farm.
3) Fattening of intact bulls.

In each country, seven farms were allocated to one of three treatments (see below):

- 'Feedback' (F)
- 'Feedback and Advice' (FA)
- 'Control' (C)

Allocation of farms was based on the importance the farmer had given in questionnaire guided interviews to detect deficiencies in housing system and management and the importance to assist in monitoring the health status of the herd through a welfare assessment scheme (Chapter 2). The seven farms with the highest scores concerning the importance of advice in the context of welfare assessment were allocated to the FA treatment.

Control farms (C) were selected with the aim to create similar group means with regard to:

- farm size (no. of animals),
- the willingness to implement modifications concerning housing and management (based on responses in the questionnaire)
- weight of bought-in bulls
- presence of bulls of weight category I (200-350 kg)

The number of beef bulls >200 kg live weight kept on the farms ranged from 41 to 700 animals (only animals in the housing systems described below, means for three visits; Table 4).

Housing systems and breeds

39 farms ran a sloped floor system (20 one-area, 19 two-area) and 36 farms kept the bulls in a deep littered system (26 one-area, 10 two-area). One farm had a bedded area that was cleaned and newly littered on a daily basis and in two farms bulls were kept in a cubicle housing system (multiple systems on a farm possible).
The animals on the study farms were of different breeds. In Austria and Germany Simmental was most prevalent with 17 out of 21 and 8 out of 21 farms, respectively (at least 90% of the animals); in Italy this was the case for Piedmontese with 7 out of 21 farms. Crosses with beef breeds (e.g. Simmental, Limousin, Charolais) were kept in three (Austria), eight (Germany) and 7 farms (Italy). Purebreds such as Limousin and Charolais were only present on five farms and milk breeds like Brown Swiss and Holstein only on three farms.

Table 4: Number of animals and pens on the study farms per treatment (F, FA and C) in AT, DE and IT (as means over all three assessments for every farm) (mean, SD and range; n= 7 farms per country and treatment).

country	treatment	number of animals mean ± SD (min-max)	number of pens mean ± SD (min-max)
AT	F	121 ± 55 (71-225)	13 ± 4 (8-18)
	FA	107 ± 54 (55-205)	11 ± 4 (7-18)
	C	79 ± 25 (41-108)	7 ± 3 (4-10)
DE	F	176 ± 103 (45-355)	16 ± 7 (5-27)
	FA	190 ± 171 (52-523)	15 ± 11 (6-30)
	C	221 ± 138 (44-438)	16 ± 12 (3-33)
IT	F	136 ± 81 (68-272)	15 ± 8 (6-29)
	FA	310 ± 290 (53-700)	29 ± 24 (8-70)
	C	252 ± 152 (69-507)	26 ± 18 (6-57)

Assessments

All beef farms were visited from April 2008 to February 2009 by one person per country. On-farm assessments were carried out largely following the Welfare Quality® protocol for fattening cattle (Welfare Quality, 2009; deviations are discussed further below, Table 5). Assessments were conducted three times on each of the 63 farms (initial, interim and final assessment). The interim assessment took place about one month after the initial assessment and the final assessment about six months after the interim assessment (Figure 6).

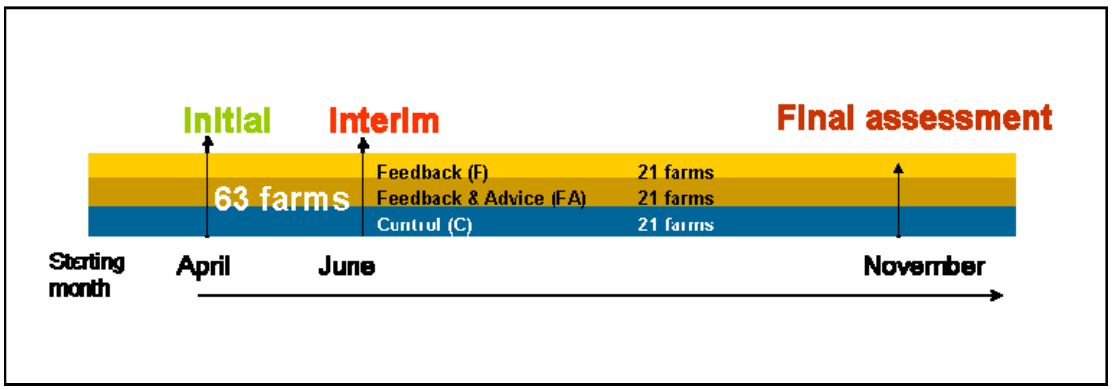

Figure 6: Study design of the implementation study of Welfare Quality on 63 beef farms.

Treatments varied in the level of information fed back to the farmer: a) feedback of the results of the initial assessment in form of a written report (feedback, F), b) written report on the results as for F and provision of additional advice (feedback and advice, FA) and c) no feedback of the results during the study (control, C). Reports for F-farmers listed results of the initial welfare assessment according to the WQ principles and criteria. Welfare relevance of the outcomes was illustrated using expert opinion derived judgements which were highlighted following the scheme of a traffic light in green ('okay'), yellow ('improvement desirable') and red ('improvement necessary') (for an example please see the Chapter 6, Appendix B). Reports did not contain information on access to an outdoor loafing area and/or pasture since this was not expected to be changed on a short- to mind-term basis. Also scores derived from Qualitative Behaviour Assessment (Criterion 'Positive emotional state') were not fed back due to a lack of experience with these outcomes of the assessment. If available, additionally means and ranges from 30 farms in Austria and 18 farms in Italy (from earlier studies) were provided for benchmarking purposes.

For the FA-farms, the results were presented in the same way as for the F-farms. However, additionally advice was provided where at least one measure of a criterion was judged as "improvement desirable" or "improvement necessary". In order to largely standardise the advice, an internal written list containing potential advice for every criterion was created in collaboration between all research partners of this project. For each criterion where improvement could ('desirable') or should ('necessary') be achieved, the assessor chose those aspects from the list of potential improvement measures which were assumed to be applicable to the respective situation on the farm. This selection of advice was written directly beneath the respective parameters. Results and advice were then discussed with the farmer during the visit of the interim assessment; for two farms this was done via telephone.

After the final assessment, FA farmers were asked about the degree of implementation of advised measures.

Retrospectively, farm level values for the 27 measures of the assessment protocol, as well as criteria, principle and overall scores were calculated for each of the 189 assessments according to the procedures described in the Welfare Quality® protocol (Welfare Quality, 2009) using updated formulas and coefficients as provided by INRA Clermont-Ferrand (Champciaux, 2011). Criterion and principle scores may range from 0 to 100. Based on the scores at principle level the farms were finally allocated to one of the following categories: 'Not classified', 'Acceptable', 'Enhanced' or 'Excellent' (Welfare Quality, 2009).

Finalisation of the score development (Welfare Quality, 2009) took place after the completion of data collection. This caused some mismatch between the available data and input necessary for the calculations. Since the score calculation does not tolerate missing values (Botreau et al., 2007), data had to be complemented using values that were expected to reflect the most likely condition (see Table 5).

Table 5: Approach used in case of missing data for the Welfare Quality score calculation.

Measure/Criterion	Missing information	Data handling	Based on consideration
Cleanliness of water points	In some cases, drinkers not visible (569 drinkers in 27 farms)	set to the score of the most prevalent state on farm	- inspection/ cleaning of water points mostly routinely done - almost no dirty drinkers on any farm
Expression of other behaviours	Access to pasture before fattening (e.g. < 200kg) not included in protocol at time of assessment (all farms)	set to zero	- partly unknown; most likely there was no pasturing before fattening period
Mild integument alterations	Hairless patches due to soiling of animals (55 farms)	set to zero	- overt swellings or lesions not likely to be overlooked
Mutilations such as disbudding or tail docking	Management routines on farms of origin unknown by the farmer (19 farms)	set to zero	- not influenced by the farmer
Ease of movement	Estimation of live weight in 100kg intervals not included in protocol at time of assessment (all farms)	set to 275kg or to 525kg	midpoint of the two weight classes (200-350kg and 350-700kg)

Statistics

The following linear mixed effects model was used in *R 2.13.1 (lme-function; www.r-project.org)* for the analysis of variance between treatment groups at WQ measure, criterion and principle level:

$y_{ijkl} = \mu + b_i + b_{ij} + \alpha_k + \beta_l + \alpha_k{:}\beta_l + \varepsilon_{ijkl}$

with intercept μ, the fixed effect „treatment" (factor with three levels F, FA and C) α_k, the fixed effect „assessment" (factor with two levels interim and final assessment) β_l, the interaction of the fixed effects $\alpha_k{:}\beta_l$, the random effect „farm" b_{ij} nested in „country" b_i and the residuals ε_{ijkl}.

Residuals were graphically checked for normal distribution and data were transformed where necessary using log, sqrt or asin-sqrt transformation. In the case of the criteria scores for 'Absence of prolonged hunger' and 'Absence of pain induced management procedures' normal distribution of residuals was not achieved and analysis of variance therefore omitted. P values were calculated based on the transformed data (if necessary) while the means given in the results section are based on the original data. For the overall score the proportions of farms in the four WQ welfare classification categories (Excellent, Enhanced, Acceptable and Not classified) were calculated and tested for differences between treatments using a Chi2 Test.

Results

Assessment at measure level

Regarding the measures subsumed under the principle of 'Good feeding', the median 'Prevalence of very lean animals' in the three assessments on all farms was zero with a maximum of seven percent. A 'Sufficient number of drinkers' was present in about 85% of the farms and about one third had 'Two drinkers per group available'.
Concerning the principle 'Good housing' it was found that the mean 'Prevalence of dirty animals' was 15% with a large variation among farms (0-72%). The mean 'Lying down duration' was around four seconds and the 'Space allowance per 700kg bull' was about 7m². Availability of an outdoor run was rare (n=7 farms) and within the farms with an outdoor run access was possible for 18% to 100% of the year.
In the principle 'Good health' measures such as 'Hampered respiration' and 'Bloated rumen' had prevalences below 1% and the occurrence of 'Coughs' was below 1 per 15 minutes. Measures such as 'Lameness', 'Diarrhoea', 'Severe skin alterations' and 'Mortality' showed prevalences of around 2%-4%, whilst the 'Percentage of animals with ocular or nasal discharge' was around 26% and 9%, respectively, with large differences between farms. The mean prevalence of 'Mild skin alterations' was about

20%. Around 56% of farms kept more than 15% of animals without horns. ‘Disbudding or dehorning’ was performed in the finishing unit on about 28% of the farms; in these farms 40 to 100% of the animals were without horns (Table 3). Tail docking was only rarely performed (six farms, max. 12% of animals).
In the principle ‘Appropriate behaviour’ the mean frequency of ‘agonistic’ and ‘cohesive behaviour’ was 2.6 and 2.4 interactions per animal and hour, respectively. The mean proportion of animals with an ‘Avoidance distance at feed rack’ greater than 100cm was 8.7%. On average 11.7% and 45.9% of the animals had an avoidance distance of 50-100cm and less than 50cm, respectively, whilst 33.7% of the animals could be touched. The ‘PC1’ for the ‘qualitative behaviour assessment’ was -0.5 on average but ranged from -4.8 to 4.8 across all farms and assessments. For further details please see Table 7.

Assessment at criterion, principle & classification level

Resulting from the low prevalence of very lean animals the scores for the ‘Absence of prolonged hunger’ criterion were rather high with an average of 93.6 points, whereas for ‘Absence of prolonged thirst’ farms reached on average 47.1 points (Table 8). This resulted in an average score of 50 for the principle of ‘Good feeding’ (range 19.6-100). For the principle ‘Good housing’ the average score was 61 points and farms ranged between 13.6 and 98.4 points. Higher scores were reached for the criterion ‘Comfort around resting’ (77.1) than for the criterion ‘Ease of movement’ with an average score of 56.9. For the principle ‘Good health’ the mean score was 49.7 (range 17-81.8) which resulted from ‘Absence of injuries’ and ‘Absence of diseases’ with mean scores of 69.1 and 40.7, respectively, and for ‘Absence of pain induced by management procedures’ farms reached on average a score of 88.5. ‘Appropriate behaviour’ was the principle with the lowest scores, ranging from 9.3 to 43.8 and an average of 24.3. This resulted from ‘Expression of social behaviour’ with a mean of 44, whilst scores for ‘Good human-animal relationship’ were on average higher with a mean of 67.3. The criterion ‘Expression of other behaviour’, represented by the measure ‘Access to pasture’ was zero in all cases. The ‘Positive emotional state’ of the animals on the farms was rated with an average score of 47.8.
32% of the farms were on average classified ‘Acceptable’ and 67% ‘Enhanced’, only one farm was classified ‘Excellent’. No farm was allocated to the ‘Not classified’ category at any assessment (Table 8).

Table 6: Detailed, selected results for mutilations at measure level for the initial and final assessment.

