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STUDY OF ANIMAL WELFARE STATUS AND LAMENESS IN DAIRY COW HERDS IN HUNGARY

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1. Introduction

Dairy farming is recognised as an image of animals chewing the grass with few, if any, negative effects on their welfare. It is understood as a traditional way of living in the countryside and dairy production is defined by the public as business which is relatively friendly to the environment. Economic constrains on the dairy farmers over the last years have drove European dairy industry to look for greater efficiencies. Some believe that those significant changes in dairying have disturbed cow's welfare. The deciding factor for incomes of dairy farmers is the ability to produce milk at the lowest cost per litre as possible, which is also limited by milk output obligated by quotas. The low profitability of dairy enterprises has, very likely, compromised investment and maintenance on many farms which in turn may neglect reducing the occurrence of lameness, mastitis and metabolic diseases. Farming nowadays is not an attractive occupation and the difficulty with finding dedicated workers is a cause for concern as well. There is evidence that production of high-yielding dairy cows have already passed the point where good cow welfare cannot be provided.

For many years, the main objective of breeders was to increase milk production and feed conversion. Management procedures were gradually modified to increase productivity. The consequence of this is that cows are metabolising and consuming more feed which can be associated with a greater risk of mastitis, lameness, infertility and other production diseases. Most of modern cows are found with a life span of less than four lactations which in Hungary stands for less than three. Cows forced to produce enormously high quantities of milk are prone to metabolic stress which effects lameness and leads to early culling.

The welfare of dairy cattle has not been previously examined in Hungary to any great extent. The need for creating such a review is especially pertinent in the light of the increasing intensification of dairy farming, legislation's obligations, increasing retailers' and consumers' demands. Such a background can be useful to provide anyone of interest (academia, authorities or commercial companies) with transparent and reliable information. There is no available information about dairy welfare standards in Hungary, except for particular production and health issues. The majority of livestock farms in developed countries are raised according to the requirements of a farm assurance scheme. These types of programmes will likely play an increasingly important role in the dairy industry. If Hungarian farmers are considering running dairy business successfully, it is very likely that they also will have to cope with animal welfare standards expected by consumers and retailers.

Lameness in cattle is a symptom of certain illnesses and disorders of the leg or the claw and occurs in several clinically recognizable forms. Lameness is usually associated with tissue damage, discomfort and is manifested as an inability to walk. Some misconceptions due to the ability of cattle to experience pain and the paucity of licensed veterinary products might aggravate welfare. What is more, farmers often underestimate the scope of the lameness problem within their herds.

Lameness has been recognized as a multifaceted condition, severely-decreasing animal welfare and is an important constraint to the dairy industry. Lameness is a major welfare problem of dairy cows and because of its negative impact on milk production is one of the most important outbreak of dairy cattle. If antibiotics are administered, milk may have to be discarded.

Mobility scoring has been developed to help farmers improve the detection of lameness and to stimulate treatment and prevention as part of a herd health program. Hoof trimming is a technique to increase the hoof angle to induce a forward shift in weight bearing, particularly in hooves with overgrown toes. Extremely affected hooves can be given relief by shifting the weight-bearing surface off affected lesions to promote healing and recovering with use of orthopaedic blocks. Throughout a large portion of the year, infectious causes of lameness are commonly managed with routine cleaning of facilities as well as the use of well managed foot baths and spraying feet in the milking parlour.

There have been few improvements in the management of lameness in dairy cattle. Management plans to minimize lameness in dairy cattle have not yet been developed because the research evidence is not robust enough to provide such a plan. Whatever the scope of lameness is reported on the farm, it is important to be aware of the costs associated with lameness and to make sound management decisions to best minimize those costs and maximize profitability. With a number of negative implications to welfare and productivity, the outbreak was considered by participating farmers to be one of the most important outbreaks to be improved. For that reason lameness was chosen to be the second topic of this doctoral dissertation.

2. Aims of the research

Dairy welfare

- The first hypothesis was tested: Hungarian Holstein-Friesian cattle have an acceptable standard of welfare.
- The other hypothesis tested claimed: voluntarily given advice about animal welfare will significantly improve specific, measurable, attainable, relevant and time-limited welfare measures in Hungarian Holstein-Friesian herds.

Lameness

- To evaluate the status of farms regarding their lameness prevention measures
- To investigate relations between the occurrence of lameness, welfare measures and environmental factors
- To observe relations between number of orthopaedic blocks used by hoof trimmers, welfare measures and environmental factors
- To rank farms regarding changes in occurrence of lameness
- To examine effectiveness of professional and on-farm hoof trimming in different conditions
- To quantify correlations between the occurrence of lameness and conformation traits
- To estimate effect of lameness on milk production
- To assess heritability of lameness

3. Material and methods

Dairy welfare

The project presumed dairy farm monitoring in Hungary. The farms were visited twice; the first time from May to December 2010 and the second time from May to December 2011. To make the project successful, there were 27 farms recruited for this study. After one year, two farms were excluded from the study because of lack of interest in further cooperation. There were, on average, 457 heads of lactating cows in the herds producing on average 9047.80 kg (min. 7390 kg and max. 10860 kg) in 2010 and 8984.36 kg (min. 7624 kg and max. 10621 kg) in 2011. The selection was firstly created on a principle of searching for as many different farms as possible. The criteria for the farm selection included the maintenance of accurate records and the willingness to commit to the trial. No aspect of herd management was changed for the purpose of the study. Farms were visited in the same months in 2010 and in 2011. The purpose of the study was to observe animal welfare in 2010, to present the welfare assessment protocol to the farm managers and to explain neglected areas on the farms. The next step included a second visit in 2011 and an assessment was performed to estimate if any improvements have been achieved after voluntarily-given suggestions.

