

**Concress sub theme: Technology**

**STATUS AND ECONOMIC IMPLICATIONS OF ANIMAL  
WELFARE IN DAIRY FARMING**

### Abstract

*The issue of animal welfare continues to be the focus of attention. There are professional and emotional discussions from many sides. For agriculture, this poses enormous challenges for the future viability of modern animal husbandry. In dairy farming, the focus of the expert discussion should be on the relationship between animal welfare and profitability. Only 21% of the milk cows reach the phase of the highest lactation performance; i.e., a majority of the cows are culled earlier due to diseases, causing high costs. This study presents the first results from the project: “**Animal welfare and economic efficiency in the future-oriented dairy farming - evaluation of various actions and their economic impact**”, using the example of four dairy farms. The analyses show weaknesses in animal welfare in all cases. The most serious deficiencies are in the barn floor and in the condition of the lying cubicles in the barns. This applies to three of the four farms under investigation. In addition, the study reveals that additional cow comfort, such as a paddock and functioning cow brushes, are rarely offered so far. This equipment was not found on any of the participating farms. The results of the cost analysis show that the animal welfare measures can cause a considerable additional cost of up to 10 cents per kg of milk. The investigations will be extended to a further 30 dairy farms in the remaining project term. The aim is to analyse the benefits of the measures concerning animal welfare and the lifetime production of the cows, as well as the marketing of the milk. At least a partial compensation of the rising production costs could be achieved.*

### Keywords

*Animal welfare, dairy farming, agricultural economics, farm management, cost analysis, analysis of weaknesses*

## 1. Introduction

High demands are placed on animal husbandry in Germany and the EU. Animal welfare is a subject strongly discussed by farmers, consumers and politicians. In society, food safety (Anonymus, 2014), but also the standardization of animal welfare (Lundmark et al, 2014) play an important role. Ethical aspects require the animal to live as long as possible according to its needs. Such modern livestock systems, which are adapted to healthy and efficient animals, have to be developed or, at least, further optimized. In Germany, therefore, compliance with an animal welfare standard for new buildings is required by the agrarian investment promotion program within the framework of agricultural policy support (Bergschmidt et al., 2014). However, the actual state of the animals with regard to their well-being and health is not taken into account, as is the case with the farm's own control, which has been prescribed by the Animal Protection Act since 2014, with appropriate animal welfare parameters (§ 11 para 8 TierSchG, 2013). In spite of the requirement of operational self-control of livestock keepers, there is no universally valid standard for carrying out and documenting the control (Schultheiß and Zapf, 2015). For this reason, a practice-oriented list of criteria and a case study were developed in research projects. In the meantime, numerous publications have shown that animal welfare can be objectively measured on the basis of direct (animal-related) parameters and, on the other hand, indirect parameters which are measured in the animal environment.

Nevertheless, the period of use of dairy cows has not been significantly increased in the past 30 years (Romans, 2011). The highest milk yield is achieved in the fourth lactation, only 21% of all cows reach this age in Germany (Romans 2011). Urgent action is required. In all measures to promote animal welfare, it is important to keep an eye on the economic impact and to develop methods that take animal welfare more into account in economic controlling. Not unimportant is the optimal period of use, which can only be achieved with healthy cows.

As the main causes for early slaughtering of dairy cows, udder diseases, infertility and diseases of the claws and limbs could be identified in various investigations (Baumgärtel, 2014). Rütz (2013) showed a direct relationship between increased animal welfare and animal performance. Moreover, Bennett (1995) and Bennett and Larsson (1996) showed on an international scale that the application of the method of the contingency valuation approach offers a possibility to link animal welfare and economics. The im-