		1. Ass. *(min-max)*	3. Ass. *(min-max)*
Dehorning Disbudding	% of farms with more than 15% of dehorned/disbudded animals	57	56
	% of farms dehorning/disbudding animals on-farm	29	27
	Average % of animals dehorned/disbudded on these farms	87 (*40-100)*	95 (*50-100)*
	% farms where animals are disbudded	100	100
	% farms using thermo-cautering for disbudding	100	100
	% farms not using anaesthesia for disbudding	44	41
	% farms not using analgesia for disbudding	94	88
Taildocking	% of farms taildocking animals	6	5
	Average % of animals tail-docked on these farms	11 (*1-33)*	12 (*1-33)*
	% farms not using anaesthesia for tail-docking	75	100
	% farms not using analgesia for tail-docking	100	100

Next two pages:

Table 7: Results of the Welfare Quality® assessment for the initial, interim and final assessment (mean and range across all three assessments) as well as p values for the general linear mixed-effect models at measure level. Abbreviations for necessary data transformations were as follows: asin-sqrt: arcsine square root, sqrt: square root, log: logarithm

Table 8: Results of the Welfare Quality® assessment for the initial, interim and final assessment (mean and range across all three assessments) at criterion, principle and classification level as well as p values for the general linear mixed-effect models as well as for the Chi2-test (classification level).

			Mean			*Min-Max*	*GLMM – Effects 2.+3. Assessment*			
Principle	Criterion	**Measure**	1. Ass.	2. Ass.	3. Ass.	*Ø Ass. 1-3*	Trans formation	*Treat ment*	*Assess ment*	*Treatment x Assessment*
1. Good feeding	Absence of prolonged hunger	% of very lean animals	0.8	0.5	0.5	*0.0 - 7.0*		n.t.[1]		
	Absence of prolonged thirst	% groups with sufficient WP	85	83	85	*0.3 - 100*	log	0.017	ns	ns
		% of groups with dirty WP	0.0	0.0	0.0	*0.0 - 0.0*	-	n.t.[1]		
		% of groups with at least two WP	33	38	35	*0.0 - 100*	asin-sqrt	ns	ns	ns
2. Good housing	Comfort around resting	Duration of lying down movement (s)	4.00	3.92	4.00	*3.0 - 4.9*	sqrt	ns	0.016	ns
		% of dirty animals	14.6	15.1	15.1	*0.0 - 72.4*	asin-sqrt	ns	ns	ns
	Ease of movement	Space allowance in m²/700kg	7.10	7.12	7.28	*4.0 - 13.3*	-	ns	ns	ns
		% days/year (and hours/day**) of availability of outdoor loafing area (or pasture*)	7.96	7.46	7.04	*0.0 - 100.0*	-	n.t.[1]		
3. Good health	Absence of injuries	% of lame animals	2.3	1.8	1.8	*0.0 - 23.0*	sqrt	ns	ns	ns
		% of animals affected with mild and severe alterations	17.3	20.6	20.6	*2.0 - 59.9*	-	ns	ns	ns
			3.8	3.2	3.2	*0.0 - 14.0*	-	ns	ns	ns
	Absence of diseases	% of animals with nasal discharge	9.8	6.6	8.7	*1.5 - 36.7*	asin-sqrt	ns	0.015	ns
		% of animals with ocular discharge	29.8	32.7	26.4	*4.9 - 61.6*	-	n.t.[1]		
		Number of coughs per animal in 15 min	0.39	0.36	0.70	*0.11 – 1.37*	sqrt	ns	<0.001	ns
		% of animals with hampered respiration	0.6	0.7	0.6	*0.0 - 4.2*	asin-sqrt	ns	<0.001	ns
		% of animals with bloated rumen	0.3	0.1	0.1	*0.0 - 3.1*	-	n.t.[1]		
		% of animals with diarrhoea	2.2	4.7	3.2	*0.0 - 22.5*	asin-sqrt	ns	ns	ns
		% of dead animals during a year	4.0	4.0	3.9	*0.0 - 17.6*	-	n.t.[1]		
	Absence of pain induced by management procedures	Practice of procedures of disbudding/dehorning animals	Please see Table 3 for details				-	n.t.[1]		
		Practice of procedures of tail-docking animals	Please see Table 3 for details				-	n.t.[1]		
		Practice of procedures of castrating animals*	-	-	-	-	-	n.t.*		
4. Appropriate behaviour	Expression of social behaviours	Frequency of head butts, displacements, fights and chases per animal and hour	2.99	2.36	2.53	*0.6 - 6.1*	sqrt	ns	ns	ns
		Frequency of social horning and social licking/animal/hour	2.55	2.30	2.33	*0.6 - 5.1*	sqrt	ns	ns	0.031
	Expression of other behaviour	Access to pasture before fattening in months* % of days/year (and hours/day) on pasture during fattening*	0.00	0.00	0.00	*0.00*		n.t.*		
	Good animal-human-relationship	% of animals with an ADF of >100cm,	10.9	6.4	8.8	*0.0 - 64.7*	-	n.t.[1]	n.t.[1]	n.t.[1]
		50cm-100cm and	11.1	11.5	12.4	*0.0 - 31.1*	-	ns	0.003	ns
		<50cm but not be touched	47.5	45.2	45.2	*18.4 - 70.5*	-	ns	ns	ns
	Positive emotional state	PC1 (calculated using predefined weights and the terms assessed in the QBA)	-0.42	-0.61	-0.48	*-4.8 - 4.8*	-	ns	ns	ns

**not occurring in this dataset, **always 24h/day in this dataset, n.t.[1] not tested due to lack of fulfilment of model assumptions*

Criteria	Mean 1. Ass.	Mean 2. Ass.	Mean 3. Ass.	*Min-Max Ø Ass. 1-3*	*GLMM – Effects 2.+3. Assessment* *Treatment*	*Assessment*	*Treatment* Assessment*
Absence of prolonged hunger	90.2	94.1	96.5	*7.8 - 100.0*	*n.t.*[1]		
Absence of prolonged thirst	47.2	49.1	45.1	*20.0 - 100.0*	*n.t.*[1]		
Comfort around resting	77.0	77.5	76.8	*40.0 - 99.0*	*n.s.*	*n.s.*	*n.s.*
Ease of movement	58.0	55.1	57.7	*0.0 - 100.0*	*n.s.*	*n.s.*	*n.s.*
Absence of injuries	68.6	69.0	69.8	*34.8 - 82.2*	*n.s.*	*n.s.*	*n.s.*
Absence of disease	40.8	38.3	42.9	*0.0 - 81.0*	*n.s.*	*n.s.*	*n.s.*
Absence of pain induced by management procedures	88.3	88.0	89.3	*37.0 - 100.0*	*n.t.*[1]		
Expression of social behaviours	42.0	45.4	45.3	*4.9 - 70.3*	*n.s.*	*n.s.*	*n.s.*
Expression of other behaviour	0.0	0.0	0.0	*0.0 - 0.0*	*n.t.*[1]		
Good human-animal relationship	65.6	70.8	65.5	*16.5 - 96.9*	*n.s.*	*p = 0.001*	*n.s.*
Positive emotional state	48.3	47.0	48.4	*9.3 - 93.0*	*n.s.*	*n.s.*	*n.s.*

Principles	Average score 1. Ass.	Average score 2. Ass.	Average score 3. Ass.	*Min-Max Ø Ass. 1-3*	*Treatment*	*Assessment*	*Treatment* Assessment*
1. Good feeding	49.1	51.6	49.2	*19.6 – 100*	*n.s.*	*n.s.*	*n.s.*
2. Good housing	61.9	60.0	61.0	*13.6 – 98.4*	*n.s.*	*n.s.*	*n.s.*
3. Good health	49.9	48.1	51.2	*17.0 – 81.8*	*n.s.*	*p = 0.027*	*n.s.*
4. Appropriate behaviour	23.8	24.4	24.8	*9.3 – 43.8*	*n.s.*	*n.s.*	*n.s.*

Classification	Percentage farms 1. Ass.	Percentage farms 2. Ass.	Percentage farms 3. Ass.	Perc. farms *Ø Ass. 1-3*	*Treatment C Ass. 2+3*		*Treatment F Ass. 2+3*		*Treatment FA Ass. 2+3*	
Not classified	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Acceptable	32%	35%	29%	32%	52%	48%	33%	14%	19%	24%
Enhanced	65%	63%	71%	67%	43%	52%	67%	86%	81%	76%
Excellent	3%	2%	0%	2%	5%	0%	0%	0%	0%	0%
					*CHI² - Test Ass. 2+3**					
					n.s.		*n.s.*		*n.s.*	

** Chi2 tests were performed only for classifications 'Acceptable' and 'Enhanced' n.t.[1] not tested due to lack of fulfilment of model assumptions*

Influence of feedback/advice

20 farmers out of the FA treatment group (n=21) provided feedback on the degree of implementation of improvement measures recommended as a result of the initial assessment. Eight of the 20 farmers reported that they had applied one or several measures as suggested in the report and during the advisory meeting (Table 9).

Table 9: Advice reportedly adopted by the farmers of the FA group (interviews carried out after the final assessment)

Kind of adopted advice	adapting feeding	additional bowls/ drinkers	dehorning pre-farm	reducing stocking density	improving airflow	improving cleanliness in barn	total
Number of measures implemented	1	2	1	3	2	1	10

At the single welfare measure level no significant effects of the two treatments (F, FA) were found when comparing the interim and the final assessment (interaction treatment*assessment; Table 7) except for the 'Frequency of social horning and social licking/animal*hour' which in the final assessment was higher in the control farms (C) and lower in treatment group FA as compared to the interim assessment; it remained rather constant for F farms. The model calculation at criterion and the principle level didn't show any interaction effect of the treatment (F or FA) and the date of assessment (2nd and 3rd).

For the level of classification there was no significant difference regarding the percentage of farms having been classified 'acceptable' resp. 'enhanced' at the 2nd and 3rd assessment. Numerically, only little changes in percentage of farms allocated to the different categories took place for the control (C) and Feedback & Advice (FA) farms, but the proportion of F farms in the category 'Enhanced' increased from 67 to 86% at the third assessment (86%, Table 8).

Discussion

State of animal welfare on the project farms at measure and criterion level:

This is to our knowledge the first on-farm study in fattening cattle using a comprehensive multi-criterion welfare assessment system. Comparison with data from the literature is therefore limited and often restricted to the use of information from experimental studies where applicable.

Regarding the criterion 'Absence of prolonged hunger' within the principle 'Good feeding', in most farms no or only single animals were scored as being very lean. In beef farms, very lean animals most likely are chronically ill or may be socially subordinate with insufficient access to feed if for example feeding space is limited. Taking expert opinion according to WQ into account (Botreau et al., 2007; Welfare Quality, 2009) the average criterion score was close to the optimum (94 points of 100).

However, in some farms substantial percentages of animals were judged of having poor body condition. Average criterion scores for 'Absence of prolonged thirst' were much lower (47/ 100), which was mainly due to the lack of a second drinker (in 60% of the pens) whilst cleanliness of drinkers was less of a problem.

The average lying down duration of about 4 s is in agreement with Brörkens et al. (2009), who also investigated behaviour around resting in fattening bulls on deep litter (including sloped floor) systems. Absmanner et al. (2009) compared behaviour associated with lying comfort on different floor types and found a slightly higher lying down duration on straw bedding than in this study (5.3 s), but nevertheless significantly shorter than in pens with concrete slats. The variation at farm level (3.0 to 4.9 s) may result from the softness of the lying area or the ability of the animals to perform undisturbed movements, e.g. depending on the stocking density or the size of the actual available lying area. The second measure of the criterion 'Comfort around resting' refers to the cleanliness of the animals. Although on average 15% of the animals were judged dirty, this ranged from 0% to more then 70%. Cleanliness of fattening cattle has been used in other studies (Tessitore et al., 2009, Schulze Westerath et al., 2007) but data cannot be directly compared due to methodological differences. Together the 'comfort around resting' criterion never scored below 40 points and low scores were mainly caused by high prevalence of dirty animals.

The criterion scores for 'Ease of movement' showed the largest and maximum possible range (0 to 100) which resulted mainly from a large variation between farms with regard to space allowance per bull and the fact that only few farms provided access to an outdoor run. The alternative housing systems with straw or at least rubber mats as lying area provided in general a higher space allowance (about 7m²/700kg bull) than in systems with fully slatted concrete floors (e.g. 2.4-2.7m²/bull if lighter than 450kg or 2.7-3.2 m² for bulls heavier than 450kg (Absmanner et al., 2009; data for Austria) or less than 3.5m²/bull in around 80% of farms in Italy (Gottardo et al., 2009)). Space allowance in this study is only a rough estimate since it is not based on true weights of the animals per pen but rather on an assumed average weight. Nonetheless three farms in this study achieved very low scores of 0 to 10 points (including not having access to an outdoor loafing area) although the space allowance as calculated in the WQ protocol was about 4m^2 per animal with 700 kg liveweight thus being close to the recommended space allowance of 4.4m^2 (Bartussek et al., 1996) to 5m^2 (SCAHAW, 2001).

As for cleanliness, lesion scoring in the present study differed from other studies e.g. with regard to assessed body regions or type and size of lesions considered making comparisons difficult (Platz et al., 2007; Schrader et al., 2001; Schulze Westerath et al., 2007 & 2009b). Results may however be seen in the light of the expert-opinion derived WQ thresholds (Welfare Quality, 2009). The average criterion score for

‘Absence of injuries’ was about 70. This rather high score was mainly determined by the low average lameness prevalence of 1.8%, while on average 20% and 3% of animals with mild and severe lesions, respectively, were regarded more of a problem according to the WQ scoring.

