DJF
rapport

Januar 1999

Nr. 9 • Husdyrbrug

Jan Tind Sørensen & C. C. Krohn

# Opstaldningens indflydelse på opdrættets adfærd, sundhed og produktion

**Ministeriet for Fødevarer, Landbrug og Fiskeri**
Danmarks JordbrugsForskning

# Opstaldningens indflydelse på opdrættets adfærd, sundhed og produktion

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DJF rapport Husdyrbrugbrug nr. 9 • januar 1999 • 2. årgang

| | | |
|---|---|---|
| Udgivelse: | Danmarks JordbrugsForskning<br>Forskningscenter Foulum<br>Postboks 50<br>8830 Tjele | Tlf. 89 99 19 00<br>Fax 89 99 19 19 |
| Løssalg:<br>(incl. moms) | t.o.m. 50 sider<br>t.o.m. 100 sider<br>over 100 sider | 50,- kr.<br>75,- kr.<br>100,- kr. |
| Abonnement: | Afhænger af antallet af tilsendte rapporter, men svarer til 75% af løssalgsprisen. | |
| Forsidetegning: | Sine Claudell, Enggaardens Tegnestue | |

# Forord

Nærværende rapport beskriver resultaterne fra en forsøgsserie, der er gennemført i projektet *Opstaldningsformens indflydelse på opdrættets produktion og velfærd (1992-97)*. Projektet blev i årene 1993-97 i hovedsagen finansieret af Landsudvalget for Kvæg. I 1996 og 1997 har DJF også bidraget med finansiering. Projektet er planlagt i en fælles projektgruppe bestående personer fra Landskontoret for Kvæg og Afdelingen for Husdyrsundhed og Velfærd. Forsøgsserien er gennemført af Afdelingen for Husdyrsundhed og Velfærd ved DJF. I 1994/95 bidrog et dobbelt masterspeciale ved KVL gennemført af Lone Harder Nielsen og Lisbeth Mogensen til forsøgsseriens gennemførsel.

Udover forfatterne har Ole Kristensen, Jens Yde Blom og Helge Kroman, Landskontoret for Kvæg bidraget ved forsøgenes planlægning

Følgende har medvirket som forsøgsværter:

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| 304 | Otto H. Sørensen | Vestergyden 2, Ørsted, 6650 Sommersted |
| 305 | Carsten & Gitte Hansen | Spidsvej 4, 6650 Sommersted |
| 313 | Svend Enevoldsen | Hindballevej 2, Hindballe, 6630 Rødding |
| 323 | Anders M. Højgård | Skodborgvej 7, Langtved, 6630 Rødding |
| 335 | Rasmus Nielsen | Ribe-Vejle Ldv 6, 6622 Bække |
| 353 | Niels M. Nicolajsen | Silkeborgvej 321, Lund, 8700 Horsens |
| 355 | Forskningscenter Bygholm | Schüttesvej 17, 8700 Bygholm |
| 373 | Jørgen Nielsen/ Peder Godiksen | Viderupgårdsvej 15, Farstrup, 9240 Nibe |
| 403 | Jørn Bækgård, | Luneborgvej 254, 9382 Tylstrup |
| 413 | Poul Erik Jensen | Hvidstenvej 111, 9830 Tårs |
| 415 | Poul Sørensen | Heagervej 19, Nordenskov, 6800 Varde |
| 504 | Aksel Brixen | Hulbæksvej 38, Ørum, 8830 Tjele |
| 514 | Børge Sørensen | Overvej 48, Vognsild, 9600 Års |
| 515 | J. Otto Kristensen | Kroagervej 43, 6823 Ansager |
| 525 | Bygholm Landbrugsskole | Hattingvej 49, 8700 Horsens |
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Følgende forsøgsteknikere har medvirket ved indsamling af data fra kvægbrugene:

| | |
|---|---|
| Niels H. Thomsen | Haderslevvej 27, Maugstrup, 6500 Vojens |
| Henning Bjerre | Skyttehusvejen 28, 7100 Vejle |
| Orla Nielsen | Højbjerg Byvej 19, 8840 Rødkjærsbro |
| Gunnar Grønning | Søndersigvej 22, Hallund, 9700 Brønderslev |
| Helge Yde | Aarup Byvej 39, 7752 Snedsted |
| Kristine Riis Hansen | Koldingvej 33, St. Andst, 6600 Vejen |

Alle, der har bidraget til projektets gennemførsel, takkes hermed.

Niels Agergaard, Forskningschef for Afdelingen for Husdyrsundhed og Velfærd

# Indholdsfortegnelse

# 1. Indledning

## 1.1 Baggrund

I de sidste 5-10 år har det omgivende samfund rettet stigende opmærksomhed mod husdyrenes velfærd. Omverdenens opmærksomhed har blandt andet rettet sig mod udformningen af produktionssystemer herunder staldsystemer, idet der ønskes taget mere hensyn til dyrenes bevægelsesmuligheder. Det har medført indførsel af regler som eksempelvis kalveregulativet i 1993 (Anonym 1993), der forbød opbinding af kalve under 6 uger. Kvægbruget har selv taget initiativ til udformning af danske anbefalinger for indretning af stalde til kvæg (Anonym 1995) som efterfølgende er blevet implementeret i Godt Landmandskab år 2000 (Anonym 1996), der er en målsætning for dansk landbrug herunder dansk kvægbrug. I de danske anbefalinger anvises indretning af stalde til kvæg under hensyn til kendt viden om dyrenes adfærd produktion og sundhed.