Protocol development, training and preparations

Farmers are busy people and like any businesspeople they want to be sure their time is not wasted. There was a need for creating protocol setting specific, measurable, attainable, relevant and time-limited (SMART) measures. The sequence of the steps necessary for the development, testing and implementation of animal-based protocol for assessing on-farm welfare was followed:

(1) First review of expert opinion
(2) Relative importance of different welfare problems
(3) Approaches to measurement of welfare problems
(4) Development and testing of protocols for on-farm assessment of animal welfare
(5) Assessment of welfare on a statistically valid sample of farms
(6) Identification of strengths and weaknesses on individual farms
(7) Second review of expert opinion
(8) Needs for intervention to address specific welfare problems
(9) Development of action plan to address specific problems on individual farms

Farm visits were established for creating an animal welfare report summarising conditions on Hungarian dairy farms. The use of some measures from already-existing protocol was driven by the fact that they were selected through a process of consultations with experts (1). Measures should be important to the welfare of animals and could be measured in a consistent way. The project, however, needed the protocol to be established again, for in Hungarian conditions some of the points of the protocols would simply not work (for example – access to the pasture). A new welfare quality tool was created including all needed measures that could be important to the welfare of animals and could be comparatively simple, meaningful, time-efficient and usable on a farm (2). These aims were reached by avoiding a usage of complicated devices and gadgets, so the research (measure) could be repeated easily by another person, for example farm manager (3). The following items were used during every visit: Psion Workabout MX hand-held computer, laminate pages with lameness and body condition scores. There was also a tape measure for checking the barn and milking parlour dimensions and thermometer for checking the silage and extra notebook in use. Additionally, the protocol was created to have a minimal-as-possible impact on cows, so the daily routine was not disrupted and farmers could work normally. Following these priorities there was need for a test which the results could be meaningfully interpreted. In case of a discussion with the farmer, there was need for confident explanations, numbers and examples that results (good or bad welfare) actually mean something. Preparation for visiting farms included training with a professional dairy cow selection assessor judging cows for selection purposes. Training was run in parallel with the work of the expert. Oral judgement of the body condition and lameness scores was performed and any hesitations were discussed.

Cow observations started with creating a protocol covering all possible questions and measures which could be taken to express all desirable animal welfare critical points on the farms. When the draft paper was ready, every point was discussed with the supervisor and professionals in dairy husbandry working at the University of Debrecen and then compared with the works of other researchers. Then the table was taken to the nearest farm cooperating with the University and checked again if the specific questions and conditions were applicable with the reality on the farm (4). A new table considered importance of use and time needed for recording of each condition. After that, the list was successfully tried on four different in-housing and management farms, discussed with their managers and action was followed on all 25 farms (5).

During each visit, strong and weak welfare areas were discussed with farm managers and possible solutions were suggested (6). From this point it was up to farm manager to follow suggestions or to follow old methods of husbandry. When the farmer did not show interest, the identification of strengths and weaknesses (6) was the last step in dealing further with welfare. In case the farmer was interested in getting more information how welfare could be improved, more reliable opinions and suggestions for particular farm(er) were gathered (7). This was carried on either at University of Debrecen (discussions with co-workers), by contact with commercial companies (e.g. trimming, flooring, semen) or by sharing experiences with other farmers. In all cases specific welfare issues were addressed (8) and, either by phone or in person, sets of solutions were proposed to farmers if needed shortly after the first visit (e.g. professional trimming, concrete grooving) (9).

The numbers of welfare measures were used to create a cattle welfare assessment protocol. The following categories for all groups of cattle were used: water access and quality, bedding – softness and cleanliness, obviously ill animals and/or with dull coats, cleanliness, injuries, flight distances, body condition scores and lameness. The welfare assessment of younger and older calves was based additionally on information about: access to water, occurrence of diarrhoea, housing and mortality. Finally, the welfare of lactating cows was estimated with more unique measures: somatic cell count, conception rate, lifespan, culling, mortality, idling and the presence of grooming brushes.

Data from the completed welfare assessments was gathered into Microsoft Excel 2007 and then transformed for use in SPSS 13.0 statistical package SPSS**.** The Shapiro-Wilk test was used to check the normality of animal welfare measures. Multiple factor analysis of variance (for normally distributed data) and Mann-Whitney test (for not normally distributed data) was performed to observe differences in animal welfare measures between 2010 and 2011. A Spearman Rank Correlation test was run to find correlations between animal welfare measures and environmental factors. A Chi-square test for relatedness or independence was used to evaluate the differences in animal welfare distributions on farms between 2010 and 2011. The welfare was checked in 2010 and the welfare report was given to farmers with suggestions for improving cattle welfare. In 2011 the same assessment was performed.

Lameness

The status of farms regarding their lameness prevention measures

During visits for welfare purposes from May to December 2010 and from May to December 2011 the potential risk areas for increasing lameness, the changes between years and the comparison with international results were examined. The measures came from international literature information about prevention solutions against lameness. The following lameness measures were defined and recorded: foot bathing and solutions used, trimming methods and its frequency, lameness case records, building type, bedding material, scraping method, passageway width and quality of the surface next to cubicles and feeders, feed space per head, extra free stalls, lunge area, brisket boards, free stall width and length, neck rail position, rising, access to water, ventilators, milking parlours, silage, access to pastures or paddocks and track conditions. Dry cows were additionally observed regarding housing in the dry period and heifers regarding the adaptation period. Lameness measures were checked in 2010 and a lameness report was given to the farmers with suggestions for decreasing prevalence of lameness. Another visit in 2011 was performed for checking if any changes occurred.

Relations between the occurrence of lameness, welfare measures and environmental factors

The measures observed were then correlated with reported occurrences of lameness using the Spearman Rank Correlation test to determine the strength of that relationship, as long as both variables were quality variables and if the variable had more than three stages. For estimating the differences between a group of two or more distributions an analysis of variance of these distributions was performed. Finally in the case of frequencies and lameness distributions, the Chi-square test was run. During the same visits, all cows leaving the milking parlour after the morning milking were observed for occurrence of lameness. Cows were checked when walking on flat, clean concrete which was free of mud, muck and other contaminations which could cause cows to walk abnormally. For that reason the locomotion scoring system was used (Table 1). For measuring intra-observer variation a video camera was used and fifty cows were randomly recorded with notes about their score. The recorded video had been watched after the farm visit. The results from that observation and the one on the farm were compared for estimating repeatability of lameness judgement ($r = 0.83$, $P<0.05$). The following formula for calculating the repeatability coefficient with data obtained from Excel for Windows and SPSS 13.0 for Windows was used: $r = S^2A/(S^2 + S^2A)$; S^2A – variance between group; S^2 – variance within group.