For criterion ‘Absence of disease’ the lowest average score within the principle ‘Good Health’ was obtained. So-called ‘warning’ and ‘alarm’ thresholds are used for the calculation of scores of the criterion. On average farms in this study stayed under the warning level for the measures ‘Coughing’, ‘Hampered respiration’, ‘Bloated rumen’ and ‘Diarrhoea’. Nevertheless warning thresholds were exceeded for ‘Nasal discharge’ (> 5% animals affected animals) and ‘Mortality’ (> 2%). The only measure exceeding the alarm threshold of 6% was ‘Ocular discharge’.

Farms achieved rather high scores of about 88 points regarding the criterion ‘Absence of pain induced by management procedures’. This partly origins from the fact that only entire male were kept and rarely tail-docked, probably due to the soft bedding in the alternative housings systems. About 43% of farms kept indeed 85-100% horned animals, which leads for these farms to 100 points according to the WQ scoring system. Furthermore, one third of farms in this dataset bought in already dehorned calves and didn’t carry out the disbudding procedure themselves. Since we were not able to trace back the disbudding procedure on the farm of origin, these farms also achieved the maximum score although they housed up to 100% of disbudded cattle. The pursued method to only include mutilations if taking place on-farm and/or known by the farmer can of course be questioned. A solution to deal with this issue would be to assume for these farms the most likely performed procedure in the country of origin (Oliver Angels, 2009). This approach would however require solid differentiation between dehorned and polled bulls to not overestimate the prevalence of disbudded animals.

The principle ‘Appropriate behaviour’ comprises the criteria ‘Expression of social behaviours’, ‘Expression of other behaviour’, Good human-animal relationship’ and ‘Positive emotional state’. The average incidence of agonistic behaviours in this study (head butts, displacements, fights and chases) was 2.5 events per animal and hour with a range of 0.6 to 5.1 interactions/bull*hour. This is lower than the mean incidence of agonistic behaviours reported in Laister et al. (2009), using comparable definitions for the behavioural measures (4.8 agonistic interactions per animal and hour); however, 50% of the beef bull herds (200 - >550kg) in Laister et al.’s study had been kept in fully slatted floor systems. On the other hand, Platz et al. (2007) using video recordings found about 1.3 agonistic interactions per hour in an experiment with rubber choice pens for 12-15 months old bulls. Differences between studies may also origin from deviant definitions of behaviours, housing facilities or other conditions. Regarding cohesive behaviours, mean incidence in the present study was rather high with 2.3

events per animal and hour. Using the same definitions, Schulze Westerath et al. (2009a) observed a mean of 0.93 events per animal and hour for cohesive behaviours when testing reliability of socio-positive behaviour in different housing systems. With 0.33 events of cohesive behaviour per bull and hour incidence was even lower in an Italian study comparing different floor types (Tessitore et al., 2009). The expert derived scores for the criterion 'Expression of social behaviour' were only moderate with about 42 points and even the best farm only reached 70 points.

The criterion 'Expression of other behaviours', representing the access to pasture before and during fattening, was set to zero points in our calculation because the data obtained did not comprise information on the pre-fattening pasture experience of the animals for the whole dataset. However, the percentage of days spent on pasture during fattening has the strongest impact on the score calculation. Not providing access to pasture in any of the farms in this study, all farms would have received the lowest score possible, independent of the origin of the calves. This means that farms buying animals from mother-suckler herds older than three months do not achieve better scores than farms purchasing artificially raised calves from dairy herds. Systems benefiting from the approach for score calculation would only be pasture-based fattening systems for steers such as prevalent in Ireland and France (SCHAW, 2001) or as described for organic beef in Denmark (Nielsen & Thamsborg, 2005).

Average scores for the criterion 'Good human-animal relationship' (67 points) were substantially higher indicating that the average situation was judged as not representing a welfare concern. In the present study on average one third of the bulls could be touched but nearly half of the animals (45.2%) withdraw from the assessor only within 0.5m. This is in the same order of magnitude as described for Austrian beef farms (Windschnurer et al., 2009) with nearly the half of animals allowing to be touched (46.2%) and an ADF smaller or equal than 0.2m in 21.5% animals. However, there was also a large variation between farms in the 'Avoidance distance at the feed rack' (ADF) measure, especially regarding the proportion of animals with a high avoidance distance (>100cm). Rather high proportions in this category were mainly found in Italian farms in this study for which the assessor also reported that animals tended to be comparably shy. This is backed up by another study on Italian beef bull farms (Tessitore et al., 2009), where the average ADF of 75cm was about double the avoidance distance in the present study (36 cm, data not shown). For the ADF measure, a country effect may play a role which might be caused by pre-farm experiences of the animals (e.g. animals in Italy bought-in at an older age and from different countries than in Austria, where only animals born in the country are kept), or according to Tessitore et al. (2009) by other factors such as pen shape or special management procedures. The number of pen-mates may also have an effect (Waiblinger et al., 2003), but was not further explored in the present study.

For the criterion ‘Positive emotional state’ a principal component score originating from Qualitative Behaviour Assessment (Wemelsfelder et al., 2009; Wemelsfelder & Lawrence, 2001) is used. This innovative measure is relatively new and ascribes the mood of the animals using a pre-defined list with fixed terms. It has not been used in the on-farm assessment context before and therefore no comparable data were found in the literature. The average criterion score of 48 indicates a somewhat neutral average situation, in terms of emotional state, however, the range was rather large.

State of animal welfare on the project farms at principle and classification level:
The principle scores show that the farms achieved on average slightly more than 50% of the possible points for the principles ‘Good Feeding’, ‘Good housing’ and ‘Good Health’. Regarding the principle ‘Appropriate behaviour’, only about a quarter of the maximum points were reached on average. Given the presumably welfare-friendly housing systems in this study with increased space allowance as compared to intensive fully-slatted floor systems and bedding, the latter was to some extent not expected. The rather low average scores resulted on the one hand from the lack of access to pasture in all farms (criterion ‘Expression of other behaviour’) but also from only moderate scores for the level of social interactions (criterion ’Expression of social behaviour) and ‘Positive emotional state’. This may be due to either rather strict expert opinion derived thresholds and weighting factors which fed into the score calculation (Botreau et al., 2007). On the other hand an in-depth analysis of factors influencing the incidence of social behaviours in the present dataset did not reveal any effect of e.g. space allowance (Schulze Westerath et al., 2009c). This indicates that either a beneficial effect of increased space allowance had not yet been reached within the range found on the project farms or other factors which are not necessarily linked with the alternative housing systems have a major impact on social behaviour incidence.
The classification results point out that two thirds of the farms were still classified as ‘Enhanced’ and one third as ‘Acceptable’. This rather good overall classification may also reflect, that development of the WQ scoring system also involved stakeholders (Botreau et al., 2007) and it was one aim to design a classification procedure that considers what can realistically be achieved in practice (Welfare Quality, 2009). However, at the same time at all levels investigated our results show that there is room for improvements. This becomes especially evident when looking at the range for the single measures and aggregated scores. It also underlines that welfare concerns expressed in the report on ‘The Welfare of Cattle kept for Beef Production’ (SCAHAW, 2001) are still valid as recently also pointed out in a review about currently used flooring systems in bull farming (Wechsler, 2011).
To our knowledge the full WQ protocol for fattening cattle was applied for the first time on a larger scale in this study including calculation of scores. A related study using

partly different measures and criteria on 102 beef farms in Italy with bulls housed in group pens either on slatted floor or deep bedding (Gottardo et al., 2009) concluded that around 70% of the farms had ‘good welfare’ levels whereas 30% had ‘poor welfare’ mainly resulting from poor stockmanship. Therefore also this Italian study revealed room for improvement on the overall classification level.

Impact of the feedback:

Due to the fact that the farmers involved in the study ran alternative housing systems we assumed that they were highly interested in animal welfare and would therefore in principle be motivated to implement changes in order to improve animal welfare. Although they stated interest in advice to improve animal welfare beforehand and willingness to implement changes in housing and management (Chapter 2) the number of actually adopted advices was rather low. Although the animal welfare assessment provided some scope for improvements on all farms, only about one out of the suggested measures was implemented on one third of the FA farms. This may be one reason why there was nearly no significant effect of treatments (F, FA and C) on any of levels (from single measures to principle scores). It is less likely due to the excellent welfare state before measures were discussed. The only significant effect was found for the incidence of cohesive social behaviours which increased in the control farms during the implementation period. The reasons for this remain unclear. It might have had an impact that during the study also a few of the control farmers implemented management changes to a similar extent as the other farmers. This may have been the case because changes can generally be expected over time, or because being part of a study alerted them to certain welfare concerns independent of any feedback (which they didn’t get). According to Leach et al. (2010) internal motivating factors like ‘pride in a healthy herd’ or a ‘good public image’ where at least ‘important’ influencing factors to improve lameness in UK dairy herds. The importance of these intrinsic factors is underlined by a study of Valeeva et al. (2007) on the relative importance of factors improving mastitis management in two different scenarios. For the majority of Dutch dairy cattle farmers ‘job satisfaction’ had the most important impact on their own decision making and this was discussed as equally ranked with economic motivation. Correspondingly, the control group farmers in this study might have been motivated to ensure good results of their farms without an ‘implementation’ from the researcher’s side for their own satisfaction. However, the motivational background to implement (or not) changes on farm for improving animal welfare deserves further research.

A more obvious factor for the absence of substantial changes in management and housing on the farms possibly leading to improved welfare measures could be a lack of time for implementing measures due to the time-scale of the study. The monitoring

period from the interim visit to the final assessment lasted for only about six months and since this period included large parts of summer and/or autumn farmers likely focussed more on crop and forage production tasks such as harvesting crops, making silage. Furthermore, even for measures implemented at an early stage, the period of six months can be regarded rather short to be effective in terms of welfare improvement. Also in dairy cattle significant improvements were not achieved during a nine months period after implementation of 'animal health and welfare plans' in organic dairy herds (Gratzer, 2011) or during a twelve months programme on dairy heifer lameness (Bell et al., 2009). However, studies using longer monitoring periods found significant effects, e.g. more pronounced udder health improvement in the second year of data analysis in Swiss dairy cattle (Ivemeyer et al., 2009), or Brinkmann & March (2011) regarding lameness reduction in German dairy herds. Also Ivemeyer et al. (2009) state that long-term management factors often might take longer than one year to be implemented or are associated with high investment (e.g. rebuilding of the stable). For most of the measures in the WQ protocol it is still unknown how much change in housing or management is needed to influence incidences/prevalences significantly or in which time span this is possible. As it is the nature of some measures to picture effects of long-term welfare states and influences there might have been a delay in becoming improvements apparent which exceeded the 6months period of the study. Another important aspect is the fact that bull fattening with an age at slaughter of about 16 to 18 months is a rather long-term business. This means that in all-in-all-out systems as well as in (semi-)continuous production systems certain newly adopted measures can only be implemented following a long-term strategy and that it takes the length of a full production cycle in order to become effective for the whole herd. E.g. omission of tail-docking in bought-in bulls will only affect only one third of the animals present in the farm after 6 months. This would not be sufficient to achieve a better welfare score with regard to the 'Absence of pain induced by management procedures' criterion, because two thirds of the animals still underwent the surgery. A similar factor that influences several scores of the protocol is the stocking density per pen, but reducing stock density in an ongoing fattening cycle is nearly impossible for logistic reasons. Even if space would be available, regrouping of animals in bull fattening should be avoided in order to prevent agonistic interactions and stress (Gupta, 2007; Mounier, 2006). In conclusion it is therefore likely that the observation period was too short for expecting considerable changes towards an improved welfare state, especially at criteria and principle level where scores are rather conservative and robust against deviations of single measures (Botreau et al., 2007).

Another reason why proposed improvements might have stayed unimplemented could have been the financial barrier for needed investments. Measures like the use of more bedding material in regions where straw has to be bought in or the reduction stocking

density (in most cases by keeping one bull less per pen) affect farm economics. There was no financial compensation of such expenses possible in the course of the project and therefore farmers might have implemented only advices that did not (directly) affect farm economics. However, the availability of incentives alone is not necessarily effective. In a study of Bell et al. (2009) a HACCP concept for lameness in UK heifers was implemented without positive effect although participating farmers could get investments reimbursed in the range of 500 to 1000 British Pounds. In the present study, a good result in the project also did not result in a (better) WQ-certification of the farm and therefore lead to a better market access or prices, because such a bonus system or labelling has yet not been implemented in the project countries. This limits possibilities for improvements if farmers belong to a 'reward-seeking' group as described for Finish pig and dairy farmers by Kauppinen et al. (2010), who investigated factors and attitudes that have potential to induce changes in farmer's behaviour towards improving animal welfare. 'Empathic', intrinsically motivated farmers form a second group, who does not necessarily require external incentives in order to aim at welfare improvement. According to the comments on perceived advantages of WQ in the questionnaire study (Chapter 2) it can be concluded that both types of farmers took part in the present project: increasing profit or personal benefits (i.e. reward-seeking) as well as improving farm animals' health and welfare (i.e. empathic) were mentioned as main motivations. Due to the lack of financial incentives in this project, we probably targeted only the empathic and intrinsically motivated farmers who only implemented a low number of measures which together with the short study period did not lead to a significant improve in welfare. However, this cannot finally be proven by our data.