Indenfor opdræt- og ungtyreproduktionen har anvendelse af fuldspaltebokse været fremherskende i mere end 20 år. Systemet har været populært ikke mindst på grund af det lave arbejdsforbrug til gødningshåndtering og fodring i forhold til stalde med opbundne dyr. Fuldspaltebokse er, med den praktiserede belægningsgrad, blevet stærkt kritiseret for at kompromittere dyrenes velfærd. Forskning har dokumenteret problemer med haletråd (Madsen 1984), unormal rejse-/lægge sig adfærd, lav tilvækst og høj foderforbrug (Andersen et al. 1991a, b) hos ungtyre i fuldspaltebokse med en høj belægningsgrad.

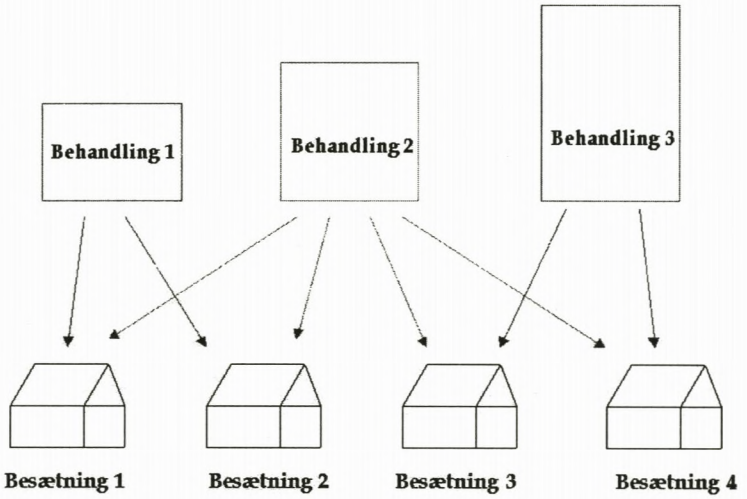
Fuldspaltebokse bliver i ligeså høj grad anvendt til opdræt som til ungtyre. Det rejste naturligt spørgsmål om hvordan fuldspaltebokse påvirkede produktion, sundhed og adfærd hos opdræt. Resultater fra ungtyreproduktionen kan ikke ukritisk overføres til opdrætproduktionen. Kvier har en anden adfærd end ungtyre. Kviers foderoptagelse og tilvækst er væsentligt lavere end ungtyres. Endelig er opdræt typisk kun opstaldet 6 måneder om året mod ungtyrenes 9 måneders ophold i fuldspaltebokse. Et omfattende litteraturreveiw på opstaldningens betydning for adfærd, sundhed og stress-fysiologiske relationer, reproduktion og produktionen viste at der var meget begrænset viden om de opstaldningsforhold, der aktuelt blev praktiseret og deres betydning for opdrættet (Jensen 1992). Dette var baggrunden for iværksættelse af en forsøgssserie til belysning af opstaldningens betydning for opdrættets produktion, adfærd og sundhed under produktionsforhold.

## 1.2 Formål

Formålet med forsøgsserien var at undersøge indflydelsen af opstaldning på opdrættets produktion, adfærd og sundhed under danske produktionsforhold.

## 1.3 Materiale og metode

Forsøgene blev gennemført i private malkekvægsbesætninger med forsøg indenfor besætninger samtidigt i flere besætninger som illustreret i figur 1.1




**Figur 1.1 Illustration af den typisk anvendte forsøgsmetodik**

Forsøgsserien tog udgangspunkt i den almindelig anvendte fuldspalteboks på 3 X 3 m. Boksen er typisk beregnet til 6 kvier (250-300 kg) svarende til en belægningsgrad på 1.5 $m^2$ per kvie. Boksen har typisk 3 m foderbordsplads og uden mulighed for at fiksere kvierne ved fodring.

Fælles for forsøgene var:

- De eksperimentelle sammenligninger blev gennemført i private besætninger.

- Forsøgsperioden der strakte sig over 5-6 måneder fra november til april-maj i forlængelse af en afgræsningssæson.

- Behandlinger blev sammenlignet med gentagelser indenfor besætning og blev gennemført parallelt på flere kvægbrug på samme tid. Typisk med en behandling der gik igen i alle besætninger (se figur 1.1)

- Staldforhold blev standardiserede ikke blot indenfor gård men også mellem gårde. Der var således mindst 50 cm ædeplads per dyr uden mulighed for fiksering. Et fodermiddel blev altid tildelt efter ædelyst.

- Pasning og overvågning af dyrene fulgte bedrifternes normale rutiner og det blev tilstræbt at minimere forsøgets betydning for den daglige pasning

- Adfærdsregistreringer blev gennemført som direkte observationer over et døgn. Hvileadfærden i form af *total liggetid, antal liggeperioder* og den gennemsnitlige *varighed af liggeperioderne* blev registreret ved interval-observationer hvert 5 eller 10 minut over 24 timer. *Synkroniteten i hvileadfærden* opgjort som minutter pr. døgn, hvor

alle kvier i de enkelte bokse lå samtidig, blev vurderet og sammenlignet. Desuden blev mængden af aggressiv adfærd udtrykt ved *stangen* og *opjagninger* registreret for hver boks. Endelig registreredes mængden af unormal adfærd i form af *biden/sutten på inventaret*, samt mængden af *"leaning"*, som også er en unormal adfærd, hvor dyret presser mule eller næseryg mod en inventardel.

