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Welfare-based feeding place design for loose-housed dairy cows

The feeding place is an important functional area within dairy cattle loose housing systems with from 4 to 6 h per milk cow and day spent there. The layout of the feeding area is also closely associated with the danger of possible lesions on animals. During attempts to get feed at the limits of reach, great forces can be exerted on the shoulder points through pressing against the feeding grid whereby forces > 500 N are classified as critical and dangerous to cow health [7]. For this reason the influence of different heights of trough bottom, trough widths and feeding grid angles were investigated on the basis of the forces applied on the shoulder points.

Emerging as basically problematical in feeding place design is the animal reaching capacity associated with head-neck length during feeding. The aim is continuous access to feed within comfortable reach of the animal resulting in low simultaneous forces against the animal body through pressing against the feeding grid. In considering a welfare-based design the following factors should be thought about:

Trough bottom height
Depending on age, breed and sex average reach is increased through raising trough bottom level from 0 to 40 cm above the animal stand level of ~ 70 to ~ 103 cm [4, 5]. Simultaneously, stress peaks are reduced from ~ 1550 Nr. to 965 Nr. [2]. In loose housing trough bottom heights of 15 to 20 cm are recommended to compensate for the missing grazing action with forage feeding indoors.

Feeding grid angle
Reach can also be extended through the angle of the feeding grid [1]. With a trough bottom height of 20 cm, reach increases from 98 to 112 cm can be observed with forces on the animal remaining the same where the grid is inclined at 20° [3]. Recommendations for feeding grid angle vary between 10 and 20° , although vertical railings can be seen most in Germany [6].

Trough profile
Limited trough widths of 60 cm allow feed uptake within the preferred reach range [4, 8]. Greater widths lead to increased stress on the front legs [2] and shoulder points. The conventional L-trough without retaining lip represents feed intake without a limit to the reach distance.

A reach limit through a trough front retaining lip reduces stresses on the cows to a fraction. [2], although only when the chosen distance between trough back an d front retaining lip is not too great [3]. Trough front lips are seldom seen because they represent a design that costs more and is more labour intensive.

Trial methods

Using 10 German Holstein milk cows, stresses on the shoulder points were recorded during simultaneous noting of the feeding movements of the animals at a scissor-yoke feeding grid. The forces at the feeding grid were determined individually at the two feeding grid bars with in each case two pressure sensors and a frequency of 20 Hz. Two measuring cameras marking the positions of three infrared diodes representing signal points on the cow halters determined the reach of the animals. The Ex-Trac (frequency 50 Hz) detected the infrared diodes as the lightest photo points (pixels) and stored the x, y z coordinates of the diode online on a PC.

Three trough bottom heights of 16, 29 and 42 cm were investigated, as were six feeding grid angles from 0 to 25° in steps of 5°, whereby feed uptake could take place either at any distance in the direction of the feeding table or alternatively limited through siting

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Keywords

Animal welfare, cow comfort, feeding rack inclination, level of manger bottom, manger width, critical load at point of shoulder

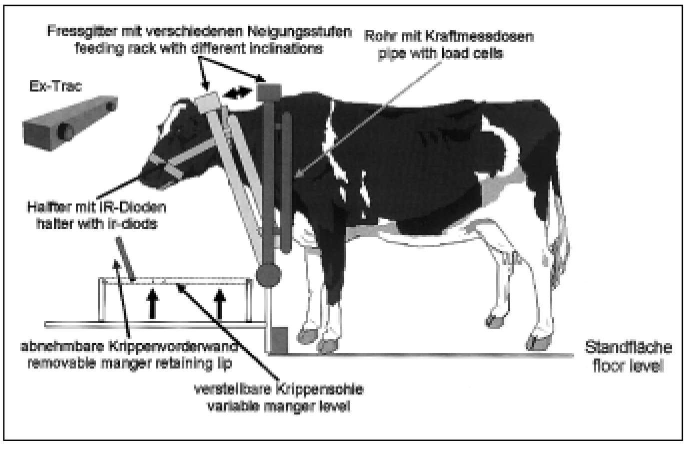

Fig. 1: Experimental design for feeding place evaluation

of a trough front retaining lip *(fig. 1)*. The distance between trough front retaining lip and back lip was based on the smallest reach of the trial animals according to [6] giving trough widths of 92 cm (trough bottom level 16 cm), 98 cm (29 cm) and 105 cm (42 cm).