Conclusions:

Although presumably animal-friendly housing systems were included in the study, based on the Welfare Quality® assessment system potential for welfare improvement was identified. Farms which had received a written report or a report plus advice on potential improvement measures did not show changes in the welfare state after a 6-months implementation period, but final conclusions would most likely require longer observation periods. Ways on how to feed back results of animal-based assessments and to integrate with advice also require further investigation.

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4. Consistency over time of single and aggregated on-farm measures of animal welfare for fattening cattle

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Abstract

Besides validity and feasibility, reliability forms an important feature of (on-farm) animal welfare assessment systems. Consistency over time is a special form of reliability meaning that results of the assessment should be representative of the longer-term farm as long as the housing and management conditions have not changed considerably. This is especially important if assessments should be used for certification purposes. Consistency over time has only rarely been investigated and to our knowledge never at the level of aggregated welfare scores. It was therefore the aim of the present study to investigate consistency over time for the single measures used in the Welfare Quality® (WQ) protocol for fattening cattle as well as for the aggregated criterion and principle scores across short (1 month) and longer-term periods (6 months). It was hypothesized that the aggregated criteria and principle scores show a better consistency over time than the single measures. Furthermore, consistency was expected to be lower with longer intervals between assessments.

Data were gathered during three visits (months 0, 1 and 7) on in total 63 beef farms in Austria, Germany and Italy. Data collection followed the WQ protocol and was performed by three well-trained assessors. Calculation of measures as well as criterion and principle scores was performed according to the WQ protocol for fattening cattle. Only data from farms where no major changes in housing and management had taken place were considered for analysis. Consistency was judged as acceptable if the WQ measures, criteria and principles showed a Spearman rank correlation coefficient greater than 0.7 between visits and showed a lower variance within than between farms. At the level of overall welfare categorisation the percentage agreement of the overall welfare classification was used. Consistency was generally better for the short interval than for visits after a longer period. Results at the measure level showed largely poor consistency with six and two out of 20 measures meeting the above mentioned requirements for repeated visits after one month and after 6 months,

respectively. As expected, resource-based measures were more consistent than animal-based ones. However, there was no clear difference between health and behavioural measures. Consistency improved with aggregation of single parameters. At criterion level, scores for five and two out of 12 criteria were considered consistent and at WQ principle level this was the case for three and one out of four principles, respectively. 79% and 75% of the farms were allocated to the same overall welfare category, respectively. Potential reasons for the partial inconsistency of the measures may be seen in the spontaneous and most likely short-term fluctuations of measures that occur under normal farm conditions, low prevalences of clinical measures and probably insufficient sample size. At criterion and principle level, aggregation of information into scores appears to smooth undirected variation at the single measure level. Even if less consistent across longer time periods results at measure level still appear suitable for feedback to the farmer due to the immediate context to the current farm situation. To deal with consistency issues over time at criterion, principle and consequently the classification level, the use of rolling averages may be considered. Further long-term studies are recommended to overcome problems with longer periods between assessments and understand more about the common influences on consistency over time that exist on farm.

Introduction

Validity, feasibility and reliability are central criteria for the selection of measures for (on-farm) welfare assessment (Waiblinger et al., 2001). Validity can be defined as the extent to which measures actually measure what they are supposed to, i.e. the meaningfulness in terms of providing information on the welfare of animals (Knierim and Winckler, 2009). Feasibility describes whether the measures may be applied under given (on-farm) conditions (Bracke et al., 2005). With regard to reliability, several aspects have to be taken into account. Inter-observer reliability refers to the agreement of two or more observers assessing the same animals in the same situation. Intra-observer reliability means that the same observer reaches similar results when repeatedly assessing e.g. video-clips or pictures. Test-retest reliability indicates that repeated tests with the same subjects reveal similar data (Windschnurer et al, 2009)

A special case of test-retest reliability is the consistency of outcomes over time (COT). It has been investigated in behavioural studies (reviewed in Bell et al., 2009), e.g. for ‘behavioural traits’ (Kralj-Fišer et al., 2007; Spoolder et al., 1996), but to our knowledge this was less the case for animal-based parameters of animal welfare assessment at farm level. COT is especially important if assessments are intended to be used for certification purposes, meaning that

results should be representative of the longer-term farm situation and not too sensitive to changes in the farming conditions or the internal states of the animals as long as the situation has not changed significantly. High levels of consistency have therefore been regarded essential for on-farm welfare measures and assessment systems (Capdeville & Vessier, 2001; Winckler et al, 2007). They will ensure fairness for the farmer and credibility of the system (Knierim & Winckler, 2009; Sørensen & Fraser, 2010); similarly, beef farmers were concerned of large day-to-day variation of on-farm measures, which may lead to a random classification of welfare state (Chapter 3). At the same time, an on-farm measure should be sensitive enough to detect variations in welfare state within farms.

An additional value of COT could be the reduction of recording costs due to less farm visits necessary. Indicators that do not change significantly over a long period of time if farm conditions remain constant do not require frequently repeated visits in order to obtain reliable estimates but the decision to reassess farms may then be based on the desired interval for the detection of actual changes in animal welfare. On the other hand, COT may be less important if the results of the welfare assessment are used for advisory purposes. In many cases repeated visits will be carried out in the course of advisory activities thus allowing for a more continuous monitoring of the on-farm situation and informed decisions on the most prevalent welfare problems on a given farm.

Studies on consistency of both animal and resource based (on-farm) measures of animal welfare are generally rare (Sundrum & Rubelowski, 2001). For dairy cattle investigations on the correlation of selected animal-related welfare parameters between consecutive farm visits were done by Winckler et al. (2007) and were found to be moderate to good consistent with regard to lameness incidence, skin lesions at the tarsal joint and avoidance distance. Nevertheless measures for social behaviour and cleanliness showed high variability. For fattening cattle, to our knowledge this question has only been addressed in the course of the Welfare Quality® project. One of the central aims of Welfare Quality® was to develop on-farm welfare assessment systems that focus primarily on animal-based measures and that are scientifically sound and feasible (Blokhuis et al., 2003). The assessment protocols which have been developed for several animal species and categories aim at providing feedback to farm managers on the welfare state of their animals and at translating this information into understandable information for consumers, e.g. for labelling purposes. Following the multidimensional concept of animal welfare, the protocols comprise several animal-based welfare parameters, but also design and management criteria (Blokhuis, 2008; Botreau et al., 2007, Chapter 3). The protocol for fattening cattle is based on 27 measures (Welfare Quality® protocol, 2009). This

information is than integrated into so called criterion and principle scores finally leading to an overall classification.
The development of the protocol for fattening cattle also included some work on COT at the measure level. Focussing on behavioural measures such as behaviours around resting (e.g. time needed to lie down; Brörkens et al, 2009) or agonistic or socio-positive interactions (Laister et al, 2009; Schulze Westerath et al., 2009), data from repeated visits in beef bull farms (approximately 2 and 6 months apart) were analysed. Measures were only suggested for the protocol if correlations between farm visits were higher than 0.7 and variance within farms was lower then variance between farms, respectively. However, not all measures finally included in the protocol were tested for consistency over time and such studies have not at all been carried out at the level of criterion and principle scores. The latter becomes even more important in terms of credibility of the welfare judgement and has been regarded an important task and perspective for further investigations (Knierim & Winckler, 2009).
It was therefore the aim of the present study to investigate consistency over time for the single measures used in the Welfare Quality® protocol for fattening cattle as well as for the aggregated criterion and principle scores across short (1 month) and longer-term periods (6 months). It was hypothesized that the aggregated criteria and principle scores show a better consistency over time than the single measures. Furthermore, consistency was expected to be lower with longer intervals between assessments.

Materials and Methods

Data collection was carried out on in total 63 bull fattening farms with alternative housing systems, i.e. with straw bedded lying areas or cubicles with rubber mats. The farms were located in Austria (n=21), Germany (n=21) and Italy (n=21). The average number of animals ranged between 102 (Austria) and 233 (Italy). For further description of the farms see also Chapter 3.
Three assessments were performed on each farm. About one month after the initial assessment an interim assessment was carried out and the final assessment took place about six months after the interim assessment. All assessments followed the Welfare Quality® assessment protocol for fattening cattle (Welfare Quality, 2009) and were performed by three trained assessors (one per country) who had reached at least satisfying inter-observer agreement (>0.7 Kendall's coefficient of concordance).
All measures, criterion and principle scores were calculated for each farm and assessment as described in the Welfare Quality® protocol (Welfare Quality, 2009) using updated formulas and coefficients (Champciaux, 2011).

Statistics

Three methods were used to assess consistency of results over time: First, Spearman's rank correlations between the initial and interim assessment and the interim and final assessment were calculated for measures, criteria and principles. Second, a comparison of variance explained by the (random) factor farm and the residuals was carried out at the level of measures, criteria and principles, based on the following linear mixed effects model that analysed the effect of assessment and country and compared initial and interim assessment as well as interim and final assessment:

$y_{ijkl} = \mu + b_i + \alpha_k + \beta_l + \varepsilon_{ijkl}$,

with the intercept μ, the fixed effects αk, assessment (factor with two levels: initial or interim assessment and interim or final assessment, respectively), βl, country (factor with three levels: AT, DE and IT) and the random effects bi, farm. All models were computed using R 2.13.1 (www.r-project.org).

Consistency of measures, criteria scores and principle scores was judged as acceptable if correlation coefficients were equal or higher than 0.7 (Martin & Bateson, 2007) and if the variance explained by the random factor (= variance between farms) was greater than the variance of the residuals describing the within-farm variance.

For modelling the effect at the level of measures, data and residuals were analyzed for normal distribution and measures transformed as necessary (for transformations at measures level see Chapter 3). Positive findings for some of the clinical measures such as 'Bloated rumen', 'Hampered respiration' or 'Diarrhoea' were too rare for statistical analysis.

For the criterion scores for 'Absence of prolonged hunger', 'Absence of prolonged thirst ', 'Absence of pain induced management procedures' and 'Expression of other behaviour' normal distribution of residuals could not be achieved through transformation. They were therefore not further considered in analysis of variance. All other criteria and principle scores fulfilled assumptions of normal distribution of the residuals without transformation.

In order to investigate consistency only in farms that provided rather stable conditions for the animals, farms that showed major deviations throughout the studying period were excluded from the calculations. 'Major deviations' were defined as alterations of resources or management exceeding changes that can be commonly expected over time. Examples for such management changes are 'substantial increase in amount of litter used', 'increased number of animals

bought in' or 'switch to TMR feeding'. Classification of farms as having experienced 'major deviations' was done by the single assessors. Due to 'major deviations' compared to the other assessments on the farms, in total 16 (AT: 9, DE: 5, IT: 2) out of the 189 assessments had to be excluded from statistical analysis. Therefore, for the period between initial and interim assessments 59 farms and for the period between interim and final assessments 48 farms were considered in the analysis.

Finally, the percentage agreement regarding overall welfare classification between the initial and interim, interim and final as well as initial and final assessment was determined for those farms which had not undergone substantial changes as described above throughout the study period (n=48). Therefore the overall classification level the proportions of the farms in the four Welfare Quality® welfare classification categories (Excellent, Enhanced, Acceptable and Not classified) were determined.

Results

Consistency of results over time at measure, criterion and principle level:
Regarding the one month period between the initial and interim assessment six measures showed both higher variance between than within farms and correlations exceeded the threshold of 0.7 (Table 10). These measures were both resource-based (percentage of groups with sufficient water points' (r_S =0.95), 'percentage of groups with at least two water points (r_S =0.94), space allowance (r_S =0.84)) and animal-based (duration of lying down movements (r_S =0.70), percentage of animals with ocular discharge (r_S =0.73), frequency of agonistic interactions (r_S =0.74); all p<0.001). Measures not fulfilling both COT criteria at least matched the criterion regarding the ratio of variance within and between farms except for 'frequency of social horning and social licking/animal/hour' and the 'percentage of animals with an avoidance distance of 50cm-100cm' (Table 10). Correlations between the two assessments varied largely and ranked from 0.03-0.68.
Over the six months period between the interim and final assessment, only two measures of provision of water showed similar measures of consistency (rS =0.91; rS =0.94; p<0.001), whereas all other measures were not satisfactory in at least one criterion. Greater between than within farm variance was determined only for measures belonging to the principle 'Appropriate behaviour' (ADF partly and QBA); however, correlation coefficients ranged from 0.47-0.67.
At criterion level the four criteria 'Comfort around resting' (rS =0.70; p), 'Ease of movement' (rS =0.73), 'Absence of disease' (rS =0.76) and 'Expression of social behaviours' (rS =0.78) showed larger variance between than within farms and

additionally correlations between initial and interim assessment were above the threshold of 0.70 (rs= 0.70 to 0.78; p<0.001). Acceptable COT was partially reached only by three criteria regarding the comparison of between and within farm variance ('Absence of injuries', 'Good human-animal relationship' and 'Positive emotional state'); correlations ranged from 0.57 to 0.68. In the six months period between interim and final assessment two criteria were judged as having good COT: 'Ease of movement' (r_S =0.70) and 'Good human-animal relationship' ('Good HAR') (r_S =0.72) (Table 11). The variance-criterion was fulfilled only by two other welfare criteria that reached only 0.53 for the spearman rank correlation: 'Ease of movement' and 'Good human-animal relationship'.
All principle scores showed smaller variance within farm than between farms. However, correlations were above threshold for only three principles (Good feeding: r_S =0.72, Good housing r_S =0.79 and Good health r_S =0.82; all p<0.001) in the initial to interim period. This was only the case for one principle in the second period (Good feeding; r_S =0.74, p<0.001) (Table 12).