- Sundhedstilstand blev registreret ved kliniske undersøgelser foretaget af praktiserende dyrlæger ved forsøgets start og slut.

- Klovbeskæring blev typisk foretaget ved start og slut af autoriseret klovbeskærer og klov- sundhed blev systematisk registreret.

- Tilvækst blev registreret ved 4-5 vejninger jævnt fordelt over forsøgsperioden.

### 1.4 Forsøgsseriens gennemførsel og beretningens indhold

I det første forsøgsår undersøgtes virkningen af at fordoble arealet per kvie i fuldspaltebokse dels fortsat som spalter dels ved at øge arealet per kvie med et opstrøet liggeunderlag. Resultaterne herfra, der er beskrevet i kapitel 2 gav anledning til at arbejde videre med et strøet hvileareal. I det andet forsøgsår gennemførtes derfor forsøg med forskellige størrelse af strøet hvileareal i eksisterende fuldspaltebokse (beskrevet i kapitel 3), samt med undersøgelser af forskellig hvileareal i dybstrøelsessystemer (beskrevet i kapitel 4). Anvendelse af strøelse giver et relativt stort arbejdsforbrug med små gruppestørrelser. Det er endvidere økonomisk fordelagtigt ved nybyggeri eller renovering af ungdyrsstalde at indrette bokse til relativt store grupper af dyr. I det tredje og fjerde år gennemførtes derfor forsøg til belysningen af virkningen af floksammensætning og flokstørrelse i dybstrøelsessystemer (kapitel 5).

I kapitel 6 opsummeres resultaterne og deres relevans i forhold til aktuel praksis diskuteres. I kapitel 7 er givet en liste over publikationer fra projektet.

### 1.5 Litteraturliste


Andersen, H.R. Ingvartsen K.L. 1991. Produktionsresultater for ungtyre afhængig af staldtype og belægningsgrad 686 Ber. Fra Statens Husdyrbrugsforsøg 31 pp

Andersen, H.R. Krohn, C.C. Foldager, J. Munksgaard L. & Klastrup S. Ingvartsen K.L. 1991. Opstaldningens og fordringens indflydelse på ungtyres adfærd, produktion og råvarekvalitet. Produktionsresultater for ungtyre afhængig af staldtype og belægningsgrad 700 Ber. Fra Statens Husdyrbrugsforsøg 31 pp

Anonym 1993. Bekendtgørelse om beskyttelse af kalve. Bekendtgørelse nr. 999

Anonym 1997. Bekendtgørelse om ændring af bekendtgørelse om beskyttelse af kalve. Bekendtgørelse nr. 1075.

Anonym 1995. Indretning af stalde til kvæg - Danske Anbefalinger. Tværfaglig rapport, 2 udgave 1995 Landbrugets Rådgivningscenter 192 pp.

Anonym 1996 Godt Landmandskab år 2000, Forlaget ved Landbrugets Rådgivningscenter 44 pp.

Jensen, M.B. 1992. Opstaldning af kvier og ungtyre. Adfærd, sundhed stressfysiologiske reaktioner, reproduktion og produktion. Et litteraturreview. Landskontoret for Kvæg 82 pp

Madsen, E.B. 1984. Sygdomme i slagtekalveproduktionen. Epidemiologisk undersøgelser og sygdomskontrol i specialiserede slagtekalvebesætninger. Licentiatafhandling KVL 168 pp.

Kapitel 2:

# Effect of Space Allowance, Access to Bedding, and Flock Size in Slatted Floor Systems on the Production and Health of Dairy Heifers

*Acta Agric. Scand. Sect. A, Animal Sci. 1996: 46, 46–53*
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ACTA AGRICULTURÆ
SCANDINAVICA
*ISSN 0906–4702*

# Effect of Space Allowance, Access to Bedding, and Flock Size in Slatted Floor Systems on the Production and Health of Dairy Heifers

**Hindhede, J., Sørensen, J. T., Jensen, M. B. and Krohn, C. C. (Danish Institute of Animal Science, Research Centre Foulum, Box 39, DK-8830 Tjele, Denmark). Effects of space allowance, access to bedding, and flock size in slatted floor systems on the production and health of dairy heifers. Accepted August 21, 1995. Acta Agric. Scand., Sect. A, Animal Sci. 46: 46–53, 1996.** © 1996 Scandinavian University Press.

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An experiment was conducted on seven Danish commercial dairy farms with 200 Danish Friesian heifers (315 kg) in 152 days from the month of November. Founded on existing slatted floor systems, 32 experimental pens were established with Low (L) or High (H) space allowance (1.5 vs. 3.0 $m^2$ per animal), different type of separate lying area (Slatted (S) vs. Bedded (B) floor) and different flock size (6 vs. 12 animals). Eating spaces were standardized to about 50 cm per animal. *Ad libitum* feeding was practised and rations contained a maximum 30% concentrates (dry matter).

An increase in space allowance from 1.5 to 3.0 $m^2$ per animal in pens with fully slatted floors increased the live weight gain by 174 g $day^{-1}$ or 31% ($P = .04$) and net energy intake per kg live weight gain was reduced by 23% ($P = .04$). Heifers housed in small pens lay down less than heifers in large pens. Access to bedding affected number of lying periods. Production, however, was not influenced by access to a bedded lying area. Flock size is of minor importance for heifers' production, when fed *ad libitum* and one eating space per animal is ensured. The prevalence of heel horn erosion was reduced and claw length was increased in heifers with access to bedding. No occurrence of tail tip necrosis regardless of pen type was found. Reproduction expressed as ages at pregnancy was not significantly influenced by any of the treatments.