Data recording took place per animal and variant over 15 minutes. Feed presented was a mixed ration (3.5 kg) of maize silage, straw and soya meal. Analysed were:

- maximum reach per animal and trough height with vertical feeding grid
- combined value of reach and force per animal and variant
- proportion of forces > 500 Nr. per animal and variant
- the three maximum forces recorded, the so-called force peaks, per animal and variant according to [2].

Results

With increasing height of trough bottom the force peaks reduced *(table 1, line 7)*. Clear reduction of force peaks also took place through increasing the feeding grid angle (10 to 25° *(table 1, columns 2 to 7)*, whereby the force peaks with a front retaining lip were in each case 250 to 400 Nr. lower than those without (*table 1*).

Raising the trough bottom level from 15 to 42 cm lead to the maximum reach being increased from ~ 97 to ~ 112 cm. While a vertical feed grid meant the protruding shoulder point very quickly limited the reach of the animals, one angled to suit more the body form of the cows permitted greater accessibility to feed through longer reach possibilities. Thus a greater amount of feed can be eaten with less effort.

Researching the functional relationships between force and reach using regression analysis showed that, within the comfortable reach (80 to 85 cm), functions were similar with and without the use of a trough front retaining lip (*see fig. 2)*. Without a front retaining lip, the forces acting on the animals then increased with lengthening reach. The force threshold of 500 N was arrived at with a reach that lengthened in line with increasing feeding grid angle and also with increasing trough bottom height; by 16 cm with the normal trough bottom height in practical farming, by vertical feeding grid by 79 cm and with an angle of 20° by 93 cm.

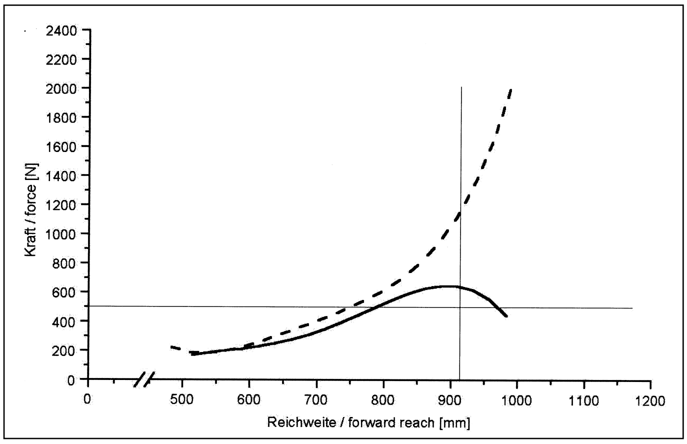

Fig. 2: Regression between reach and force; manger bottom level 16 cm, inclination 0°, with or without manger retaining lip

Summary

The design of the feeding place had an influence on the reach of the animals at feeding and on possible stresses to their bodies. With the aim of reducing the latter, forces of > 500 N should be avoided through positioning feed within comfortable reach of the animals. Practical translation of these findings can be achieved through constructional design of the trough of suitable feeding placement.

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Table 1: Maximum load, depending level of manger bottom, manger width and feeding rack inclination

Angle of feeding grid [°]	Height 16 cm with K.*	Height 16 cm without K.*	Height 29 cm with K.*	Height 29 cm without K.*	Height 42 cm with K.*	Height 42 cm without K.*
0	1607	1913	1392	1618	1460	1679
5	1474	2023	1335	1591	1325	1623
10	1462	1642	1068	1673	1099	1412
15	1373	1678	1054	1647	1020	1258
20	1111	1337	1078	1376	839	1111
25	882	1213	965	1357	837	1121
0 - 25	1318	1634	1149	1543	1097	1367