Consistency of results over time concerning the overall welfare classification

The percentage agreement regarding farms with the same welfare classification in the initial and interim assessment was 79% and between the interim and the final assessment 75%. 65% of farms achieved the same classification in the first and the last assessment. Farms which did not maintain the same classification mostly changed by one classification level and improved and changed for the worse in approximately equal shares (Table 13).

Next two pages:

Table 10: Consistency of the welfare measures from initial to interim assessment and interim to final assessment of the farms without "major deviations" as correlations between the welfare measures (rs), as effect of assessment and/or country on the welfare measure and the comparison of the variance within and between farms.

Table 11: Consistency of the welfare criteria from initial to interim assessment and interim to final assessment of the farms without "major deviations" as correlations between the welfare criteria (rs), as effect of assessment and/or country on the welfare measure and the comparison of the variance within and between farms.

Criteria	Measure	initial to interim assessment				interim to final assessment			
		r_S[a]	effect of assessment and country[b]	variance within farm < between farms[c]	n	r_S[a]	effect of assessment and country[b]	variance within farm < between farms[c]	n
Absence of prolonged hunger	% of very lean animals	0.29*	rare → n.t		59	0.68***	rare → n.t		49
Absence of prolonged thirst	**% groups with sufficient water points(WP)**	**0.95*** **	CO	**yes**	59	**0.91*** **	CO	**yes**	49
	% of groups with dirty WP	rare	n.t.			rare	n.t		
	% of groups with at least two WP	**0.94*** **	n.s.	**yes**	59	**0.94*** **	n.s.	**yes**	49
Comfort around resting	**Duration of lying down**	**0.70*** **	CO	**yes**	55	0.45**	ASS, CO	no	42
	% of dirty animals	0.74***	CO	no	59	0.47***	CO	no	49
Ease of movement	**Space allowance in m²/700kg**	**0.80*** **	n.s.	**yes**	59	0.52***	n.s.	no	49
	% days/year (and hours/day**) of availability of outdoor loafing area (or pasture*) (OLA)	rare	rare → n.t			rare	n.t		
Absence of injuries	% of lame animals	0.36**	CO	yes	59	0.39**	CO	no	49
	% of animals with mild and severe alterations	rare	rare → n.t			rare	rare → n.t		
Absence of diseases	% of animals with nasal discharge	0.48***	ASS, CO	yes	59	0.15	ASS	no	49
	% of animals with ocular discharge	**0.73*** **	ASS, CO	**yes**	59	0.69***	ASS, CO	no	49
	% of animals with hampered respiration	0.03	n.t		59	0.19	n.t		49
	Number of coughs per animal and 15mins	0.55***	n.s.	yes	59	0.27	ASS	no	49
	% of animals with bloated rumen	rare	n.t		59	rare	n.t		49
	% of animals with diarrhoea	0.43***	n.t		59	0.63***	n.t		49
	% of dead animals during a year	rare	n.t		59	rare	n.t		49
Absence of pain induced by management procedures	Practice of procedures and % of disbudded/dehorned animals	rare	n.t			rare	n.t		
	Practice of procedures and % of tail-docked animals	rare	n.t			rare	n.t		
Expression of social behaviours	**Frequency of head butts, displacements, fights and chases per animal and hour**	**0.74*** **	ASS, CO	**yes**	59	0.48***	CO	no	49
	Frequency of social horning and social licking/animal/hour	0.55***	n.s.	no	59	0.51***	n.s.	no	49
Expression of other behaviour	Access to pasture before fattening in months, % of days/year on pasture during fattening*	not occurring→ n.t.				not occurring→ n.t.			
Good animal-human-relationship	% of animals with an ADF of >100cm,	0.46	ASS CO	yes	59	0.55***	ASS	yes	49
	% of animals with an ADF 50cm-100cm	0.29*	n.s.	no	59	0.67***	ASS CO	yes	49
	% of animals with an ADF <50cm but not be touched	0.54***	CO	yes	59	0.47***	CO	no	49
Positive emotional state	PC1 calculated using the terms assessed in the QBA	0.68***	n.s.	yes	59	0.53***	n.s.	yes	49

[a]: Spearman's correlation coefficient r_S. ***: p<0.001. **: p<0.01 *: p<0.05; [b]: significant effect of assessment (ASS) and country (CO); n.s.: not significant, n.t.: test not conducted due to non-fulfilment of model assumptions (no variance; no normal distribution achievable); [c]: yes: variance within farms smaller than between farms (→ consistency acceptable); no: variance within farms not smaller than between farms (→ consistency not acceptable); n.t.: no test conducted due to non-fulfilment of model assumptions

Measures		Criteria	Initial to interim assessment				Interim to final assessment			
			r_S[a]	effect of assessment and country[b]	variance within farm < between farms[c]	n	r_S[a]	effect of assessment and country[b]	variance within farm < between farms[c]	n
% of very lean animals		Absence of prolonged hunger	0.27*	n.t.	n.t.	59	0.68***	n.t.	n.t.	49
% groups with sufficient WP % of groups with dirty WP % of groups with at least two WP	Decision tree for scoring	Absence of prolonged thirst	0.67***	n.t.	n.t.	59	0.73***	n.t.	n.t.	49
Duration of lying down % of dirty animals		**Comfort around resting**	**0.70*** **	COU	**Yes**	59	0.43***	COU	No	49
Space allowance per animal/700 kg Access to OLA		**Ease of movement**	**0.73*** **	n.s.	**Yes**	59	**0.70*** **	**n.s.**	**Yes**	49
% of lame animals % of animals with mild and severe alterations		Absence of injuries	0.57***	COU	Yes	59	0.53***	COU	Yes	49
% of animals with nasal discharge & ocular discharge Number of coughs/ animal/15mins; % animals with hampered respiration % of animals with bloated rumen & diarrhoea % of dead animals during a year		**Absence of diseases**	**0.76*** **	COU	**Yes**	59	0.55***	COU	No	49
% dehorned animals % tail-docked animals	Decision tree	Absence of pain induced by management procedures	0.92***	n.t.	n.t.	59	0.99***	n.t.	n.t.	49
Frequency of agonistic & socio-positive interactions/ animal/hour		**Expression of social behaviours**	**0.78*** **	COU	**Yes**	59	0.56***	COU	No	49
Access to pasture before/during fattening		Expression of other behaviours	n.t	n.t	n.t	59	n.t	n.t	n.t	49
ADF of >100cm, 50-100cm and <50cm		**Good human-animal relationship**	0.61***	ASS, COU	Yes	59	**0.72*** **	ASS, COU	**Yes**	49
PC1 calculated from QBA		Positive emotional state	0.68***	n.s.	Yes	59	0.53***	n.s.	Yes	49

[a]: Spearman's correlation coefficient r_S. ***: p<0.001. **: p<0.01 *: p<0.05
[b]: significant effect of assessment (ASS) and country (CO); n.s.: not significant, n.t.: test not conducted due to non-fulfilment of model assumptions (no variance; no normal distribution achievable).
[c]: yes: variance within farms smaller than between farms (→ consistency acceptable); no: variance within farms not smaller than between farms (→ consistency not acceptable); n.t.: no test conducted due to non-fulfilment of model assumptions

Table 12: Consistency of the welfare principles from initial to interim assessment and interim to final assessment of the farms without "major deviations" as correlations between the welfare principles (rs), as effect of assessment and/or country on the welfare measure and the comparison of the variance within and between farms.

Criteria	Principles	Initial to interim assessment				Interim to final assessment			
		r_S[a]	effect of assessment and country[b]	variance within farm < between farms[c]	n	r_S[a]	effect of assessment and country[b]	variance within farm < between farms[c]	n
Absence of prolonged hunger Absence of prolonged thirst	**Good feeding**	**0.72*** **	n.s.	**Yes**	59	**0.74*** **	n.s.	**Yes**	49
Comfort around resting Ease of movement	**Good housing**	**0.79*** **	n.s.	**Yes**	59	0.60***	n.s.	Yes	49
Absence of injuries Absence of diseases Absence of pain induced by management procedures	**Good health**	**0.82*** **	COU	**Yes**	59	0.52***	COU	Yes	49
Expression of social behaviours Expression of social other behaviour Good human-animal relationship Positive emotional state	Appropriate behaviour	0.69***	n.s.	Yes	59	0.41**	n.s.	Yes	49

[a]: Spearman's correlation coefficient r_S. ***: p<0.001. **: p<0.01 *: p<0.05
[b]: significant effect of assessment (ASS) and country (CO); n.s.: not significant, n.t.: test not conducted due to non-fulfilment of model assumptions (no variance; no normal distribution achievable).
[c]: yes: variance within farms smaller than between farms (→ consistency acceptable); no: variance within farms not smaller than between farms (→ consistency not acceptable); n.t.: no test conducted due to non-fulfilment of model assumptions

Table 13: Consistency of the welfare classifications from initial to interim assessment, interim to final assessment and initial to final assessment of the farms without "major deviations" as percentage agreement of the welfare classifications

Classification	n	Percentage agreement → Farms with same welfare classification	Percentage farms that improved by 1 category	Percentage farms that improved by 2 categories	Percentage farms that decreased by 1 category	Percentage farms that decreased by 2categories
Initial to interim assessment	48	**79**	8	0	10	2
Interim to final assessment	48	**75**	15	0	10	0
Initial to final assessment	48	**65**	13	0	10	2

Discussion

For several measures correlation analyses and analyses of variance could not be computed due to very rare findings (e.g. percentage of animals with bloated rumen) and/or skewed distribution of data (e.g. percentage of very lean animals). Therefore interpretation at measure level is restricted to a subset of measures only (20 out of 27), however, we were able to fully analyse criterion and principle scores.

At measure level consistency over time (COT) was not satisfactory for the majority of the investigated parameters independent of the length of the observation interval. Comparing the 1-month with the 6-months interval in this study, correlation coefficients mostly decreased with the longer interval and the ratio of variance within and between farms increased. There might have been several reasons for the rather low level of consistency. Although the farms that had reported changes in housing or management (Chapter 3) and some other farms that had been identified by the assessors were discarded from the calculation of COT, there might still have been farmers who changed the management routines or handling of the animals and therefore had an impact on the measures without our knowledge. However, it was not the general impression during the farm visits that conditions substantially changed throughout the study period. Therefore, other variable but less well defined factors such as seasonal effects, weather conditions, or events such as visits of the veterinarian obviously induced changes in the measures of welfare. However, rather little is known on such short-term fluctuations and their effects. There are some indications that at least behavioural measures may change at very short intervals. For example Laister (2009) investigated the day-to-day variation of incidence of agonistic and socio-positive behaviours on ten Austrian beef bull farms where correlation of single measures ranged from 0.09 to 0.90. The lower value refers to horning which is also included in the WQ-protocol. Although these results have to be interpreted carefully due to the small sample size, they give an idea of which daily fluctuation within ‘normal’ farm conditions may be expected. Assessing clinical parameters in dairy cattle at five bimonthly intervals, Winckler et al. (2007) also found that correlations between consecutive visits varied considerably, e.g. 0.48 to 0.78 for lameness and 0.05 to 0.37 for skin lesions at the carpal joint.

Besides the changes that appear to be the result of normal fluctuation in farm routine within several months some possible other reasons were identified. Low correlation of measures between the initial and interim assessment occurred mainly for measures of health status with low prevalence (principle ‘Good health’). The calculation of sample sizes from which prevalences are derived

according to the Welfare Quality® protocol (Welfare Quality, 2009) refers to an accepted deviation of 10% (d=0.10) from the true value thus leaving substantial room for variation in the outcome. Therefore estimated prevalences often origin from only one or two animals showing respective symptoms. Additionally the proposed sample sizes for some 'clinical measures' were difficult to reach, e.g. due to the limitations in approaching the bulls close enough. The relatively large influence of sample size in on-farm assessment on estimated prevalences on farm level has recently been proven for selected welfare indicators in finishing pig farms using a bootstrapping method (Mullan et al., 2009). It was concluded, that even large (and not feasible) sample sizes consisting of up to 80% of the pens were unable to reflect the true situation of the whole farm for measures with low prevalences; this was due to large deviations between pens. Mullan et al. (2009) state that also the expected prevalences of the investigated measures should be known to calculate appropriate sample sizes. If this situation is also true for beef cattle, which is commonly kept in multiple pens, is unknown and deserves further investigation.

Resource or management-based measures have been described to have a high repeatability (Johnsen et al., 2001). This was confirmed for the measures of water provision but to a lesser extent for the measure of stocking density thus indicating that also management-related measures may change considerably. COT of design or management criteria has never been tested to our knowledge before, especially if viewed in the context with the number of animals that are supposed to use resources (e.g. stocking density).