portance of this linkage as an economic success factor is shown by Lusk et al. (2011) in recent studies with the result that animal welfare is the central requirement for modern agriculture and the economy plays an important role in the animal welfare debate. In addition to the challenge of reconciling the needs of animals, consumers, policy makers and farmers, the debate should also take into account the fact that German farmers are competing with foreign animal producers (Isermeyer, 2014). Therefore, there is a clear need for a cost-benefit analysis of animal welfare measures in dairy farming. This is the aim of the research project "**Animal welfare and economic efficiency in the future-oriented dairy farming - evaluation of various actions and their economic impact**". On the basis of a weakness analysis of the animal welfare state on dairy farms and an economic evaluation of animal welfare measures, procedural and economic recommendations for action can be given to the animal owners. The main objective is to ensure the profitability of the farms with increasing demands on animal husbandry. This is to be expressed in the long term in an extended period of use. The first project results from four case studies are presented in this publication. A total of 30 additional farms are to be included in the investigation in the course of the year.

## **2. Proceeding**

The investigating farms of the first four case studies are located in Mecklenburg-Vorpommern and one in Brandenburg. All are large enterprises and are managed by employed managers. The size of the herd on the farms ranges from 220 to 1,500 cows. Three of the four farms have the Holstein-Friesian breed and one the Jersey breed. The animals are kept on all farms in free barns or open barns. On one farm, this barn is equipped with deep lying cubicles, on one with normal and deep litter cubicles and on the other two farms with normal lying cubicles. As a milking system, a milking parlour is installed on three farms and a milking robot is installed on one farm.

The results of the investigations from data collection to data analysis are shown in Figure 1. The following data are collected on the farms:

- A) In the animal welfare / technology section, the key figures are technopathy and animal behaviour, the environment of management, management and feeding in the group of highly lactating cows. Data collection was carried out using the following methods:

1. with the help of the software Cows and More (pro Plant and Landwirtschaftskammer Nordrhein-Westfalen, 2016), which is designed for analysing the weak points of the animal welfare in dairy cows (e.g.: where the cows lie, the dimensions and condition of the booths)
2. with a supplementary survey form (e.g.: barn climate, avoidance distance)
3. by visual inspection with image documentation (e.g.: special characteristics of the barns, arrangement of functional areas)

In this way the animal welfare state is recorded on the farms.

B) In the economic project section these data are linked to economic key figures of the enterprises (e.g.: income / income ratio, direct costs free services, calculable profit), with the methods:

1. Gross margin calculation for the milk operation of each farm
2. Query of data from the herd management program of the farms (e.g.: causes of leaving, age of birth, birthrate rate)
3. Further relevant data on controlling and management (e.g.: qualification of employees and work processes in barns)

In the second step of the project analysis, the data records of the animals' actual state are compared with the animal welfare status. The target values of animal welfare indicators were previously developed on the basis of a broad literature research. On this basis, a weakness analysis is carried out on the farms. On the basis of the identified weaknesses in the areas of technopathy and animal behaviour, the environment of management, management and feed, recommendations for action can be given with the help of previously established target values of animal welfare indicators.

<b>Data base</b>		
Current state of animal welfare		Current state of profitability in milk production
Technopathies, Animal behavior	Environment	Input – Output – Relations Gross margin calculation Profitability
Management	Feed	
<b>Analysis</b>		
Current state of animal welfare		Target state of animal welfare
<b>Selection of measures</b>		
<b>List of measures</b>		
<b>Recommendation for the actual state of animal welfare</b>		
Short-term measures		Long-term measures
Improvement of the management = usually increases the working hours		Additional investments
<b>Economic evaluation of animal welfare measures a base</b>		
Target values of animal welfare indicators		Targets for profitability
Technopathies, Animal behavior	Environment	
Management	Feed	

**Figure 1: Project flow**

Source: Own presentation

The list of measures includes short-term and long-term measures which can contribute to an increase in animal welfare. Measures which can be implemented in the short term are measures which can be implemented in a few days or weeks. This mainly concerns management measures. Compared to this, measures that can be implemented in the long term include, for example, investments that require more planning and therefore a certain lead time.

The recommended measures are individually assessed economically for each farm. As a result, it is possible, among other things, to determine the extent to which investment requirements and operating costs will be high. A further step will be to examine whether the additional costs of animal welfare measures can be covered by the monetarily measurable benefits of the measures on animal health and lifetime production and how much the milk price would have to rise to bear the marginal costs.