Table 1. Locomotion score of dairy cattle

Lameness score 1 Normal	Stands and walks normally with a level back. Makes long confident strides.
Lameness score 2 Mildly lame	Stands with flat back, but arches when walks. Gait is slightly abnormal.
Lameness score 3 Moderately lame	Stands and walks with an arched back and short strides with one or more legs. Slight sinking of dew-claw in limb opposite to the affected limb may be evident.
Lameness score 4 Lame	Arched back standing and walking. Favouring one or more limbs, but can still bear some weight on them. Sinking of the dew-claws is evident in the limb opposite to the affected limb.
Lameness score 5 Severely lame	Pronounced arching of back. Reluctant to move, with almost complete weight transfer off the affected limb.

Relations between number of orthopaedic blocks used by hoof trimmers, welfare measures and environmental factors

Cooperation with the leading professional trimming company helped obtained the information about the number of orthopaedic blocks used during trimmings on 15 out of 25 farms in 2010 and 2011. The number of blocks was transformed to units of blocks/100 cows (lactating and dry). All cows leaving the milking parlour were observed for the occurrence of lameness following the method described above. Environmental factors considered were described in chapter ‘The status of farms regarding their lameness prevention measures’. Then there was the possibility to run a Spearman Rank Correlation test, analysis of variance and Chi-square test to determine the strength of relationships between the number of orthopaedic blocks used on farms and environmental factors.

Rank of farms regarding changes in occurrence of lameness

During and between visits, farmers were given suggestions on how to minimise the risk for lameness occurrence. The observations of the 25 farms in two years with explanation of lameness prevention solutions affected in creating a rank of farms with their successes in dealing with lameness. Average lameness occurrences were put together in a rank from the greatest decrease to the greatest increase in an average percentage of lame cows on each farm with significant differences between 2010 and 2011.

Effectiveness of professional and on-farm hoof trimming in different conditions

Detailed investigations of trimming methods helped to rank farms according to their effectiveness in decreasing the number of lame cows in different circumstances. Similarly to previous parts of the current study, 25 Holstein-Friesian herds were observed. Two farms were found with no changes and cows were trimmed by on-farm trimmers as well as four farms with no changes with professional hoof trimmers employed. On four farms engineering projects were carried out (1 – milking parlour renewed, 1 – automatic scrapers and 2 – straw yards swapped for free stalls) and the on-farm trimming team was working. On three farms there were also engineering projects (1 – cubicles in one of the barns renewed and 2 – straw yards swapped for free stalls) but professional workers were employed. Two farms had exceeding levels of the following mycotoxins and these mycotoxins were observed: Alfatoxin Total > 0.005 mg/kg, T-2 > 1mg/kg, Zearlaenon > 0.15 mg/kg, DON > 2.5 mg/kg and an exceeded level of *Clostridium perfringens* > $1x10^2$ cfu/kg. On one farm a relatively high level of urea in milk was reported (43 mg/dl). Finally, on one farm, a probable TMR imbalance was observed. On three farms there were changes of trimming services. On the last four farms there were no changes (2), cubicles were renewed (1) and there was change in trimming (1), but on those farms the differences were reported to be not significantly different. Eleven on-farms trimming teams and four professional teams (companies) were judged. All cows leaving the milking parlour were observed for the occurrence of lameness following the method already described. Lameness estimations were put together into Excel for Windows. The results from 2010 and 2011 were compared using SPSS 13.0 for Windows by running a Chi^2 test using the number of cows in particular scales form 1 to 5. For checking the significance between changes on farms with on-farm trimmers and professional services, univariate analysis of variance was used.

Correlations between the occurrence of lameness and conformation traits

Out of 25 farms, 5 farms were selected for precise observations to measure correlations between the occurrence of lameness scores, body condition scores and conformation traits. Judge from the Hungarian Holstein-Friesian Association observed heifers at 15-18 months of age. Conformation recording recommendation integrated with the World Holstein-Friesian Federation guidelines on the international harmonisation of linear type was used. Linear classification is based on measurements of individual type traits instead of options. It describes the degree of trait not the desirability. Depending on age of cows locomotion scores were observed from one up to several years after the traits were observed. Every month from May 2010 to November 2011, five cows from the first lactation and five cows from second lactation were selected which gave a total of 826 cows. In some months there were less than five cows calving. During the visits the cows on the farm were judged for their locomotion score and body condition score. A 5-point scale locomotion score of dairy cattle was used which was described earlier. The cows were observed in the barns and were provided with relatively dry, unobstructed concrete surfaces. Cows which were found in the cubicles were given a few minutes to recover after standing up, so the impact of muscle cramps would not affect the cows' locomotion. For evaluating the body condition score, a 5-point scale condition score of dairy cattle published by was used. For measuring intraobserver variation notes were made at the beginning of the observation. Half of the cows were observed for the second time at the end of each visit and the results were compared with the first observation. The number of cows observed twice ranged from five (during the first visit) up to sixty (during the last visit, if no cow left the farm). Repeatability coefficient for locomotion scores was $r=0.87$, $P<0.05$ and for body condition scores $r = 0.92$, $P < 0.05$. The cows were observed for one and a half years, which means the animals were observed in different production groups (barns), stages of lactation and during dry period as well. Culled and slaughtered cows were included in records. All lactating cows entering the milking herds were judged at 15-18 months of age by the judge from Hungarian Holstein-Friesian Association. Production data and type traits reported were retrieved from the RISKA farm herd management software. Data was collected and transformed in Microsoft Office Excel application. A table was prepared and put into SPSS 13.0 for Windows. For calculations, the Pearson correlation coefficient between type traits and lameness score, and its associated significance value (p) was used to interpret the correlation between measures.