Key words: digital disorders, feed conversion ratio, feed intake, resting behaviour, skin trauma, weight gain.

## Introduction

In Scandinavia most growing cattle are kept in loose housing systems, mainly with slated floors. In recent years, systems with fully slatted floors have been criticized for welfare reasons, in particular because of the low space allowance that is commonly practised, and because slats may not be suitable as a lying surface. Several experiments have been carried out to establish knowledge for developing convenient housing systems for growing cattle. Comprehensive reviews focusing on the effect of housing system on the production and welfare of growing cattle by Jensen (1992), Ingvartsen & Andersen (1993) and Mossberg (1994) show that most experiments have been con-

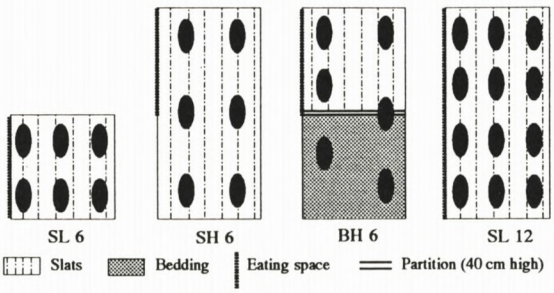


*Fig. 1.* Four pen types established in fully slatted floor systems.

ducted on intensively fattening bulls, whereas experiments estimating the effect of housing on the production and welfare of heifers are few and not conclusive (Beneke, 1985; Fisher et al., 1994; Koch, 1984; Morrison et al., 1970). This experiment aims to establish such knowledge. Mossberg (1994) recommends experiments that embrace production, health and behaviour, and Ingvartsen & Andersen (1993) advocate that studies are conducted into which of the effects of space allowance, space at feed manger and group size, respectively, may be singled out.

The purpose of this experiment was to estimate the effect of space allowance, access to a bedded lying area and flock size on the production, health and behaviour of heifers housed in pens with a slatted floor. This paper investigates the influence on production and health. The influence of space allowance and access to bedded lying area on resting behaviour has been analysed by Jensen et al. (1995).

## Materials and methods

### *Experimental design*

The experiment was conducted on seven Danish commercial dairy farms with Danish Friesian heifers. On all farms heifers were normally housed in groups of six in pens of about 3 × 3 m with slatted floors and six eating places. Four different pen types were established with different space allowance (1.5 vs. 3.0 $m^2$ per animal), different type of separate lying area (slatted vs. bedded floor) and different flock size (6 vs. 12 animals) as illustrated in Fig. 1. Eating places were standardized to one (approx. 50 cm) per animal.

The pen type with fully slatted floor, high space allowance and small flock size was used as a reference on all seven farms (Table 1). The effect of access to bedding was analysed by comparing SH6 and BH6, and the effect of flock size was analysed by comparing SL6 and SL12. The effects were analysed within herd. All four pen types were present in one herd, three pen types were present in one herd, and two pen types were present in five herds. Except for SL12, each pen type was represented by two pens in each herd. The effect of space allowance and the effect of access to bedding were compared in four herds respectively, whereas the effect of flock size was compared in two herds. A total of 32 pens and 200 heifers were included in the experiment.

All heifers in the experiment had been grazing during the summer period and were at least eight months from calving at the beginning of the experiment. For each herd the average live weight at the start of the experiment is shown in Table 1. In each herd heifers were grouped according to similarity in weight, age and state of pregnancy – one heifer in each group for pen type SH6, SL6 and BH6 and two heifers for SL12. The heifers in each group were then randomly assigned to pen type. Flock size per pen was 6 heifers for pen type SL6, SH6 and BH6, except for herd 7 where the flock size was 5 heifers. There were small differences in pen size between herds, as shown in Table 1. Within herd, all repeated pens were of equal size. The experiment was conducted from November 1993 to April 1994. It appears from Table 1 that the experimental period varied from 143 days to 164 days between herds.

Animals were fed according to Danish standards for heifers and were planned to have a daily gain of about 700 g (Ingvartsen & Sørensen, 1987). The feed rations were based on available feeds on each farm and calculated as least-cost rations. High or medium energy concentration feeds were fed restrictively to each pen and low energy feeds were fed *ad libitum*. In herds 4 and 5, all feeds were fed *ad libitum* as total mixed ration. The possible intake of bedding in pens BH6 was considered as negligible. Unbred heifers were bred during the experiment according to a preplanned reproduction strategy.

During the experiment, one heifer in herd 4 was removed owing to a scapula distortion. The heifer was immediately replaced by a similar heifer. Data on

Table 1. Description of experimental design, pen types and animals for all seven farms

| Treatment index | | | | SL6 | SH6 | BH6SL12 |
|---|---|---|---|---|---|---|
| *Pen type* | | | | | | |
| Floor type, eating/lying area | | | | Slats | Slats | Slats | Slats |
| Floor type, separate lying area | | | | – | Slats | Bedding | – |
| Space allowance | | | | Low | High | High | low |
| Flock size[1] | | | | 6 | 6 | 6 | 12 |
| Pens per herd | | | | 2 | 2 | 2 | 1 |
| | Init. weight, kg | | | | | | |
| Herd | Mean | SE | Exp. period, days | Space allowance, $m^2$ per heifer SL6 | SH6 | BH6 | SL12 |
| 1 | 277 | 24 | 164 | 1.60 | 3.20 | – | – |
| 2 | 303 | 34 | 163 | 1.50 | 3.00 | – | – |
| 3 | 310 | 17 | 145 | 1.50 | 3.00 | – | 1.50 |
| 4 | 314 | 25 | 148 | 1.50 | 3.00 | 3.00 | 1.50 |
| 5 | 345 | 15 | 155 | – | 3.20 | 3.20 | – |
| 6 | 316 | 41 | 148 | – | 3.00 | 3.00 | – |
| 7 | 343 | 17 | 143 | – | 3.06 | 3.06 | – |
| Total number of pens (32) | | | | 8 | 14 | 8 | 2 |
| Total number of heifers (200) | | | | 48 | 82 | 46 | 24 |