### 3. Results

#### 3.1 Situation and need for improvements in animal welfare

Table 1 presents a summary of the weakness complex found in the farms in relation to animal welfare. In addition, the right column of the table counts on how many farms each problem appears. The lower column shows the number of weak points per plant.

Table 1: Vulnerability analysis animal welfare

Nr.	Weakness	Farm 1	Farm 2	Farm 3	Farm 4	Number of farms, total
1	No / too little paddock	x	x	x	x	4
2	No / broken brushes	x	x	x	x	4
3	Floor of moving area dirty			x		1
4	Floor of moving area uneven	x				1
5	Floor of moving area slippery		x	x		2
6	Need repairing loose and broken elements		x	x		2
7	Incorrect lying cubicle dimensions		x	x		2
8	Too less cows lying in the cubicles	x		x		2
9	Lying on the floor of the moving area			x		1
10	Cows are dirty	x	x	x		3
11	cubicles are dirty	x		x		2
12	Insufficient litter/bedding material in the lying cubicle	x		x		2
13	Hairless spots or increase in circumference on limbs	x	x	x		3
14	Non-rapid lying behaviour		x			1
15	Lowering of the head during walking	x	x	x	x	4
16	Lameness		x	x		2
17	Poorly positioned drinking bowl				x	1
18	Illumination	x				1
19	Barn climate	x				1
	Total number of weak points per farm	11	10	14	4	

Source: Own survey according to Cows and More (2016)

The situation analysis of the state of animal welfare on the farms shows that there were relevant faults on all farms. There are also clear differences between the farms in the number of deficiencies, and the strength of the deficiencies is clearly different. These factors indicate the extent of the need for improvement in animal welfare and the necessary measures. Table 2, which is divided into short-term and long-term measures, shows which measures are recommended for individual farms. The right column also shows the number of farms for which the measure is recommended. The bottom column shows how many measures are recommended per farm.

Farm 1: As a short-term measure, new cow brushes should be placed, as the existing ones were worn out and cow brushes are standard of cow comfort. It was also found that the cows lie too less in the lying cubicles and remain chewing in the floor/moving area. The high degree of contamination of the cows is also a sign that the lying cubicles are dirty and there is too little litter/bedding material. Therefore, the daily lying cubicle care should be improved. A sufficient litter/bedding material in the lying cubicles of the animals also prevents hairless spots and increased circumferences of the legs. As a long-term measure, it is recommended to renew the slattered floor, since there are uneven parts and it has edges, which is presumably a major reason for the lowered head-holding of the animals when walking. Lowering the head while walking indicates poor floor conditions, because the cows move more cautiously and look at the ground instead of sensing the environment as usual (Richter and Esser, 2006). In addition, the illumination and air conditioning of the barn is insufficient. In this barn, it is advisable to open a side of the barn completely and to install curtains instead. The expansion of the already existing paddock, which is too small for the number of animals, could be included in the necessary reconstruction. Regarding to the literature of Krause and Huesmann (2016), there are good reasons why paddocks are recommended. In stables with paddocks cows have more space to move and can choice their environment. On a paddock the cows are exposed to climate stimuli. This improves their health and has a positive impact to their hormonal balance and metabolism.

Farm 2: This farm has ten weak points with respect to the animal welfare, so it is in the middle range. Nevertheless, serious deficiencies were found. For the same reasons, as in farm 1, cow brushes should be installed in the short term and the lying cubicle care should be improved. In addition, loose elements were found in the lying cubicle separation. To prevent technopathies they should be repaired. Likewise, a row of lying cubicles is clearly too short. For this purpose, a remodelling solution should be found in the long term. In addition, it is advisable to rework the floor in the barn and to make it non-slip, as the cows have a lowered head position during running and excessive lameness was found. Also in this farm a paddock for the cows is missing.