Still results at measure level may be used for weak point analyses or advisory activities taking place close to the assessment. Even if they may fluctuate in future, the outcomes refer to the actual state regarding the different components of welfare. Additionally it can be assumed that problems which do not become evident in one assessment will be detected in consecutive assessments if they really represent a consistent welfare problem affecting a meaningful proportion of animals.

Consistency improved with aggregation; at criterion level, scores for five and two out of 12 criteria were considered consistent. This effect has several potential reasons. Combining of two or more measures may smoothen undirected fluctuations. Some criterion scores are calculated using thresholds, e.g. 'Absence of disease'. If in this case prevalences are substantially lower than the applied 'warning' or 'alarm' threshold (Welfare Quality, 2009) they may vary thus causing low correlations at the single measure level, but do not lead to changes in the criterion score as long as prevalence stays below the threshold. On the other hand, this does not apply to all measures. Decision trees used for score allocation for the criterion 'Absence of prolonged thirst' contain a threshold of at

least 15% of the animals affected by e.g. too low numbers of drinkers available. Rather small changes in the latter as indicated by the high correlations between visits, lead to a substantially lower consistency at criterion level, obviously due to farms with the percentage of animals affected oscillating around the above mentioned threshold. Consistency of the criterion 'Ease of movement' was satisfactory even after six months, although the corresponding measures 'space allowance' had poor consistency, while 'access to outdoor area or pasture' in the majority of the farms remained constant.

The general effects as described for the criterion level also apply to the principle scores, where acceptable consistency was achieved for three and one out of four principles, respectively. The multi-criteria evaluation model as used by Welfare Quality® (Welfare Quality, 2009) improves consistency by integrating information, especially for short periods (here: 1 month). This underlines the potential of the WQ protocol to reliably evaluate the welfare state and offers opportunities for further use. Again, over the six months period consistency over time declined markedly also for the aggregated scores thus challenging the immediate application of the tool for certification purposes.

Taking the overall classification into account, 79% and 75% of the farms remained in the same category when comparing initial with interim (1month) and interim with final assessment (6 months). Therefore, across all farms there was no effect of the length of the interval between assessments on the consistency of classification. However, the results also mean, that up to 25 % of the farms were allocated to another category. About half of them reached a better overall classification of welfare, and half a worse category. Considering the fact that only farms without major changes in housing and management were used for this analysis, it is questionable if such a high proportion of shifts between categories even in the course of short-term periods would be accepted by the farming community. Although none of the farms was 'not classified' at any assessment the switching between the two categories 'Enhanced' and 'Acceptable' might already be sufficient to loose a certification status depending on the thresholds set in possible future welfare labelling systems.

Therefore and if better consistency over time is desired for more measures or for longer time periods (simulation) studies with different sample sizes and more feasible strategies to achieve them could clarify if higher confidence intervals or/and lower accepted variance with regard to sample sizes would improve repeatability. With regard to credibility of the certification processes a favourable option would be the assessment in certain intervals of each farm to allow calculations with 'rolling averages'. This would open up possibilities to decrease the influence of fluctuating conditions during the whole production period that are obviously unavoidable in on-farm situations.

Conclusions

The rather low consistency at measures level may be regarded a minor problem if the information is fed-back to the farmers and subsequently used for advisory purposes. A higher proportion of criteria and principle scores showed promising consistency over time, indicating that the integration to criteria and principles reduces variance within farms. However, although consistency over time improved with aggregation to criterion and principle scores the repeatability over six months was not sufficient for reliable welfare classification as it would probably be used for certification purposes. In order to raise reliability at this level the use of rolling averages may be recommended, but this would also mean a longer baseline assessment period until sufficient reliable data has been gathered. Determination of the number of assessments and intervals needed require further long-term studies. Redefinition of measures might be an additional option.

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5. Concluding remarks and further research need

The increasing societal request for farm animal welfare forms an important background for further research in this field. One of the areas of research is the development of suitable on-farm welfare assessment systems such as Welfare Quality® (WQ) taking feasibility, validity and reliability into account (Knierim & Winckler, 2009). In this thesis (1) perceptions and attitudes of beef farmers towards a mainly animal-based welfare assessment system were investigated and (2) the welfare state of beef bulls was described using the WQ assessment system. Additionally the effects of different feedback strategies of results from an initial assessment were evaluated and (3) the consistency over time at the level of WQ single welfare measures as well as aggregated criterion and principle scores and welfare classification were described.

As the WQ protocol has been developed to be A) a reliable animal welfare on-farm assessment system and B) give feedback to the farmer to improve the animals' welfare state (Blokhuis, 2008), some conclusions from ther present thesis may be drawn as steps towards a future implementation of the WQ protocol for fattening cattle.

Conclusions on the suitability of the Welfare Quality® on-farm assessment protocol:

The protocol was substantially accepted by farmers and they were interested to join such a system, expecting benefits that match the intentions of WQ. Nevertheless some comments and further ideas can be formulated as conclusions:

- As described in Chapter 3, cases of missing values occurred due to either missing information (e.g. history of disbudding procedure on calf rearing farms) or failure to achieve minimum sample sizes, thus challenging the feasibility of the protocol. In order to be applied on a larger scale, practical solutions for dealing with these problems have to be found.

  For mutilations that are not performed in the fattening unit and for which the farmer does not have information on the procedures applied, a solution could be to assume the most likely performed procedure according to the report of the ALCASDE project (Oliver Angels, 2009) which assessed the most prevalent procedures for mutilations (dehorning and castrating) across the EU-countries.

  Too small sample sizes were mainly a problem regarding the assessment of hairless spots on the legs due to soiling, which made it together with limited accessibility of the bulls (pens can not be entered for safety reasons) impossible to actually see the skin/coat in certain body regions. The

assessment of such mild alterations therefore tended to be less feasible and lower sample sizes achieved may also have compromised consistency of measures. Three approaches are possible: First, assessment could be restricted to large lesions and swellings only because they are likely to be detected even in dirty animals. Minor alterations are most likely less relevant for animal welfare; however, there are no validation studies on this issue available. This approach would also result in a modification of the score calculation and would therefore require refinements not only in the description of the measures but also in the aggregation steps. Secondly, animals that are too dirty could be rated with a 'standard-incidence' of alterations based on benchmark data. Also this solution would need some time until such data are available. Thirdly, the affected farm could be assessed repeatedly, taking animals into account that are clean enough to score, until the desired sample size is achieved. This would mean more effort in terms of repeated visits for scoring the animals. Nevertheless, all approaches would need testing before inclusion in the on-farm assessment protocol.
Feasibility of assessments could further be a simplified by using central data bases (such as Rinderdatenbank or HIT) that provide data such as number and age of the animals or mortality rates (Mullan et al., 2009).

- Due to the fact that farmers were concerned about misclassification and investigations of consistency over time were not promising for longer time intervals, for the time being we suggest to use rolling means of consecutive farm visits for WQ welfare classification. This has also been suggested by Mullan et al. (2009) for dealing with inconsistencies that origin from low and unbalanced prevalences in pens of finishing pigs. Another possibility would be to assess the less consistent measures more often and if necessary then perform only a partial assessment with less parameter, in order to save time and costs (Sørensen et al., 2007).

Conclusions on the suitability of the Welfare Quality® protocol in terms of an advisory tool:

The farmers wished to receive feedback and advice and this can be seen as an important basic motivation to apply welfare assessment systems such as Welfare Quality® and to use them to improve animal welfare. Nevertheless there are some ideas with regard to the feedback-tool:

- The two feedback treatments in this study did not have a significant effect with regard to welfare improvements. However, taking the short monitoring period of only about 6 months into account it appears to be too early to discard the chosen approaches. Nevertheless based on other studies (e.g. Brinkmann & March, 2011) it might be promising to better tailor the advice to the farm-specific situation rather than providing a more general list of potential measures.

- In the questionnaire study, farmers largely connected economic aspects with animal welfare. Unfortunately our knowledge regarding economic or personal benefits following animal welfare improvements is limited; studies in this regard for fattening cattle are completely missing. As farmers expect at least balanced costs for improved animal welfare cost-benefit-ratio should therefore be further investigated and may also be actively addressed in discussions with farmers before implementation of the WQ assessment system.

Further studies in the context of animal-based welfare assessment systems:

The following further research topics regarding on-farm welfare assessment in beef bulls are suggested:

- Acceptance of WQ criteria and principle scores and classification by the farmers
- Motivations of beef farmers to improve welfare states in different housing and production systems
- On-farm factors affecting sensitivity of welfare scores
- Longer-term studies on implementation of welfare assessment systems in different housing and production systems
- Cost-benefit studies of welfare improvement strategies
- Correlation of socio-demographic, housing and management data with the welfare outcomes to identify potential risk-factors for poor welfare

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6. Appendix

A) Questionnaire introducing Welfare Quality®

Dear operator!

In the following Questionnaire we want to ask you something about your attitudes, opinions and expectations to a new on farm - assessment with focus on animal suitable husbandry systems. Your statements remain anonymous, but they influence the further design of the project "Welfare Quality®", in which Europe Institutions are working on. We invite you to participate here!

General Information

1) How many bulls do you have at full occupancy on the farm?

_____ fattening places

2) What is the size of your farm?

_____ hectares

3) What is the live weight of the bought-in bulls?

_____ kg

4) What is the live slaughter weight?

_____ kg

5) What is the average duration of the fattening period?

_____ months

6) Which proportion of the farm income originates from the bulls fattening?

_____ %

7) How many housing systems for bull fattening do you operate on the farm?

[ ]a one
[ ]b two
[ ]c three

8) How many bulls live in System 1?

_____ bulls

In the following questions give for each system you operate the type of areas accessible for the animals:

9) What is the housing system 1 for the bulls like?

[ ]a one part system
[ ]b two parts system
[ ]c three parts system

10) What is the floor type of the lying area in system 1?

[ ]a sloped floor
[ ]b rubber mats/mattresses
[ ]c deep litter
[ ]d others: …

11) What is the floor type in the activity area of system 1?

[ ]a deep litter
[ ]b solid concrete
[ ]c solid mastic asphalt
[ ]d concrete slats
[ ]e rubberized slats
[ ]f others:

12) What is the floor type in the outdoor run of system 1?

[ ]a natural ground
[ ]b solid concrete
[ ]c solid mastic asphalt
[ ]d concrete slats
[ ]e others:

13) Is the barn of system 1...

[ ]a open
[ ]b closed

14) Is the ventilation system in the barn of system 1…

[ ]A natural
[ ]B with forced ventilation
[ ]C with additional fans

15) Is the barn of system 1...

[ ]a insulated
[ ]b not insulated

Only if there are two different housing systems: One system→32)

16) How many bulls live in System 2:

_____ bulls

17) What is the housing system 2 for the bulls like?

[ ]a one part system
[ ]b two parts system
[ ]c three parts system

18) What is the floor type of the lying area in system 2?

[ ]a sloped floor
[ ]b rubber mats/mattresses
[ ]c deep litter
[ ]d others: …

19) What is the floor type in the activity area of system 2?

[ ]a deep litter
[ ]b solid concrete
[ ]c solid mastic asphalt
[ ]d concrete slats
[ ]e rubberized slats
[ ]f others:

20) What is the floor type in the outdoor run of system 2?

[ ]a natural ground
[ ]b solid concrete
[ ]c solid mastic asphalt
[ ]d concrete slats
[ ]e others:

21) Is the barn of system 2...

[ ]a open
[ ]b closed

22) Is the ventilation system in the barn of system 2…

[ ]A natural
[ ]B with forced ventilation
[ ]C with additional fans

23) Is the barn of system 2...

[ ]a insulated
[ ]b not insulated

Only if there are three different housing systems: Two systems→32)

24) How many bulls live in System 3:

_____ bulls

25) What is the housing system 3 for the bulls like?

[ ]a one part system
[ ]b two parts system
[ ]c three parts system

26) What is the floor type of the lying area in system 3?

[ ]a sloped floor
[ ]b rubber mats/mattresses
[ ]c deep litter
[ ]d others: …

27) What is the floor type in the activity area of system 3?

[ ]a deep litter
[ ]b solid concrete
[ ]c solid mastic asphalt
[ ]d concrete slats
[ ]e rubberized slats
[ ]f others:

28) What is the floor type in the outdoor run of system 3?

[ ]a natural ground
[ ]b solid concrete
[ ]c solid mastic asphalt
[ ]d concrete slats
[ ]e others:

29) Is the barn of system 3...

[ ]a open
[ ]b closed

30) Is the ventilation system in the barn of system 3…

[ ]A natural
[ ]B with forced ventilation
[ ]C with additional fans

31) Is the barn of system 3...

[ ]a insulated
[ ]b not insulated

Go on here if there is only one system on the farm:

32) For how many years do you have the bulls fattening as an agricultural production branch on your farm?

_____ years

33) What is the main motivation for bull fattening on your farm?

[ ]A Inherited/tradition
[ ]B Cattle are favourite farm animals
[ ]C Response to market demands
[ ]D Switch from milk production
[ ]E Others:

34) How many persons are, independent of the extent, working on the farm?

_____ person/s

35) How many persons are, independent of the extent, working with the bulls?

_____ person/s

36) How many of the persons working with the bulls are family members ?

_____ person/s

37) How many of the family members working with the bulls are female?

_____ person/s

38) How many of the external workers working with the bulls are female?

_____ person/s

39) To whom do you sell your animals?