[1] Except for herd 7, which had 5 heifers per pen.

the removed heifer and the replacement heifer was not included in the statistical analysis.

### *Recordings*

Live weight was measured at the beginning of the experiment and every five weeks, in total five times during the experiment. Feed intake was measured per pen during 24 h every week. *Ad libitum* feed was analysed for dry matter, protein and ash. Energy content was calculated using standard values for digestibility.

Each heifer was systematically examined for clinical illness, skin lesions and other traumas by a veterinarian at the beginning and at the end of the experiment in all herds. Each heifer was hoof trimmed at the beginning and at the end of the experiment. Digital disorders, hoof quality, and claw length were recorded at the hoof trimming. Digital disorders were classified into the following classes: heal horn erosion, interdigital dermatitis, light sole ulcers, severe sole ulcers, red sole, and red-white line in the sole.

The cleanness of each heifer was recorded weekly. Clinical examinations were carried out by the same veterinarian and recordings of digital disorders were carried out by the same hoof trimmer across all herds. All other recordings were conducted by a technician from the Danish Institute of Animal Science.

### *Statistical methods*

Live weight gain was analysed by analysis of variance by the statistical model shown in equation 1.

$$Y_{ijkl} = b0 + T_i + H_j + (HT)_{ij} + P_{ijk} + A_{ijkl}, \quad (1)$$

where: $b0$ = general mean, $T$ = pen type, $H$ = herd, $HT$ = the interaction between pen type and herd, $P$ = pen within herd and treatment, and $A$ = animal within pen, herd and treatment.

Feed intake and feed conversion were analysed by analysis of variance by the model shown in equation 2.

$$Y_{ijk} = b0 + T_i + H_j + (HT)_{ij} + P_{ijk}. \quad (2)$$

The effect of space allowance, access to bedding, and flock size were analysed separately. The effect of flock size was analysed by equation 3.

$$Y_{ij} = b0 + T_i + H_j + (HT)_{ij}. \quad (3)$$

The effect of pen type in equations 1, 2 and 3 was tested by an $F$-test using the interaction between treatment and herd as the error term.

Effects of treatment on digital disorders, skin lesions and traumatic injuries were analysed as a repeated measurement analysis ignoring herd and pen effects. Effect of treatment was tested for marginal homogeneity by the main effect of the repeated measurement factor (Crowder & Hand, 1990, p. 114). Two by two comparisons were tested by McNemars non-parametric test.

Table 2. Feeding regimes for the seven herds. SFU (Scandinavian feed units) per heifer per day

| | | Restrictive | | *Ad libitum* |
|---|---|---|---|---|
| Herd no. | Total | Concentrate molasses, beets, potatoes and pulp | Silage from grass, maize and beet top | Ammonium-treated straw of cereal, grass-seed and pea |
| 1 | 4.3 | 3.5 | 0 | 0.8 |
| 2 | 4.9 | 2.5 | 1.4 | 1.0 |
| 3 | 5.7 | 4.0 | 1.1 | 0.6 |
| 4 | 6.8[1] | 2.3 | 3.9 | 0.6 |
| 5 | 5.6[1] | 0.7 | 3.8 | 1.1 |
| 6 | 5.4 | 3.8 | 0 | 1.6 |
| 7 | 5.0 | 3.3 | 0 | 1.7 |

[1] Total mixed ration *ad libitum*.

Reproduction was expressed as days open and was analysed by comparing survival curves using a log rank test (Thysen, 1988).

## Results

### *Growth, feed intake and feed conversion ratio*

The feed rations and feed intake are described in Table 2 at herd level. The *ad libitum* feeds in all herds had an energy concentration equivalent to grass silage with low digestibility. The intake of *ad libitum* feed was at least 0.6 SFU (Scandinavian feed unit) of ammonium-treated straw per animal daily in all seven herds. The average daily feed ration did not exceed 30% concentrates (DM basis) in any treatment within herd.

The treatment effects on live weight gain, feed intake, and feed conversion ratio (FCR = SFU $kg^{-1}$ live weight gain) are shown in Table 3. It appears that access to a lying area with bedding and flock size did not significantly affect daily gain, feed intake or feed conversion ratio ($P > .36$).

As seen in Table 3, there was a significant increase in live weight gain by increasing the space allowance from 1.5 to 3.0 $m^2$ per animal in systems with a fully slatted floor ($P = .04$). The average increase was 174 g $day^{-1}$ or 31%. The effects were consistent among herds as it appears from Fig. 2. In all four herds, Standard deviation in daily weight gain tended to be lower in SH6 pens compared with SL6 pens.

The space allowance had no significant influence on feed intake ($P > .35$). The feed conversion ratio was 2.15 SFU or 23% lower per kg live weight gain for SH6 than for SL6 ($P = .04$). This effect was seen clearly in all four herds as shown in Fig. 2.