Farm 3: In this farm the list of weak points is the longest with fourteen. Six measures to improve animal welfare are recommended. In the short term, broken barriers found in the barn have to be repaired, since these are outstanding and cause a risk of injury. Furthermore, a better cleaning of the floor is necessary, since it was very dirty during data col-



lection. This could be achieved in this farm by a more frequent shifting manure frequency. However, there is an enormous number of cows lying on the slattered floor and could thus be injured by the automatic slipper. For example, injuries of tails, udders and even leg fractures are known. The latter is achieved by the fact that the animals get under the slides. Therefore, a cleaning robot would be preferred in this farm. Also, the floor is not optimally safe and should be worked on. Both points can be the cause for the noticeably many lamenesses and the lower head-holding of the animals while running. In a shorter time the lying cubicle care on the farm could be improved. This is because the lying cubicles as well as the animals were filthy. However, this is also due to the lying of many cows on the slattered floor. The unsuitable lying cubicle dimensions are also regarded as the cause of this. The neck straps are too low and too far forward. A paddock for the cows should also be established in the long term.

Farm 4: This farm has only four weak points and three measures are recommended to eliminate them. In the short term, the potions should be converted as they are in the middle of a passageway and their unfavourable location hinders free cow traffic and increases the risk of injury in this area. In addition, it is recommended to install cow brushes and, in the long run, to build a paddock for the cows. The third weakness is the lowered head position while walking. However, no negative cause could be determined for this. Possibly this behaviour could result from the fact that the lying cubicles were covered with a lot of coarse-grained straw, which formed a thick layer in the walking floor.

Table 2: Recommended measures animal welfare

Measurements	Farm 1	Farm 2	Farm 3	Farm 4	Number of farms, total
Short term					
Brushes (1 brush for 55 cows)*	x	x		x	3
Change potions				x	1
Improve floor cleaning			x		1
Improve the lying cubicle care	x	x	x		3
Repair loose and broken parts		x	x		2
In the long run					
Replace / renew the floor	x	x	x		3
Open the barn side	x				1
Paddock installation (4,5 m <sup>2</sup> /cow)**	x	x	x	x	4
Replace the lying cubicle		x	x		2
Number of measures total per farm	<b>5</b>	<b>6</b>	<b>6</b>	<b>3</b>	

Source: Own survey according to Cows and More (2016); \*Reubold (2004); \*\*Krause und Huesmann (2016)

### 3.2 Economic analysis of animal welfare measures

The economic evaluation refers to the measures derived from the operational analysis for the improvement of animal welfare. A distinction is made between short-term and long-term measures. The individual changes are examined in horizontal and vertical farm comparison. The costs of the individual measures are divided into annual costs for technical changes and annual costs for additional management costs in the barn.

The calculation of the annual costs for the additional technical measures is carried out using the approximate calculation:

$$K_j = (A_o - R_w) / N + (A_o + R_w) \times (q - 1) / 2 + \Sigma R / N$$

with:  $K_j$  = annual costs;  $A_o$  = initial investment sum;  $R_w$  = remainder value;  $N$  = years;  $q$  = interest factor;  $R$  = repair costs

A fixed interest rate of 3% is assumed for the calculation of the annual costs. The calculation of the yearly maintenance costs is based on an average of 3.6% of the investment sum. The additional management costs are calculated with a fixed hourly wage of 15 € for additional labour load.

The individual measures include: 1. the installation of brushes; 2. the repair of loose and broken parts; 3. the improvement of the floor cleaning; 4. the change in the position of the drinking portions; and 5. the additional care of lying cubicles (3 minutes per cow and day); 6. the reconstruction of lying cubicles, 7. the replacement of the floor in the moving area, 8. the opening of one barn side, and 9. the construction of a paddock for the cows (Table 3).

The annual cost of the individual investment measures is between 227 and € 1,476 € per cow. The costs for the individual measures are between 60 and € 1,000 € with pure labour costs (2 and 4).