Effect of lameness on milk production

The material and methods from previous chapter were used to find associations between lameness scores, body condition scores and monthly calculated milk yields of 826 dairy cows on five farms. Production data was also retrieved from the RISKA farm herd management software and contained: milk yield, percentage of fat, protein and somatic cell count. The dataset contained a farm ID (1-5), cow ID, parity (1-3), months of lactation, body condition score (1-5), lameness score (1-5), clinically lame and not lame (1=lame=lameness score 3-5; 0=not lame=lameness score 1-2), never lame (1=lame at least once; 0=never lame during the observational period), lame for the first time (1=lame for the first time; 0= already lame or not lame in time of checking), and monthly calculated milk yield. BCS, LS and milk yields were also coded with observations up to five months before and up to five months after observed lameness for each three parameters. The Kolmogorov-Smirnov test of normality for a sample size of more than hundred was used to measure milk yield data which was found to be normally distributed (P>0.05). The occurrence of first lameness by month in milk was plotted, and the mean lactation curve for cows that were never lame and cows that were clinically lame during a lactation (ever lame) was compared visually in Excel for Microsoft. Data was collected and transformed in the Microsoft Office Excel application. Different linear models were used to evaluate the traits. For the analysis of milk production data, two linear models were used. Model I included five locomotion scores effects from the two months before and up to two months after the milk production data: (Milk = Cow[a)] + Farm[b)] + Lactation[b)] + Month of lactation[b)] + Ever Lame[b)] + Locomotion score (-2)[b)] + Locomotion score (-1)[b)] + Locomotion score (0)[b)] + Locomotion score (+1)[b)] + Locomotion score (+2)[b)]). Model II included body condition scores as further fixed effects from the period two months before and up to two months after the milk production data: (Milk = Cow[a)] + Farm[b)] + Lactation[b)] + Month of lactation[b)] + Ever Lame[b)] + BCS (-2)[b)] + BCS (-1)[b)] + BCS (0)[b)] + BCS (+1)[b)] + BCS (+2)[b)]). Model III was used to test the effect of locomotion scores on body condition scores (BCS): (BCS = Cow[a)] + Farm[b)] + Lactation[b)] + Month of lactation[b)] + Ever Lame[b)] + Locomotion score (-2)[b)] + Locomotion score (-1)[b)] + Locomotion score (0)[b)] + Locomotion score (+1)[b)] + Locomotion score (+2)[b)]). Model IV included the effects of body condition scores on locomotion scores: (Lameness = Cow[a)] + Farm[b)] + Lactation[b)] + Month of lactation[b)] + Ever Lame[b)] + BCS (-2)[b)] + BCS (-1)[b)] + BCS (0)[b)] + BCS (+1)[b)] + BCS (+2)[b)]). Additional fixed effects were lameness information from the period of two months before and up to two months after the measuring BCS measuring time. The fixed effects for each model were analysed by least-square analysis using the GLM-procedure in SAS 8.2 statistical software. For pairwise comparison the Dunnett test was used as the default.

[a)] random effect

[b)] fixed effects

Heritability of lameness

The same 826 milking cows from the five herds were chosen for estimating heritability and repeatability of lameness scores, body condition scores and milk yields. The significances of effects included in the four models presented were also calculated. The cows' 10-digit individual numbers (ENAR – Egységes Nyilvántartási és Azonosítási Rendszer) retrieved from the RISKA farm herd management software were converted with help of Hungarian Holstein-Friesian Association into pedigree data. The variance components were estimated with the GLM-procedure in SAS 8.2 statistical software **(SAS, 1999)**. The heritability was calculated as a ratio:

$$\sigma^2_a/(\sigma^2_a + \sigma^2_e),$$

while repeatability as:

$$(\sigma^2_p + \sigma^2_a)/(\sigma^2_p + \sigma^2_a + \sigma^2_e),$$

where: σ^2_a – the additive component;

σ^2_p – the permanent environment component;

σ^2_e – the error variance.

4. Main results of the thesis

Dairy welfare

Assessment of Hungarian Holstein-Friesian cattle proved welfare status on 25 farms observed being not drastically different to those found in the literature. 25 Holstein-Friesian dairy farms were better managed in aspects like fewer cows with hair loss, non-hock injuries, hock and knee lesions and shorter flight distance. Similar distributions with other authors were found with dirty hindlimbs, dirty udders, bedding lameness, mortality and culling of lactating cows, lifespan and mortality of calves. The worst results in comparison to already-presented studies were dirty flanks (Tables 2-7).

Table 2. Water and bedding quality for all age groups in 2010 and 2011

Group of cattle	Measure	Category	Percentage of farms 2010	Percentage of farms 2011	Difference
Young calves (<70days)	Water quality	1 – Clean	88	92	+4
		2 – Partly dirty	8	4	-4
		3 – Dirty	4	4	0
	Bedding	1 – Deep, clean and dry	80	72	-8
		2 – Uneven, soiled but dry	12	20	+8
		3 – Poor, soiled and wet	8	8	0
Older calves (>70days)	Water quality	1 – Clean	68	68	0
		2 – Partly dirty	12	8	-4
		3 – Dirty	20	24	+4
	Bedding	1 – Deep, clean and dry	48	56	+8
		2 – Uneven, soiled but dry	28	16	-12
		3 – Poor, soiled and wet	24	28	+4
Heifers	Water quality	1 – Clean	48	56	+8
		2 – Partly dirty	28	24	-4
		3 – Dirty	24	20	-4
	Bedding	1 – Deep, clean and dry	16	24	+8
		2 – Uneven, soiled but dry	28	28	0
		3 – Poor, soiled and wet	56	48	-8
Dry cows	Water quality	1 – Clean	32	36	+4
		2 – Partly dirty	32	32	0
		3 – Dirty	36	32	-4
	Bedding	1 – Deep, clean and dry	40	48	+8
		2 – Uneven, soiled but dry	36	32	-4
		3 – Poor, soiled and wet	24	20	-8
Lactating cows	Water quality	1 – Clean	24	32	+8
		2 – Partly dirty	32	36	+4
		3 – Dirty	44	32	-12
	Bedding	1 – Deep, clean and dry	28	20	+8
		2 – Uneven, soiled but dry	48	60	+12
		3 – Poor, soiled and wet	24	20	+4

Table 3. Welfare measures taken for young calves (<70days) in 2010 and 2011 and the difference between the observations in the two years

Measure	2010		2011		Differ.	Sig.
	Mean or % of farms	Std. dev.	Mean or % of farms	Std. dev.		
Water – No./1m of trough	15.32	13.07	13.78	12.46	-1.54	NS
Obviously ill (%)	3.50	2.86	3.20	3.22	-0.30	NS
Dirty flanks (%)	10.86	11.95	9.30	8.71	-1.56	P<0.001
Dirty hindlimbs (%)	7.41	14.80	5.76	8.32	-1.65	P<0.001
Dirty belly (%)	6.93	19.11	4.44	6.08	-2.49	P<0.001
Hair loss (%)	2.65	2.67	2.51	2.17	-0.14	NS
Non-hock injuries (%)	1.94	1.86	1.97	2.84	+0.03	NS
Hock and knee lesions (%)	2.46	2.51	2.09	1.95	-0.37	NS
Neck rail injuries (%)	9.40	9.97	10.43	13.21	+1.03	NS
Flight distance (cm)	71.68	20.29	71.88	20.30	+0.20	NS
Thin (BCS 1+2) (%)	12.23	9.60	10.59	8.10	-1.64	P<0.001
Lameness (%)	2.81	3.87	2.85	2.97	+0.04	NS
Unlimited water (% farms)	72	-	80	-	+8	NS
Diarrhoea (%)	4.50	4.62	4.21	3.83	-0.29	NS
Reared together (% farms)	20	-	16	-	-4	NS
Mortality (%)	10.49	13.86	11.18	11.26	+0.28	NS