### *Health and reproduction*

The prevalence of digital disorders was recorded at 31% of the heifers at the end of the experiment. The prevalence of heel horn erosion (erosive ungulae), interdigital dermatitis, light sole ulcers, red sole, and red-white line was found to be: 16, 9, 6, 3 and 1%, respectively, at the beginning of the experiment and 23, 3, 4, 3 and 0% respectively, at the end of the experiment. Heel horn erosion as well as interdigital dermatitis were found in two heifers at the beginning and in one heifer at the end of the experiment. Two heifers were found to have heel horn erosion as well as sole ulcers at the beginning of the experiment. Except for these five cases, all heifers could be classified in one of the digital disorder classes. Observations of red sole and red-white line were pooled together with light sole ulcers.

Based on a previous survey in 30 commercial dairy herds and the literature on heifers (Frankena et al., 1992, 1993) and adult cattle (Hannan & Murphy, 1983; Murphy et al., 1987), five key variables were chosen for further testing. These five variables and the effects of treatments are shown in Table 4.

A test for marginal homogeneity for transfer from one class to another from the beginning to the end of the experiment was carried out for each comparison (space allowance, access to bedding and flock size). The hypothesis of marginal homogeneity could not be rejected. Separate analysis for presence/absence of heel horn erosion and sole ulcers, respectively, were carried out using McNemar's nonparametric test for a difference. There was a significant decrease in the prevalence of heel horn erosion by introducing access to bedding compared with full slatted floor ($P = .02$). All other comparisons were found to be non-significant.

Claw length was measured by a subjective judgement on a five-level scale (1 = short and 5 = long). It

Table 3. Effect of space allowance, lying area and flock size on heifers' live weight gain, feed intake and feed conversion ratio

| Treatment index | Weight gain, g day$^{-1}$ | Feed intake, SFU day$^{-1}$ | Feed conversion ratio, SFU kg$^{-1}$ weight gain |
|---|---|---|---|
| Space allowance, 16 pens | | | |
| Low (SL6) | 570 | 5.39 | 9.44 |
| High (SH6) | *744* | *5.49* | *7.29* |
| High–low | *174* | *0.10* | *−2.15* |
| *P* | .04 | .35 | .04 |
| Lying area, 16 pens | | | |
| Slats (SH6) | 755 | 5.74 | 7.56 |
| Bedding (BH6) | *754* | *5.68* | *7.46* |
| Bedding–slats | *−1* | *−0.06* | *−0.10* |
| *P* | 1.00 | .68 | .86 |
| Flock size, 4 pens | | | |
| Small, 6 (SL6) | 543 | 6.16 | 11.20 |
| Large, 12 (SL12) | *617* | *6.12* | *9.84* |
| Large–small | *74* | *−0.04* | *−1.36* |
| *P* | .41 | .67 | .37 |

was assumed that only long claws (4 and 5) would be of importance for the welfare of the heifers. Data on claw length were, therefore, pooled into two groups: short/normal length (1,2 and 3) and long claws (4 and 5). Each treatment effect was tested using McNemar's nonparametric test. A significant increase in the percentage of long claws was found by giving access to bedding ($P = .004$). No significant effects of space allowance or flock size on claw length were found.

No significant difference in skin lesions or traumatic injuries and no difference in cleanness were found betweeen the pen types. Tail tip necrosis was not observed in any of the pen types.

There was no significant difference in reproduction calculated as days open between any of the treatments.

## Discussion

### *Growth, feed intake and feed conversion ratio*

*Space allowances.* An increase in space allowance from 1.5 to 3.0 m$^2$ per animal increased the live weight gain by 31% and reduced the FCR by 23%. No significant effect was found on feed intake, although feed intake was higher at the high space allowance in all herds. Using the equations given by Ingvartsen & Andersen (1993), an increase in space allowance from 1.5 to 3.0 m$^2$ per animal was expected to increase live weight gain and feed intake by 16% and 7%, respectively, and to reduce FCR by 10%. The equations are primarily based on experiments with bulls and steers fed concentrates *ad libitum* and weighing between 250 and 500kg. Furthermore, space allowance was often confounded with feeding space, so conditions for feed intake in pens with a low space allowance have possibly been impaired compared with our experiment, which may explain the different influence on feed intake, but not differences in FCR and live weight gain.

Some studies with heifers (Morrison et al., 1970; Kock, 1984; Beneke, 1985; Müller, 1988) have found effects similar to those found in bulls with respect to feed intake, live weight gain and FCR. Fisher et al. (1994) found in study with beef heifers in pens with fully slatted floors that live weight gain was increased 45% ($P < .05$) when the space allowance was increased from 1.5 to 3.0 m$^2$ per animal. The reduced growth when decreasing the space allowance is explained by decreased feed intake and especially by a poor feed conversion ratio. A higher ratio of the feed ration is used for maintenace in heifers compared with bulls, which could explain why heifers seem to be more sensitive to decreasing space allowance than are bulls. Ingvartsen & Andersen (1993) suggest that the reduction in performance is likely to be the "biological cost" of coping with social stress.

*Access to bedded lying area.* Access to a straw-bedded lying area did not affect feed intake, daily weight gain or FCR. The fact that space allowance affects production, whereas bedding does not, may explain why previous experiments comparing animals in pens with slatted versus bedded floors have often produced contradictory production results. In several experiment, space and floor type have been confounded

because the space allowance has been significantly lower in systems with slats than with bedding. With the same space allowance (1.8 $m^2$ per animal), Andersen et al. (1991) found no differences in performance of bulls on slatted or bedded floors.