[ ]A directly to consumers (off farm) →42)
[ ]B to a local small-scale slaughterhouse/butcher →42)
[ ]C to a cattle dealer →42)
[ ]D to a contractual partner (label programme →40)
[ ]E to a marketing company →42)

40) If you sell animals to a contractual partner with Label:
Are there some requirements regarding animal husbandry exceeding the legal requirements
(if such exist)?

[ ]a Yes
[ ]b No

41) If there are some requirements regarding animal husbandry above the legal requirement: What are these?

_____

Personal information:

42) May we ask your age?

_____ years

43) Gender of the interviewed person?

[ ]a male
[ ]b female

44) What is your position on the farm?

_____

45) Where do your professional skills come from?

[ ]A Agricultural School
[ ]B Vocational Training
[ ]C University degree in agriculture/animal science
[ ]D Additional courses
[ ]E Family
[ ]F Other

46) Where the following subjects presented during your agricultural training?
Animal Behaviour:

[ ]a Yes
[ ]b No

47) Health Management

[ ]a Yes
[ ]b No

48) Indicators of Well being:

[ ]a Yes
[ ]b No

49) Animal Welfare Legislation

[ ]a Yes
[ ]b No

50) How do you get information about the topic "Animal welfare"?

[ ]A from state agricultural organisations
[ ]B from the farm vet
[ ]C from the animal health service
[ ]D through reading magazines
[ ]E through searching the web for useful information
[ ]F through visiting information meetings/symposia
[ ]G other:

51) What does the term "Animal welfare" mean to you?

_____

52) How do you recognize a good state of welfare in your animals?

_____

53) How do you recognize a bad state of welfare in your animals?

_____

54) Who on the farm (position) is mostly caring for the welfare state?

_____

If not obvious from the previous question...

55) What is the gender of this welfare-sensitive person?

[ ]a female
[ ]b male

At this stage of the interview, an information on the Welfare Quality® assessment system shall be given

Expectations towards the WQ on-farm assessment system

56) How important is in your opinion a tool such as the Welfare Quality® assessment system regarding the welfare state of the animals and its improvement on a farm?

[ ]1 Completely unimportant
[ ]2 Unimportant
[ ]3 Rather unimportant
[ ]4 Rather important
[ ]5 Important
[ ]6 Very important

57) How important is it in your opinion that the Welfare Quality® assessment system is able to detect deficiencies in the housing system and the herd management?

Completely unimportant [ ]1 [ ]2 [ ]3 [ ]4 [ ]5 [ ]6 Very important

58) How important is it in your opinion that the Welfare Quality® assessment system is able to assist the veterinarian and you in monitoring the health status of the herd?

Completely unimportant [ ]1 [ ]2 [ ]3 [ ]4 [ ]5 [ ]6 Very important

59) Which further benefits would you expect from Welfare Quality®?

_____

60) What are the objections you may have in mind towards Welfare Quality®?

_____

61) Why would you enter the Welfare Quality® on-farm assessment scheme?

[ ]A to improve management performance
[ ]B to fulfil the requirements of a Label programme for regular use
[ ]C to increase animal welfare
[ ]D to reduce medical treatments
[ ]E other:
[ ]F not at all

62) How would you rate your motivation, to participate in such a scheme continuously (i.e. in regular intervals)?

Very low [ ]1 [ ]2 [ ]3 [ ]4 [ ]5 [ ]6 Very High

63) Is it important for you that in the context of Welfare Quality® you will be offered advice for the problems which have been identified?

Completely unimportant [ ]1 [ ]2 [ ]3 [ ]4 [ ]5 [ ]6 Very important

64) Would you in principle be prepared to implement modifications in the housing system in order to improve the outcomes of the Welfare Quality® assessment?

[ ]a Yes
[ ]b No

65) Would you in principle be prepared to implement modifications in management in order to improve the outcomes of the Welfare Quality® assessment?

[ ]a Yes
[ ]b No

66) Would you in principle be prepared to spend more time in the barn every day to improve the outcomes of the Welfare Quality® assessment?

[ ]a Yes →67)
[ ]b No →68)

Only if "yes"...

67) If you would spend more time: What would be the maximum time possible (minutes per day)?

_____ min/person/day

Only if "No"...

68) If you would not spend more time: Why?

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69) Would you in principle be prepared to accept higher costs to improve the results of the Welfare Quality® assessment?

[ ]a Yes, even if it doesn't pay back in terms of money 70)
[ ]b Yes, if revenues and costs are balanced 73)
[ ]c Only if the income increases additionally 71)
[ ]d Not at all 72)

Following 3 questions only optional...
For answer a)...

70) If it doesn't pay back in terms of money: How many Euros per animal and day?

_____ Euros/animal/day →73)

For answer c) ...

71) If the income increases additionally: How much increase is needed?

_____ % more of total income/Year →73)

For answer d) ...

72) If not at all: Why?

_____

73) Which advantages for your animals would you expect from the implementation of Welfare Quality®?

_____

74) Which are the personal benefits you would expect from an improvement in animal well-being through Welfare Quality®?

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75) As part of the Welfare Quality® project it is planned to develop a new label for beef produced in systems which ensure good animal welfare. Would you in principle be prepared to take part?

[ ]a Yes 76)
[ ]b No 82)

Following 6 Questions only if you could imagine to join such a label:

How much would you agree to the following statements?

76) "My animals are feeling better!"
I strongly disagree [ ]1 [ ]2 [ ]3 [ ]4 [ ]5 [ ]6 I strongly agree

77) "I have fewer losses of animals!"
I strongly disagree [ ]1 [ ]2 [ ]3 [ ]4 [ ]5 [ ]6 I strongly agree

78) "I have a pure conscience!"
I strongly disagree [ ]1 [ ]2 [ ]3 [ ]4 [ ]5 [ ]6 I strongly agree

79) "I can earn more from it!"
I strongly disagree [ ]1 [ ]2 [ ]3 [ ]4 [ ]5 [ ]6 I strongly agree

80) "My business increases in Prestige!"
I strongly disagree [ ]1 [ ]2 [ ]3 [ ]4 [ ]5 [ ]6 I strongly agree

81) Which external incentives would you expect when joining a Welfare Quality® label?

Go on here if there is no wish to join the label:

82) Would you in principle be interested in the Welfare Quality® on-farm assessment in the future (when finalized)?

[ ]a Yes *12 more questions follow for the implementation!*
[ ]b No *End of questionnaire*

This part of the interview only has to be carried out if there is an interest in applying the Welfare Quality® on-farm assessment:

83) What is an acceptable duration of a Welfare Quality® on farm assessment, carried out by an external assessor?

_____ hours

84) How long would you be available for questions within the Welfare Quality® assessment?

_____ hours

85) If offered on a commercial basis: How much would you be willing to pay for a complete Welfare Quality® on-farm assessment, including the feedback of the results, carried out by an assessor?

_____ Euro

86) Which of the following data that are recorded within Welfare Quality® you would like to collect and report yourself using predefined recording sheets?

[ ]A management data (feeding routines, …)
[ ]B animal housing structure data (housing design, layout of the barn, …)
[ ]C animal health data (herd health records)
[ ]D none

87) How much time would you want to spend on the data collection mentioned in the previous question?

_____ hours

88) Would you mind entering data within Welfare Quality® in an electronic database?

[ ]a Yes
[ ]b No

89) How often would you want to carry out repeated surveys within Welfare Quality®?

_____ times/year

Feedback of results:

90) How do you want to get feedback (statistics, report) on your data from the Welfare Quality® protocol data?

[ ]a Written
[ ]b Written and oral per telephone
[ ]c Written and oral within a visit

91) Which type of written report do you prefer?

[ ]a Printed
[ ]b CD
[ ]c E-mail
[ ]d Available in the Internet

Training and technical support:

92) Which external persons would you like to include in the process?

[ ]A Veterinarians
[ ]B Farmer colleagues
[ ]C Feeding experts
[ ]D Investment consultants
[ ]E Experts on housing/construction
[ ]F General farm advisor
[ ]G Other:

93) If you want to carry out some parts of Welfare Quality® yourself: How much time would you accept to spend for training?

_____ hours

94) In which context would you like a Welfare Quality® training to take place?

[ ]a in a meeting with colleagues
[ ]b within an evening symposium
[ ]c via Internet or interactive CD
[ ]d using only a manual

***Interviewer** information:*

95) Farm code:

_____

96) Interviewer code:

[ ]a MK
[ ]b HSW
[ ]c ET

97) Atmosphere during the conversation?

[ ]a positive
[ ]b negative
[ ]c neutral

98) Was there enough time for the interview?

[ ]a Yes
[ ]b No

99) How was the alertness of the interviewed person?

[ ]1 unalert all the time
[ ]2 unalert most of the time
[ ]3 alert half of the time
[ ]4 alert most of the time
[ ]5 alert all the time

100) Was the interviewed person in your opinion in principle interested?

[ ]a Yes
[ ]b No

101) Further details that seem to be important to you to interpret the questionnaire later on:

B) Example for a feedback-report

Feedback

of the on-farm welfare assessment

with

WELFARE QUALITY®

Introduction:

For the animal welfare assessment, four main areas of concern (principles) are defined: good feeding, good housing, good health and appropriate behaviour. These areas of concern can be assessed by looking at different criteria and measures.
In the following, the results of the welfare assessment with Welfare Quality® for the different measures on your farm are presented in relation to values of farms already assessed with this assessment scheme. Data for these values were recorded on 30 farms in Austria and 18 farms in Italy with bulls in littered systems and on fully slatted floors. Out of these data, the mean and the range (minimum to maximum value) are shown. For a few parameters, there are no data from other farms. Additionally, a judgement in terms of animal welfare is given in most cases in form of a three-stage rating following the scheme of a traffic light: “not acceptable”, “improvement desirable” and “OK” (shown as red, yellow and green areas).

Results:

The results of the single measures are presented according to the areas of concern and the criteria. The meaning of symbols and colours in the figures are as follows:

- Mean of the reference data from the Austrian and Italian farms
- Range (=minimum to maximum) of the reference data from the Austrian and Italian farms
- Your Farm

Welfare rating:

- OK
- Improvement desirable
- Not acceptable

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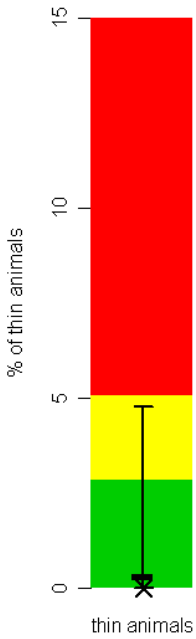
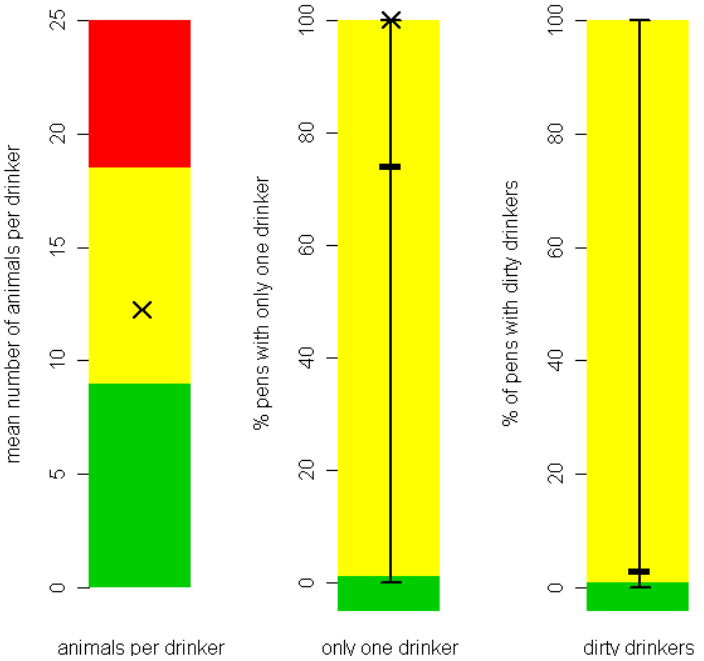
1. Good feeding:

Absence of prolonged hunger





Absence of prolonged thirst

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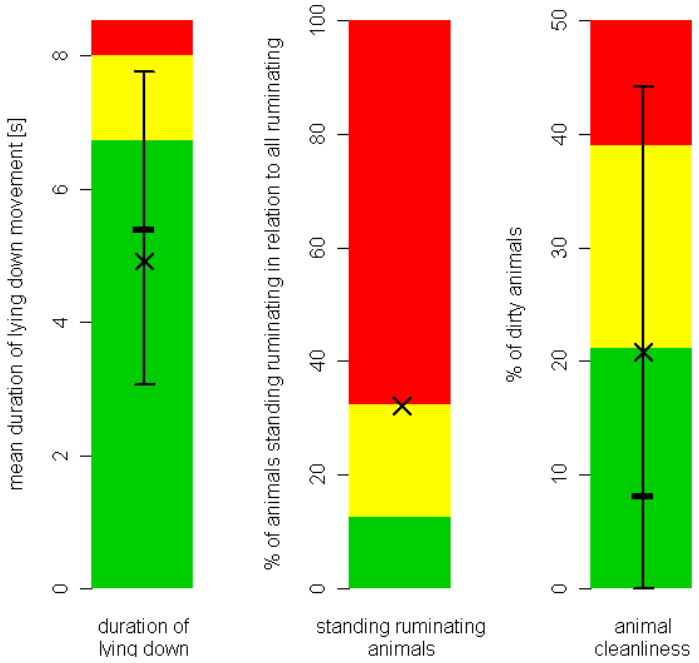
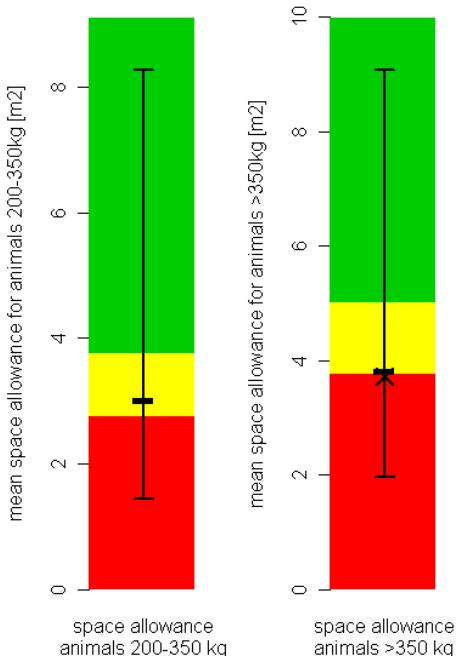
2. *Good housing:*

Comfort around resting



Ease of movement



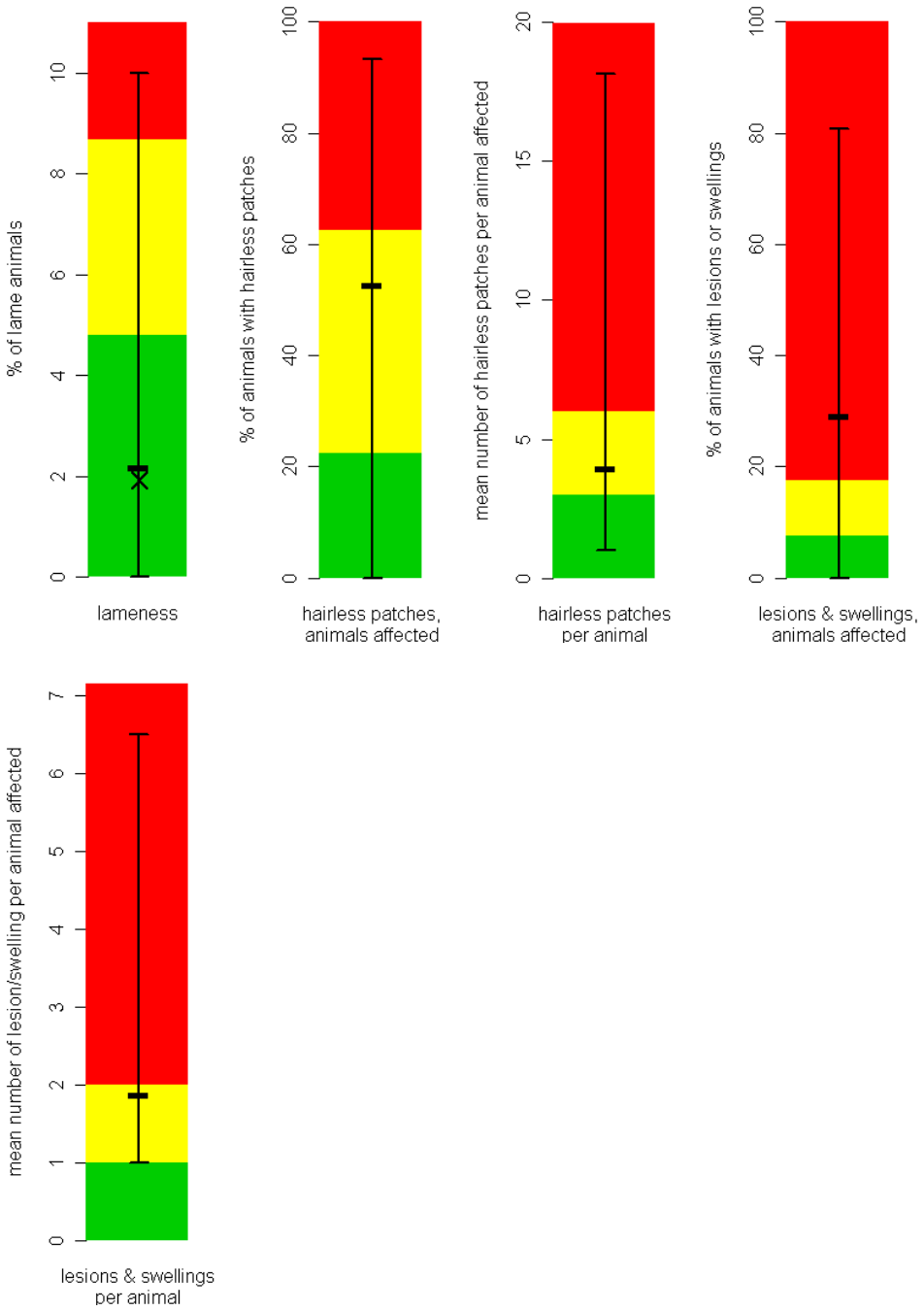
Thermal comfort

No pen with animals panting

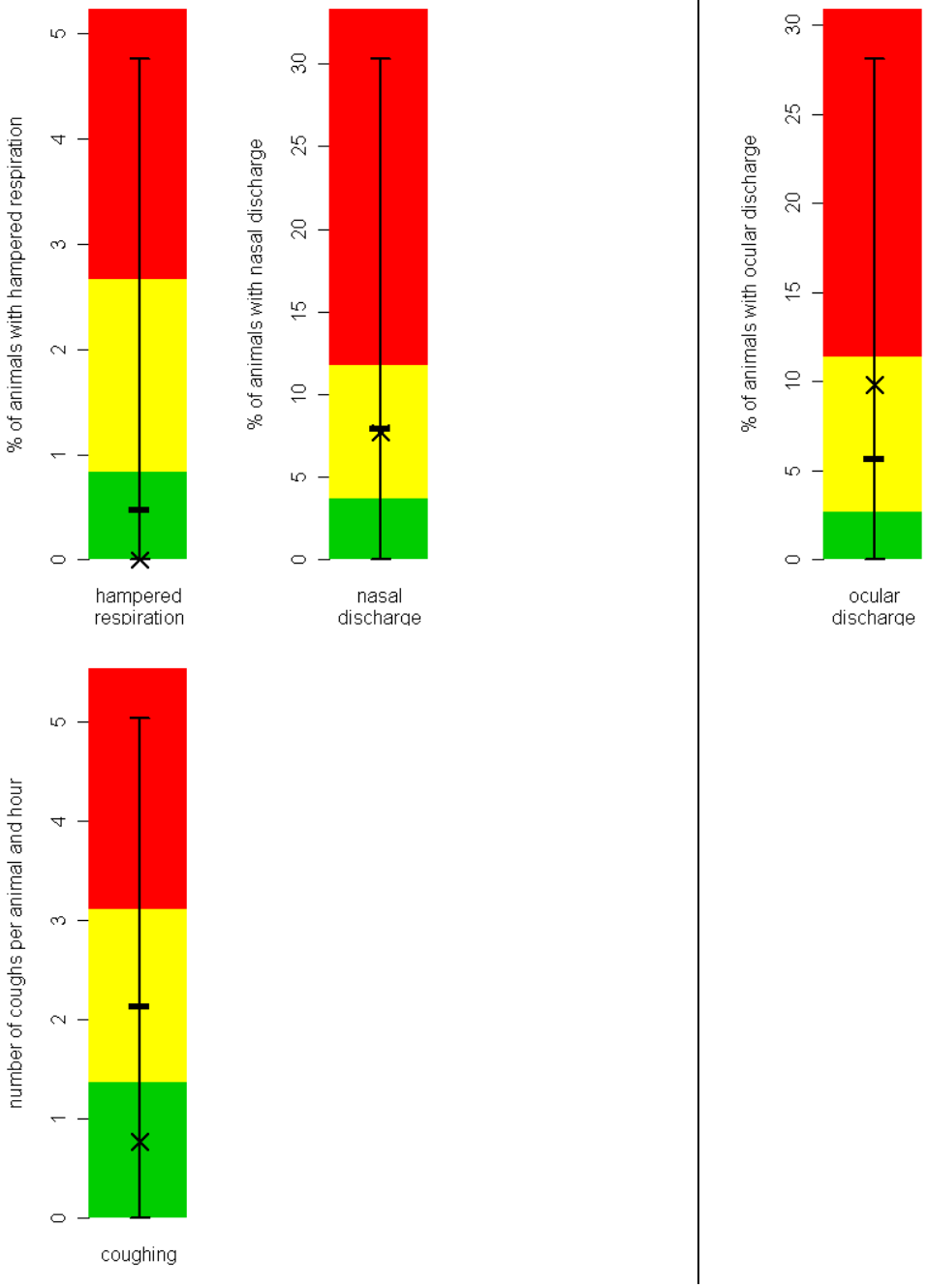
→ Heat stress: 

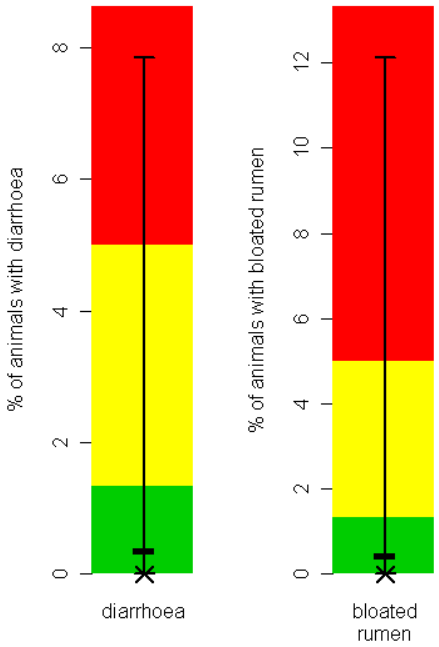
Good health:

Absence of injuries

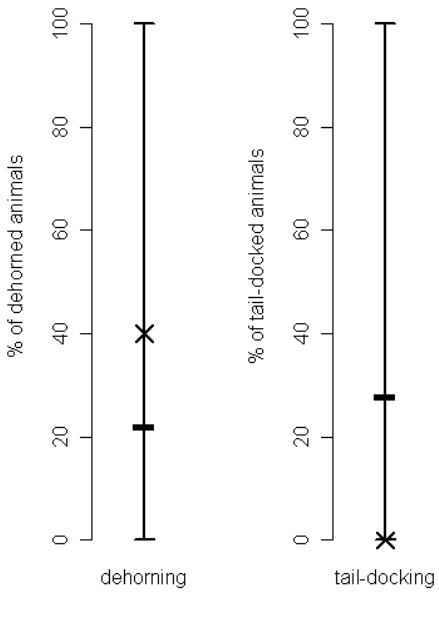


Absence of diseases





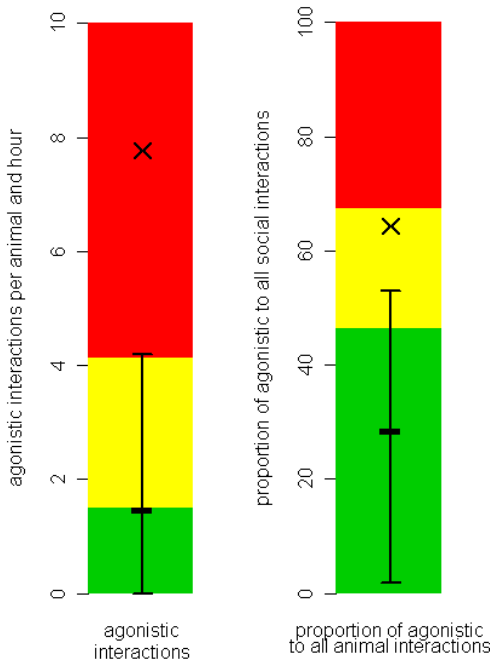
Absence of pain induced by management procedures



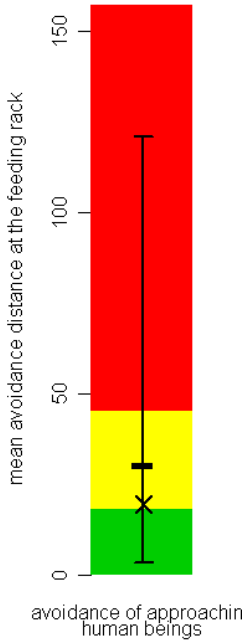
→ Pain induced by dehorning could be reduced

Appropriate behaviour:

Social behaviour



Animal-human-relationship



Abnormal behaviour

25 % of pens with animals performing tongue rolling

→ Tongue rolling:

Summary:

In total … parameters were assessed. Out of these ... were rated as “OK”, … as “improvement desirable” and … as “not acceptable” concerning animal welfare (a summary is listed in the following table).

(*only for the “advice farms”:)*

possible issues for improvement could be:

- …
- ….).

C) Table of Content for Figures and Tables:

Figures:

Tables:

D) Bibliography

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