Table 4. Welfare measures taken for older calves (>70days) in 2010 and 2011 and the difference between the observations in the two years

Measure	2010		2011		Differ.	Sig.
	Mean or % of farms	Std. dev.	Mean or % of farms	Std. dev.		
Water – No./1m of trough	56.23	35.76	58.89	29.87	+2.66	NS
Obviously ill (%)	2.54	2.34	3.02	2.99	+0.48	NS
Dirty flanks (%)	22.48	29.04	21.94	26.61	-0.54	NS
Dirty hindlimbs (%)	35.70	37.45	36.03	35.23	+0.33	P<0.001
Dirty belly (%)	27.24	32.23	25.77	30.91	-1.46	P<0.001
Hair loss (%)	2.59	3.84	3.02	3.79	+0.43	NS
Non-hock injuries (%)	2.87	2.45	2.86	2.23	-0.01	NS
Hock and knee lesions (%)	7.06	13.94	8.19	14.78	+1.13	P<0.001
Neck rail injuries (%)	34.45	39.26	36.76	36.06	+2.30	P<0.001
Flight distance (cm)	96.16	56.22	92.76	59.78	-3.40	NS
Thin (BCS 1+2) (%)	6.21	4.17	6.43	5.28	+0.22	NS
Lameness (%)	5.48	5.68	6.74	4.32	+1.26	NS
Unlimited water (% farms)	100	-	100	-	0	NS
Diarrhoea (%)	2.18	1.79	2.78	2.47	+0.61	P<0.005
Reared together (% farms)	100	-	100	-	0	NS

Table 5. Welfare measures taken for heifers in 2010 and 2011 and the difference between the observations in the two years

Measure	2010		2011		Differ.	Sig.
	Mean or % of farms	Std. dev.	Mean or % of farms	Std. dev.		
Water – No./1m of trough	52.69	25.76	56.25	23.62	+3.56	NS
Obviously ill (%)	3.77	4.21	3.26	3.80	-0.51	P<0.05
Dirty flanks (%)	21.70	19.29	20.70	16.68	-1.00	NS
Dirty hindlimbs (%)	41.41	29.11	35.61	25.05	-5.80	P<0.001
Dirty udder (%)	42.06	37.17	36.34	33.23	-5.72	P<0.001
Hair loss (%)	5.11	3.55	4.13	2.96	-0.98	NS
Non-hock injuries (%)	5.57	4.48	7.60	6.17	+2.03	P<0.001
Hock and knee lesions (%)	8.38	10.49	9.75	8.91	+1.37	P<0.05
Neck rail injuries (%)	35.74	31.30	33.42	29.97	-2.32	P<0.005
Flight distance (cm)	88.88	23.52	84.52	25.71	-4.36	NS
Thin (BCS 1+2) (%)	5.16	5.17	7.20	5.96	+2.05	P<0.05
Fat (4+5) (%)	11.52	8.60	10.26	7.29	-1.26	P<0.05
Lameness (%)	7.46	4.91	7.65	3.81	+0.19	NS
Adaptation period (% farms)	24	-	24	-	0	NS

Table 6. Welfare measures taken for dry cows in 2010 and 2011 and the difference between the observations in the two years

Measure	2010		2011		Differ.	Sig.
	Mean or % of farms	Std. dev.	Mean or % of farms	Std. dev		
Water – No./1m of trough	36.32	22.85	34.45	19.23	-1.87	NS
Obviously ill (%)	3.51	3.45	4.91	3.62	+1.40	P<0.05
Dirty flanks (%)	21.85	24.06	16.90	18.02	-4.95	P<0.001
Dirty hindlimbs (%)	37.38	26.44	34.73	21.75	-2.66	NS
Dirty udder (%)	21.62	30.75	15.24	18.38	-6.38	P<0.001
Hair loss (%)	10.51	8.91	11.66	8.38	+1.15	NS
Non-hock injuries (%)	11.65	13.86	12.93	13.42	+1.28	P<0.05
Hock and knee lesions (%)	15.28	13.03	16.75	13.39	+1.47	P<0.05
Neck rail injuries (%)	43.56	23.53	38.79	22.20	-4.77	P<0.001
Flight distance (cm)	97.12	38.26	98.40	36.47	+1.28	NS
Thin (BCS 1+2) (%)	13.17	9.41	18.62	12.29	+5.45	NS
Fat (4+5) (%)	17.85	10.29	22.31	12.92	+4.46	NS
Lameness (%)	24.90	9.33	28.30	10.73	+3.40	NS

Table 7. Welfare measures taken for lactating cows in 2010 and 2011 and the difference between the observations in the two years

Measure	2010		2011		Differ.	Sig.
	Mean or % of farms	Std. dev.	Mean or % of farms	Std. dev.		
Water – No./1m of trough	44.83	23.47	42.56	22.69	-2.27	NS
Obviously ill (%)	4.13	2.97	5.58	4.38	+1.46	P<0.001
Dirty flanks (%)	26.85	27.22	20.19	18.08	-6.66	P<0.001
Dirty hindlimbs (%)	50.14	33.17	43.62	29.88	-6.52	P<0.001
Dirty udder (%)	24.73	26.69	20.97	23.56	-3.76	P<0.001
Hair loss (%)	13.19	11.05	14.09	11.11	+0.90	NS
Non-hock injuries (%)	14.17	16.30	14.35	13.33	+0.18	NS
Hock and knee lesions (%)	18.24	14.57	23.03	19.28	+4.79	P<0.001
Neck rail injuries (%)	49.30	35.68	45.63	35.11	-3.66	P<0.001
Flight distance (cm)	87.92	42.49	82.86	34.90	-5.06	NS
Thin (BCS 1+2) (%)	27.28	16.21	40.40	14.07	+13.13	P<0.001
Fat (4+5) (%)	15.65	11.36	5.89	3.42	-9.76	P<0.001
Lameness (%)	27.31	13.51	35.29	10.88	+7.98	P<0.001
Lifespan (No.)	2.42	0.26	2.47	0.24	+0.05	NS
Culling (%)	20.06	13.65	21.11	12.24	+1.05	NS
Mortality (%)	4.86	6.84	4.80	5.65	-0.06	NS
Idling (%)	11.34	7.04	13.72	8.69	+2.38	P<0.001
Grooming brushes (% farms)	36	-	36	-	0	NS