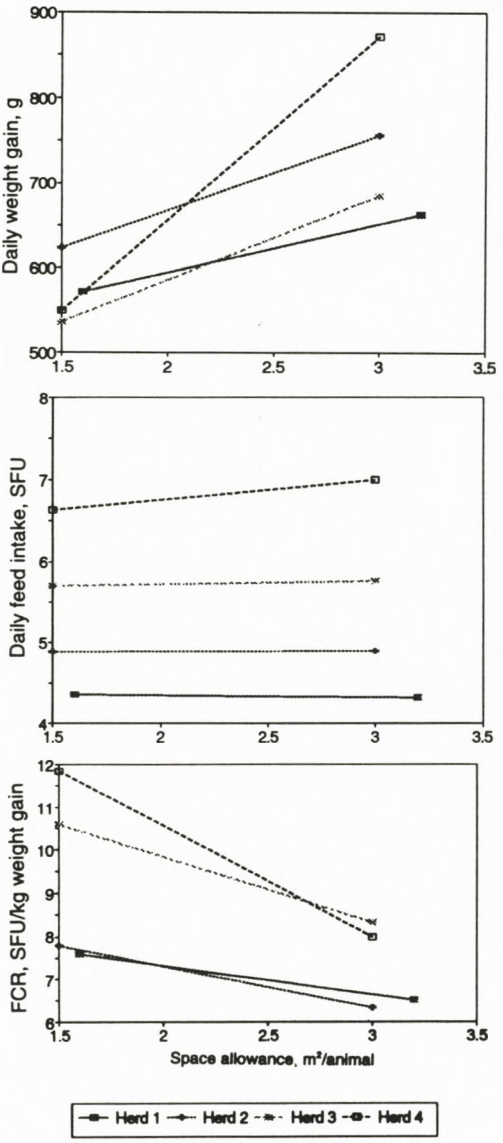


*Fig. 2.* Live weight gain, feed intake and feed conversion ratio in heifers in four herds with fully slatted floor pens and with low (SL6) and high (SH6) space allowances.

*Flock size.* No effects of flock size on feed intake, live weight gain or FCR were found when the space allowance in fully slatted floor pens was 1.5 $m^2$ per animal and one eating place per animal and *ab litum* feeding were ensured. In each herd the heifers were randomized in all pens to achieve equal average body weight and SE in all pens. The maximum difference in initial body weight in each pen was approximately 50 kg in herd 3 and 80 kg in herd 4.

Neither Morrison et al. (1981) nor Hanekamp et al. (1990) found differences in production parameters between groups of bulls or steers, which varied from 5 to 20. However, group size was confounded with space allowances and these experiments are therefore not comparable to this experiment. The consequence of increasing flock size with space allowance per animal kept constant may depend on the social stability of the group. In newly established groups, more animals are likely to result in more disturbance and more aggression, while no such effect is expected in well-established groups.

### *Health and reproduction*

The feed rations were rich in roughages (at least 70% on DM basis), which reduce the risk of diseases compared with *ad libitum* feeding with concentrates (Andersen et al., 1991; Mossberg, 1994). The incidence of heel horn erosion was reduced in heifers with access to bedding. Although effects of housing systems on digital disorders in heifers are scarcely reported in the literature, there are a few studies in support of our findings. Bradley et al. (1989) found that 5 out of 13 heifers (18 months old) developed heel horn erosion during a winter period in concrete cubicles. In comparison, no heifers in a similar group developed heel horn erosion during a summer pasture period. Frankena et al. (1992, 1993) found straw bedding to be protective against interdigital dermatitis, which is considered to be a light case of heel horn erosion in heifer calves aged 2.5 to 12 months. The protective effect of access to straw bedding on heel horn erosion is also in agreement with findings for adult cattle (Hannan & Murphy, 1983; Murphy et al., 1987).

In the present experiment, claw length increased in heifers with access to bedding, which is also in agreement with similar studies on fattening bull calves (Attrell & Lidfors, 1989; Andersen et al., 1991; Pougin et al., 1983). The behavioural studies of our experiment suggest that heifers with access to a bedding lying area have fewer problems in changing position from standing to lying and vice versa, than do heifers in pens with fully slatted floors. This may be due to the animals being less averse to changing position on bedding, but it may also be influenced by

Table 4. Prevalence of digital disorders and skin trauma at the end of the experiment in the different pen types (%)

| | Space allowance | | Access to bedding | | Flock size | |
|---|---|---|---|---|---|---|
| | Low | High | No | Yes | Small | Large |
| Sole ulcer/red sole | 15 | 10 | 11 | 4 | 8 | 0 |
| Heel horn erosion | 15 | 10 | 48 | 24 | 25 | 8 |
| Long claws | 25 | 10 | 39 | 89 | 38 | 38 |
| Skin lesions | 4 | 8 | 7 | 2 | 4 | 0 |
| Traumatic injuries | 13 | 2 | 2 | 2 | 13 | 4 |

the better health condition of the claws in these animals.

Because of grazing during the previous summer and triming at the beginning of the experiment, the effect of a bedded lying area on claw condition is expected to be relatively small.

No occurrence of tail tip necrosis, regardless of pen type, was found. Madsen et al. (1987) found an increased incidence in bulls when the space allowance on slatted floors was reduced to 1.3 $m^2$ per animal. The problem has also been observed in beef heifers in Canadian feed lots (Drolia et al., 1990). However, Madsen (1984) found heifers less susceptible to tail tip necrosis than bulls and underlined that the problem is most serious on slats in the summertime.