Table 3: Determination of annual additional costs for individual animal welfare measures

Lfd . Nr.	Animal welfare measure	Investment, €	Usage, years	Depreciation, € per year	Repairs, € per year.	Interest, € per year	Hours per cow and year	Yearly costs per unit, €
1	Brushes	1,200	7	171	43	12		227
2	Repair of loose and broken parts						60	60 *
3	Improve floor cleaning	6,000	5	1,200	216	60		1,476
4	Change the position of the potions	1,000						1,000 *
5	Additional care of lying cubicle (3 min.)						18	274
6	Reconstruction of lying cubicle	3,000	15	200	108	30		338
7	Replacement of the floor in the moving area	50	15	3	2	1		6
8	Open barn side	5,000	20	250	180	50		480
9	Paddock installation	4000	20	200	144	40		384

Source: KTBL; Own calculation, \* Individual measures

The annual additional costs of the proposed animal welfare measures vary depending on the scale of the measures between 99,285 € in farm 4 and 1,170,934 € in farm 2. The farms 1 and 3 are in the middle range with 147,331 € and 286,008 € respectively. The cost burden per kilogram of milk produced is between 0.06 € and 0.10 €. The farms 1 and 2 are located at 0.068 € and 0.079 € respectively in the middle section (Table 5).

Table 4: Additional costs for measures to improve animal welfare per farm

Farm		Farm 1	Farm 2	Farm 3	Farm 4	
Herd size, number of cows		220	1,500	280	253	
Milk yield, kg per cow		9,816	9,887	9,500	7,500	
Average long-term milk price, €/kg		0.30	0.30	0.30	0.40	
Animal welfare measure		Yearly costs per unit, €	Type and number of recommended measures			
Short-term	Brushes	227 €	4	30	5	5
	Repair of loose and broken parts	60 €		1	1	
	Improve floor cleaning	1,476 €			3	
	Change the position of the potions	1,000 €				1
	Additional care of lying cubicle (3 min.)	274 €	220	1,500	280	
	<b>Sum; € per year</b>		61,132 €	417,484 €	82,271 €	2,133 €
	<b>Costs per cow, € per year</b>		278 €	278 €	294 €	8 €
	<b>Costs per kg milk, €</b>		0.0283 €	0.0282 €	0.0309 €	0.0013 €
	<b>Costs in % of milk price</b>		9 %	9 %	10 %	0,3 %
Animal welfare measure		Yearly costs per unit, €	type and number of recommended measures			
Long-term	Reconstruction of lying cubicle	338 €		500	280	
	Replacement the floor in the moving area	6 €	220	1,500	280	
	Open barn side	480 €	1			
	Paddock installation	384 €	220	1,500	280	253
	<b>Sum; € per year</b>		86,199 €	753,450 €	203,737 €	97,152 €
	<b>Costs per cow, € per year</b>		392 €	502 €	728 €	384 €
<b>Costs per kg milk, €</b>		0.04 €	0.051 €	0.077 €	0.059 €	
<b>Costs in % of milk price</b>		13 %	17 %	26 %	15 %	
Additional costs	<b>Sum; € per year</b>		147,331 €	1,170,934 €	286,008 €	99,285 €
	<b>Costs per cow, € per year</b>		670 €	781 €	1,021 €	392 €
	<b>Costs per kg milk, €</b>		0.068 €	0.079 €	0.108 €	0.06 €
	<b>Costs in % of milk price</b>		23 %	26 %	36 %	15 %

Source: Own calculations; Table 1 -3

The additional costs are divided into short- and long-term costs depending on the measure. The absolute amount of short-term costs varies between 2,133 € and 417,484 € in

farm 2. The cost per kilogram of milk produced is between 0.0013 € and 0.0309 €. Additional costs of up to 10 cents / kg of milk would be significant, which will be discussed further below. The share of extra costs in milk production is therefore between 15% and 36%. For short-term and long-term costs, the share is between 0.33% and 10.30%, or 13.33% and 25.67%.