Voluntarily given advice to farmers affected in highly significant improve in cleanliness of all groups of cattle and from significantly to highly significantly improve of body conditions of thin younger calves, fat heifers and fat lactating cows. There were significantly less obviously-ill heifers reported and from very to highly significantly less neck rail injuries among heifers, dry and lactating cows. Decrease in welfare was observed in older calves with highly significantly dirtier hindlimbs, highly significant and significantly higher number of thin heifers and lactating cows, respectively. A higher number of older calves with diarrhoea and more dry and lactating cows being obviously ill were estimated. More lameness and idling behaviours were found in lactating cows. A higher number of hock and knee lesions was discovered among older calves, heifers, dry and lactating cows. Finally, more neck rail injuries among older calves with more non-hock injuries in heifers and dry cows were observed. A total of eighteen positive and fourteen negative measures were discovered after providing farmers with dairy welfare solutions. Estimates found in the study confirm that farmers made compromises between improved cleanliness with better body conditions and ill cattle with injuries.

Lameness

Status of farms regarding their lameness prevention measures

Table 8. Lameness measures taken for lactating cows – part 1

Measure		% of farms 2010	% of farms 2011	Difference (Not sign.)
Methods of trimming				
Professional trimming		52	60	+8
On-farm trimming		40	40	0
No trimming		8	0	-8
Records of lameness cases		52	56	+4
Housing type Free stall		48	60	+12
Straw yard		52	40	-12
Bedding mat. Corn stover		4	24	+20
Straw		96	76	-20
Scraping method Tractor		84	76	-8
Scraper		16	24	+8
Grooved concrete		28	32	+4
Surface quality	1 – relatively dry, no holes not slippery	4	16	+12
	2 – wet or some holes or slippery	60	52	-8
	3 – wet, some holes and slippery	36	32	-4
Lunge area		46	60	+14
Brisket board		62	73	+11
Rising 1 - Unrestricted		44	36	-8
2 - Mildly restricted		40	44	+4
3 - Seriously restricted		16	20	+4
Easy water access		64	64	0
Ventilators		68	72	+4
Steps in milking parlour		24	28	+4
Grooved concrete		60	72	+12
Smooth turns		32	32	0
Silage exposure (%)		100	100	0
Clamp tidiness		44	52	+8
Access to paddocks		44	40	-4
Shade		64	62	-2
Track camber		7.7	15.4	+7.7
Stones on track		38.47	30.77	-7.7
Sharp turns		23.07	30.77	+7.7
Good gateway condition		23.07	30.77	+7.7
Dry cows in straw yards		84	84	0
Heifers adaptation period		24	24	0
Heifers – trimming		28	28	0

Table 9. Lameness measures taken for lactating cows – part 2

Measure		2010		2011		Difference (Not sign.)
		Mean	Std. dev.	Mean	Std. dev.	
Foot bathing (No./week)		1.38	1.45	1.56	1.42	+0.18
Trimming (No./year)		1.72	0.61	1.95	0.28	+0.23
Passageways (cm)		356.10	85.09	348.80	86.71	-7.30
Extra free stalls (No.)		8.28	3.84	8.99	3.79	+0.71
Free stall length (cm)		221.77	17.22	223.80	16.92	+2.03
width (cm)		114.08	5.94	115.87	5.57	+1.79
Neck rail horizontal (cm)		164.46	18.47	167.20	16.20	+2.74
vertical (cm)		116.54	10.28	117.37	9.57	+0.83
Degree – turning (°)		82.80	42.45	80.00	43.08	-2.80
Silage	Dark layer – top (cm)	16.80	10.30	12.80	12.51	-4.00
	Mould on clamp (%)	14.72	24.63	11.70	15.05	-3.02
	Mean temperature (°C)	29.43	6.07	26.86	6.26	-2.57
	Big bale damage (%)	3.20	10.09	1.20	4.15	-2.00
Building-paddock (m)		175.7	257.5	188.4	263.4	+12.7
Width of track (m)		4.91	2.51	4.70	2.62	-0.21

Relations between the occurrence of lameness, welfare measures and environmental factors

Table 10. Correlations between occurrence of lameness, welfare measures and environmental factors observed on 25 dairy farms in Hungary

Measures	No. of farms	Correlation coefficient (lameness)	Significance
Foot bathing (No./week)	50	+0.29	0.045
Extra free stalls (%)	50	-0.41	0.034
Milking cows – Obviously ill (%)	50	+0.29	0.040
Milking cows – BCS*1 (%)	50	+0.36	0.010
Milking cows – BCS*2 (%)	50	+0.40	0.004
Milking cows – BCS*3 (%)	50	-0.52	0.001
Thin dry cows (%)	50	+0.43	0.002
Dry cows bedding cleanliness	50	-0.31	0.03

*) Body Condition Score

Table 11. Analysis of variance between means of lameness in different environmental conditions

Measures	No. of farms	Mean of lameness	Std. dev.	Significance
Limited access to water	19	36.31	12.76	0.029
Easy access to water	31	28.23	11.99	
Feeder (flat surface)	25	27.08	12.88	0.018
Feeder (concrete trough)	25	35.52	11.44	
Feed yard non-grooved	31	35.97	12.03	0.001
Feed yard grooved	19	23.68	10.25	
Milking parlour with no steps	32	28.42	12.82	0.032
Milking parlour steps >5cm	18	36.42	11.32	

Table 12. Analysis of variance between mean occurrence of hock and knee lesions in straw yard and free stall barns

Measures	No. of farms	Mean of hock and knee lesions	Std. dev.	Significance
Straw yard	24	13.88	11.88	0.006
Free stall	26	26.85	18.92	

