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# The effect of reward duration on demand functions for rest in dairy heifers and lying requirements as measured by demand functions

Margit Bak Jensen*, Lene Juul Pedersen, Lene Munksgaard

*Department of Animal Health and Welfare, Danish Institute of Agricultural Sciences, Research Centre Foulum, PO Box 50, DK-8830 Tjele, Denmark*

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**Abstract**

The present experiment investigated the effect of reward duration on elasticity of the demand function for rest, and assessed for how long dairy heifers are motivated to lie on a 24-h basis. In Part 1, eight heifers housed in tether stalls had free access to lie down for 9 h daily, while they could work for access to lie during 6-h daily test sessions. The price of access to lie down was varied by varying the fixed ratio of pressing a panel per reward (FR) from 10 to 50, and the reward duration was 20, 30, 50 or 80 min. The reward duration affected the elasticity of the demand function. Based on the number of rewards earned, the elasticity of the demand function for 20-min rewards was more elastic (elasticity −0.33) than the demand functions for the longer reward duration periods (elasticity −0.07 to −0.08; $P < 0.001$). Also based on the lying time during test sessions, the elasticity of demand function for 20-min rewards was more elastic (elasticity −0.32) than demand functions for the longer reward duration periods (elasticity −0.01 to −0.10; $P < 0.001$). Heifers interrupted lying during the reward periods more often, the longer the reward duration ($P < 0.001$). With a reward duration of 50 min, heifers earned approx. 4 h of lying in addition to the 9 h where they were free to rest, i.e. they could lie down for a total of 13 h. In Part 2, the same dairy heifers were free to rest for 6 h and could work for access to lie during 12 h daily. Reward duration was always 50 min. Here heifers earned approx. 7 h of lying during the test sessions (elasticity −0.07). During the 6 h where the heifers were free to rest

* Corresponding author. Tel.: +45 89 99 13 25.
*E-mail address:* margitbak.jensen@agrsci.dk (M.B. Jensen).

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they lay down during on average 5.5 h, i.e. total lying time was on average 12.5 h. This suggests that heifers of this age and stage of pregnancy have an inelastic demand for rest of about 12–13 h per 24 h.


*Keywords:* Dairy cattle; Demand functions; Elasticity; Heifers; Lying behaviour; Rest

## 1. Introduction

Under commercial housing conditions, the lying behaviour of cattle may be compromised, for instance due to low space allowances, or due to hard and slippery floors in the lying area. Increasing the space allowance from 1.5 to 3.0 $m^2$ per animal increased the lying time from 11 to 13 h per 24 h in 300 kg dairy heifers housed in pens with slatted floor (Hindhede et al., 1996). Improving the quality of the floor may also increase the lying time, as providing a mattress in tie stalls with concrete floor increased the lying time from 10 to 12 h per 24 h in dairy cows (Haley et al., 2001). Furthermore, loose-housed dairy cows in a straw yard system lay down for longer than cows in a cubicle system (Phillips and Schofield, 1994; Fregonesi and Leaver, 2001). It is undoubtedly very important to provide dairy cattle with a good opportunity to lie, and in the above-mentioned studies it is assumed that the longer the lying time, the better the welfare.

Very low lying time due to overcrowding conditions has been associated with higher incidences of lameness (Leonard et al., 1996), and low ranking dairy cows in a cubicle system that stood for a longer time were also more predisposed to lameness (Galindo and Broom, 2000). However, once the cows had developed lameness, they lay down for longer than healthy cows (Fayed, 1997). Thus, a long lying time is not always a sign of better welfare. If cattle lie down for a long time, this may also reflect problems changing position, or lameness. Therefore, it would be relevant to determine the minimal lying time acceptable for healthy dairy cattle of different age classes. In other words, to determine for how long healthy cattle are motivated to lie on a 24-h basis.

One way of measuring the strength of motivation is by means of demand functions based on operant conditioning techniques (Dawkins, 1983; Matthews and Ladewig, 1994). The use of demand functions has been inspired by economic theory, and a demand function describes the change in consumption as a function of price. Plotted in log–log coordinates, the slope of the demand function, the elasticity, determines the importance of the behaviour in question. The less elastic the demand function, the more important is the behaviour (Ladewig and Matthews, 1996). The reward duration has to be controlled in order to generate valid demand functions, because animals tend to compensate for an increase in price per visit by increasing the duration of the visits if they have this possibility (Sherwin and Nicol, 1996; Cooper and Mason, 2000). However, short reward duration periods may be of less value than longer ones. In cattle it was found that both the level of free rest and the reward duration affected the elasticity of the demand function for rest (Jensen et al., 2004). The demand was less elastic when the level of free rest was 9 h rather than 15 h per 24 h. This may be because 15 h of free rest enabled the animals to rest for long enough outside the test situation. Furthermore, with 15 h of free rest the elasticity of the demand for rest increased when the fixed ratio of pressing a panel per reward (FR) was increased. Thus, the