The relative proportion of the additional costs is essentially influenced by the measures: paddock, additional care of lying cubicles and the reconstruction of the lying cubicles. Depending on the number of necessary measures per farm, the construction of a paddock comprises between 38% and 98% of the additional costs and thus forms the proportionally largest cost block in this view. The measures: removing brushes, repair of loose and broken parts in the moving area of the animals, improving floor cleaning, changing the position of the potions, renewing the floor in the moving area and opening the barn side are summarized in the category "other measures" (Fig. 2).

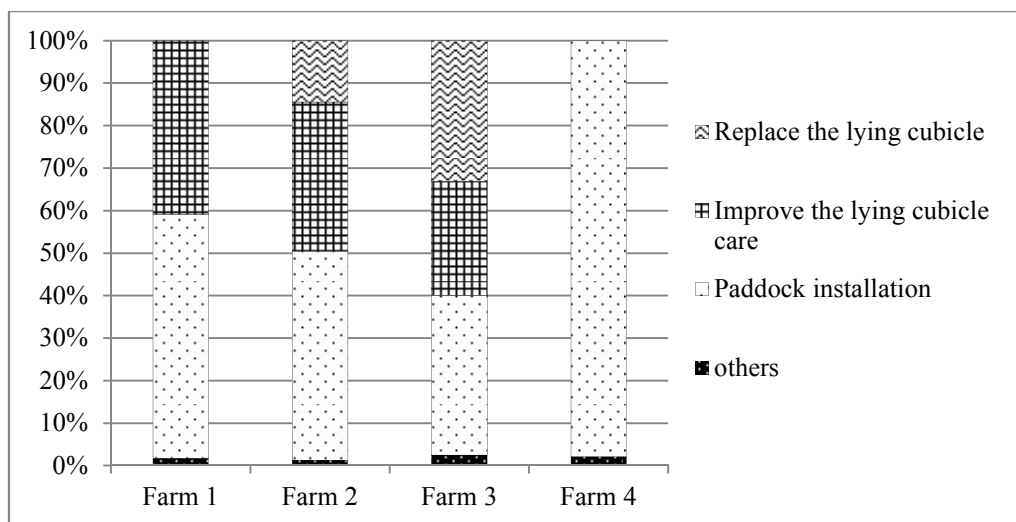


Figure 2: Relative cost of animal welfare measures

Source: Own presentation

So far, there are no legal requirements which require the construction of a paddock. Furthermore, this could be replaced under favourable operating conditions by the possibility of daily grazing. The comparison also concludes that smaller and rapidly implementable measures, such as changing the position of potions and improving soil cleansing, will only increase costs marginal but could have a rapid positive effect on animal welfare.

Furthermore, it would be necessary to investigate whether a "too economical" management has been carried out at the expense of animal welfare. It is possible that synergy

effects also compensate for the new costs. In the case of future new buildings of cow barns, the improvements introduced here could be avoided if the planning and construction were to pay more attention to the needs of the animal welfare and thus save subsequent costs.

Finally, it should be noted that the amount of annual additional costs per farm varies greatly depending on the range of measures. It is clear that, in particular, the existing number of animals and a high milk yield associated with them have a significant influence on the cost distribution in the dairy sector. This is seen retrospectively, particularly when comparing the annual additional costs between farms 2 and 3. It is to be assumed that farms with high numbers of animals and milk quantity can better compensate for the investments in animal welfare than farms with low numbers of animals and medium quantities of milk.

#### 4. Conclusion

In general, it can be assumed that measures which can already be implemented in the short term, such as e.g. cow brushes or improved box and floor cleaning, could have a positive effect on animal welfare. Whether the resulting additional costs of the measures can be covered, cannot be answered here. Expected positive effects could be: falling veterinary costs, an increase in milk yields with a simultaneous prolongation of lifetime production of the cows and an improvement in consumer acceptance. However, it remains questionable whether an increase in animal welfare alone affects the consumer acceptance of modern animal husbandry so much that a resulting higher milk price can cover expenditure on animal welfare measures.

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