Table 13. Rising opportunities with different cubicle setups

		Measures			
		No lunge area	Lunge area present	No brisket board	Brisket board present
Rising scores	1 - Unrestricted	0	12	0	12
	2 - Mildly restricted	9	3	6	6
	3 – Very restricted	4	0	3	1
No. of farms		28		23	
Df		2		2	
Chi-Square Tests - Value		18.96		10.87	
Asymp. Sig. (2-sided)		0.001		0.005	

Relations between the number of orthopaedic blocks used by hoof trimmers, welfare measures and environmental factors

Table 14. Analysis of variance between mean the number of orthopaedic blocks used by hoof trimmers in different environmental conditions

Measures	No. of farms	Mean blocks	Std. dev.	Significance
On-farm hoof trimming	10	5.63	3.85	0.044
Professional hoof trimming	14	10.65	5.64	
Straw yards	14	6.72	4.20	0.019
Free stalls	10	11.86	5.72	
Scraping – scraper	19	7.29	3.99	0.003
Scraping – tractor	5	14.83	6.45	
Lunge area present	5	7.42	3.76	0.004
Lunge area not present	5	16.31	3.16	
Water surface quality – good	16	7.36	4.35	0.039
Water surface quality – bad	8	11.87	6.38	
Feed yard surface grooved	13	6.39	3.41	0.012
Feed yard surface not grooved	11	11.79	6.03	
Parlour – smooth flooring	12	7.98	5.47	
Parlour – rough flooring	8	12.34	4.82	0.04
Parlour – rubber flooring	4	4.59	1.48	
No access to paddocks	10	12.75	4.40	0.001
Access to paddocks	14	6.09	4.34	
Track – no stones	6	3.84	1.59	0.047
Track – stones present	4	7.51	3.68	

Table 15. Correlations between the number of orthopaedic blocks used by hoof trimmers, welfare measures and environmental factors observed on 25 dairy farms in Hungary

Measures	No. of farms	Correlation coefficient (blocks)	Significance
Foot bathing (No./week)	24	+0.59	0.003
Hoof trimming per year	24	+0.41	0.049
Extra free stalls (%)	24	-0.85	0.002
Passageways – feeder (m)	24	-0.42	0.042
Building – paddock (m)	10	+0.82	0.007
Passageways – cubicles (m)	20	-0.60	0.005
Neck rail – vertical position	10	-0.73	0.016
Lactating cows perching (%)	20	+0.51	0.02
Heifers dirty hindlimbs (%)	20	+0.45	0.02

Effectiveness of professional and on-farm hoof trimming in different conditions

Table 16. Changes in occurrence of lameness after on-farm and professional hoof trimming

<table>
<tr><th rowspan="2">Sig.</th><th colspan="2">Claw trimming</th><th rowspan="2">Lameness in 2011 in comparison to 2010 (%)</th><th rowspan="2">No. of farms and changes observed</th></tr>
<tr><th>2010</th><th>2011</th></tr>
<tr><td rowspan="9">Yes</td><td colspan="2">On-farm</td><td>+8.8</td><td>2 – no change</td></tr>
<tr><td colspan="2">Professional</td><td>+5.6</td><td>5 – no change</td></tr>
<tr><td colspan="2">On-farm</td><td>+18.9</td><td>1 – milking parlour renewed
1 – automatic scrapers
2 – straw yards swapped for free stalls</td></tr>
<tr><td colspan="2">Professional</td><td>+2.1</td><td>1 – cubicles in one of the barns renewed
2 – straw yards swapped for free stalls</td></tr>
<tr><td colspan="2">On-farm</td><td>+17.6</td><td>1 – high level of urea
1 – mycotoxins</td></tr>
<tr><td colspan="2">Professional</td><td>+15.2</td><td>1 – mycotoxins
1 – TMR imbalance</td></tr>
<tr><td>On-farm</td><td>Professional</td><td>-13.6</td><td rowspan="3">3 – change in claw trimming</td></tr>
<tr><td>Professional</td><td>On-farm</td><td>+21.6</td></tr>
<tr><td>No</td><td>Professional</td><td>-12.3</td></tr>
<tr><td rowspan="4">No</td><td colspan="2">On-farm</td><td>-0.2</td><td>1 – no change</td></tr>
<tr><td colspan="2" rowspan="2">Professional</td><td>-10.8</td><td>1 – no change</td></tr>
<tr><td>-1.7</td><td>1 – cubicles renewed</td></tr>
<tr><td>No</td><td>Professional</td><td>-0.1</td><td>1 – claw trimming</td></tr>
</table>

Rank of farms regarding changes in the occurrence of lameness

Among the 25 farms the prevalence of lameness was decreased on 16% of the farms and controlled (did not change statistically) on 20% of the farms; that means that those farmers recognised the locomotion problems and took effective actions. The most common effective changes were employing professional hoof trimmers, checking cows between trimmings and provisions of effective foot baths. One needs to consider that on the majority of farms engineering projects, silage contamination with mycotoxins and probable energy-imbalanced diets were reported between 2009 and 2011. Those factors are very likely to be thought to have a significant impact on the increased number of lame cows. It is also possible that an elevated occurrence of lameness between 2010 and 2011 will drop after some time on farms where negative factors were observed. The results give promising information that decreasing the prevalence of lameness is possible on Hungarian dairy farms. On the other hand, there was proof that old and unreviewed routine programs for preventing lameness need to be altered and implemented according to changing conditions on the farms.

Correlations between the occurrence of lameness and conformation traits

Table 17. Correlations between lameness and traits observed on 5 dairy farms

Trait	Present study	**BOETTCHER et al. (1998)**	**BOELLING and POLLOTT (1998a)**	**BOELLING and POLLOTT (1998b)**
Rear Leg Side View	+0.30**	+0.13**	+0.44**	+0.22*
Front Teat Placement	+0.19**	-0.33**	-	-
Rump Angle	+0.18**	-0.03**	-	+0.03**
Back Teat Placement	+0.18**	-	-	-
Dairy Form	+0.18**	+0.60**	-	-
Udder	+0.15**	-	+0.07*	-
Udder Cleft	+0.14**	-0.46**	-	-
Body Depth	+0.14**	+0.42**	-	-
Udder Depth	+0.13**	-0.44**	-	-0.15 to 0.15*
Stature	+0.13**	-	-	-
Strength	+0.12**	+0.22**	-	-
Rear Udder Height	+0.12**	+0.26**	-	-
Rump Width	+0.12**	+0.63**	-	-
Milk yield/1 lact.	+0.12**	-	+0.09*	-
Feet and legs	+0.11*	+0.11*	-	-
Teat Length	+0.10*	+0.30**	-	-
Fore Udder Attachment	+0.09**	-0.06*	-	-
BCS	-0.40**	-	-	-
Rear Leg Rear View	-	-0.68*	-	-
Foot Angle	-	-0.76*	-0.08*	-0.21*

* – $P < 0.05$; ** – $P < 0.01$

Effect of lameness on milk production

Among all the cows, 48.2% of them on five farms became lame at least once during the study. The incidence of first episode of lameness peaked at 1 and 3 months after calving. Never lame cows produced 1.22 kg more milk/d than cows that were lame at least once. This is a mean of 372.1 kg extra kilograms of milk over 305 days of lactation. In the study, cows that were lame at least once during the study had a higher fat content in the milk (mean 3.57% and standard deviation 0.82) in comparison to never lame cows during the study (mean 3.41% and standard deviation 0.89). In the present study significantly more lame cows were observed in winter than in the summer. In the current study the BCS was significantly higher in non-lame cows (scores 1-2) in comparison to lame cows (scores 3-5) two months before milk yield test day and lameness were observed. Regarding milk yields, the highest milk yields were observed in those cows that had the lowest lameness score observed two months earlier. The relationship between lameness score (two months earlier) and current milk yields shows that if the cows' locomotion score changes from 1-2 to 3-5 there will be a significant drop in milk production observed in the preceding two months.

Heritability of lameness

eritability was found to be very low in four models and the lowest in the model including the effect of body condition scores on locomotion scores (0.029). Effects significantly influencing milk yield in the first model including the effect of locomotion scores on milk yield were cow, farm, lactation number and locomotion scores observed two months earlier. In the second model with the effect of body condition scores on milk yield cow, farm, lactation number and cow being ever lame, affected significantly milk yield the most. The third model consisting of the effect of locomotion scores on body condition scores was influenced significantly by cow, farm, lactation, cows being ever lame, current locomotion score and locomotion score observed two months later. The fourth model with the effect of body conditions scores on lameness scores was significantly affected by all factors except lactation number and month of lactation.

5. New scientific results

Dairy welfare

1. Even the great shift of milk yields in the last 12 years the average welfare measures were not different to those found in the literature.
2. In total, eighteen positive and fourteen negative measures were discovered after providing farmers with dairy welfare solutions.

Lameness

1. The effectiveness of professional over on-farm hoof trimming was proved on Hungarian dairy farms.

2. The relationship between the lameness score (2 months earlier) and current milk yield shows that if the cows' locomotion score changes from 1-2 to 3-5 there will be significant drop in milk production observed in the succeeding two months.

3. BCS was significantly higher in non-lame cows (scores 1-2) in comparison to lame cows (scores 3-5) two months before milk yields and locomotion were observed.

6. Publications, proceedings, presentations and workshops related to the dissertation

Publication in impact factor journal:

Gudaj, R.T., Brydl, E., Lehoczky, J. and Komlósi, I. (2013): Impact of different management methods on prevalence of lameness in 25 Holstęin-Friesian herds in Hungary. Annals of Animal Science. (Accepted for printing 16 January 2013, vol., issue and no. of pages not provided, impact factor: 2009 – 0,346; 2010 – 0,209; 2011 – 0,389).

Publications in refereed (peer reviewed) journals:

Gudaj R.T., Brydl. E. and Komlósi, I. (2012): Improving welfare on 25 Holstein-Friesian farms in Hungary. Animal welfare, ethology and housing systems, Volume 8, Issue 2, 240-253.

Gudaj R.T., Brydl. E. and Komlósi, I. (2012): Associations between the occurrence of lameness, number of orthopaedic blocks used by hoof trimmers and management risk factors in dairy cow herds. Animal welfare, ethology and housing systems, Volume 8, Issue 2, 223-239.

Gudaj R.T., Brydl. E. and Komlósi, I. (2012): Analysis of lameness traits and type traits in Hungarian Holstein-Friesian cattle. Animal welfare, ethology and housing systems. Animal welfare, ethology and housing systems, Volume 8, Issue 2, 215-222.

Gudaj R.T., Brydl. E., Posta, J. and Komlósi, I. (2012): Effect of lameness on milk production on Holstein-Friesian farms in Hungary. Hungarian Journal of Animal Production, Volume 61, Issue 2, 66-77.

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Gudaj, R.T. (2010): Lameness and well-being in dairy cattle in Szűcs, E., Konrád, Sz., and Sossidou, E.N. (2010) Basics of animal welfare & product quality. Gödöllő: Szent István University Press, 231-255.

Publications in Hungarian dairy journal:

Gudaj R.T., Budai Cs., Brydl E., Komlósi I. (2012): A sántaság alakulása hazai tehenészetekben III. Sikerek a sántaság megelőzésében és csökkentésében. Holstein Magazin, Volume 20, Issue 5 40-42. [In Hungarian].

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Proceedings:

Gudaj, R.T., Brydl E., Lehoczky J. and Komlósi I (2012): Risk factors for increased use of orthopaedic blocks by hoof trimmers on dairy farms, 22nd International Congress of the Hungarian Association for Buiatrics, 17-20 October 2012, Kecskemét, Hungary. 47-53.

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Gudaj, R.T., Lehoczky, J., Brydl, E. and Komlósi, I. (2011): Kulawizny krów mlecznych na Węgrzech. In: Proceedings of Present problems of buiatrics, conference of Polish Association for Buiatrics, 7-8 October 2011, Łomża, Poland. 41-47.

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Gudaj, R.T. (2010): The behaviour of cows in response to rubber mats in milking parlour stalls. In: Proceedings of 63rd Students' International Scientific Conference at Russian State Agricultural University, 16-19 March 2010, Moscow, Russia, 53-62.

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Training in the Welfare Quality® Assessment Protocols, Host - Prof. Christopher Winkler, September 23, 2011, BOKU-University of Natural Resources and Life Sciences, Vienna, Austria.

Provisional Programme 1st Biobusiness Workshop organized by The Institute of Animal Hygiene, Animal Welfare and Farm Animal Behaviour, University of Veterinary Medicine Hannover, Foundation in the Institute of Animal Welfare and Animal Husbandry, Friedrich-Loeffler-Institut Dörnbergstrasse 25/27, 29223 Celle, Germany, 2010.11.15