Reproduction, expressed as days open, was not significantly influenced by any of the treatments. Beneke (1985) found that slatted floors compared with bedding reduced all oestrus activities, i.e. the duration of oestrus and the period of mounting, whereas crowding (1.6 vs. 3.0) did not influence the oestrus period and oestrus cycle, although it reduced the overall fertility rate (percentage pregnant after a maximum three inseminations) by 13%.

### *Behaviour*

The effect of space allowance and access to a straw-bedded lying area on resting behaviour was investigated on three farms (herds 3, 4 and 7; Table 1). The behavioural studies included recordings of position and behaviour of individual heifers at 5 min intervals during 24 h. An overall analysis was conducted. Effects on behaviour were tested by analysis of variance using mean squares for interaction between pen type and farm as the denominator for the $F$-test.

Space allowance affected lying time. Heifers housed in small pens lay down less than heifers housed in large pens: 643 (standard error 26), 766 (s.e. 14) and 811 (s.e. 23) min for SL6, SH6 and BH6, respectively; $F_{2,2} = 20.72$; $P = .05$. Thus, reduction in space allowance may reduce lying time, and the result shows that a space allowance of 1.5 $m^2$ per heifer is insufficient for heifers of around 400 kg live weight.

Access to bedding affected the number of lying periods. In pens with straw bedding in the separate lying area, heifers had more lying periods: 6.6 (s.e. 0.6), 9.2 (s.e. 0.5) and 14.5 (s.e. 0.9) for SL6, SH6 and BH6, respectively; $F_{2,2} = 241.5$; $P = .004$). This probably reflects fewer problems in getting up and lying down on straw than on a concrete slatted floor, which is hard and often slippery.

In large pens (SH6 and BH6) the effect of bedding in a separate area on lying time in this area was investigated by the Wilcoxon Mann Whitney Test (Siegel & Castellan, 1988) using pen as the statistical unit. Heifers clearly preferred to lie on the straw ($P < .05$). However, not all individuals could lie down at the same time in this area, which occupied half of the pen (i.e. 1.5 $m^2$ per heifer).

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Kapitel 3:

# Resting and social behaviour of dairy heifers housed in slatted floor pens with different sized bedded lying areas

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Applied Animal Behaviour Science 54 (1997) 307–316

APPLIED ANIMAL BEHAVIOUR SCIENCE

# Resting and social behaviour of dairy heifers housed in slatted floor pens with different sized bedded lying areas

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Accepted 6 November 1996

**Abstract**

The hypothesis that an increase in the straw bedded resting area for group housed heifers would increase synchronization of resting behaviour and decrease aggressive and abnormal behaviour was tested. An experiment was conducted on two Danish commercial dairy farms with 20 Danish Friesian heifers (approximately 400 kg) from November 1994 to April 1995. The experimental pens were constructed on existing slatted floor and contained a total area of 27 $m^2$ per pen with five heifers in each pen. Three different sizes of lying area (1.8, 2.7 and 3.6 $m^2$ per heifer) bedded with straw were established in each pen for three consecutive periods of 5 weeks. Resting and social behaviour were recorded using direct observations for 24 h at the end of each 5 week treatment period. The synchronization of resting behaviour was reduced ($P = 0.002$) when the heifers were offered 1.8 $m^2$ bedded lying area per heifer compared with 2.7 or 3.6 $m^2$ per heifer, and the heifers were more aggressive, as more butting ($P = 0.007$) and forcing another heifer to stand up ($P = 0.02$) were seen. The frequency of leaning against other heifers was highest ($P = 0.05$) at the lowest space allowance in the bedded area. The results indicate that increasing the resting area from 1.8 $m^2$ to 2.7 or 3.6 $m^2$ per heifer improved the welfare of group housed dairy heifers. © 1997 Elsevier Science B.V.

*Keywords:* Anomalous behaviour; Agonistic behaviour; Bedded lying area; Cattle; Resting behaviour; Social behaviour; Space allowance

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*PII* S0168-1591(96)01211-7

## 1. Introduction

In Denmark, heifers are typically housed in groups of five or six animals in pens with fully slatted floors (Anonymous, 1988). Heifers in slatted floor pens changed position from lying to standing and vice versa less frequently than heifers in straw bedded pens, and were lying down for longer periods (Irps, 1987; Müller, 1988). These differences may be ascribed to problems when the heifers change position, as more intentions to lie down and more interruptions of lying down have been observed in pens with slatted floor (Müller et al., 1986). These observations indicate that slatted floors were not suitable as lying areas and did not ensure adequate welfare of heifers. Therefore, the welfare of heifers housed on slatted floors may be improved by introducing an area with straw bedding. Jensen et al. (1995) demonstrated that heifers preferred a straw bedded area to an area with slatted floor while lying, and a straw bedded area of 1.5 $m^2$ per 400 kg heifer did not allow all heifers to lie down at the same time. As space allowance for young bulls was increased, level of aggression (Kondo et al., 1989) and level of abnormal behaviour (Wierenga, 1987) was decreased. Further, as space allowance was increased, Larsson et al. (1983) observed a decreased frequency of forcing another animal to stand up, which in turn decreased the number of lying periods. Longer and fewer lying periods related to less social disturbance is a positive welfare symptom with regard to the effect of space allowance on resting behaviour. However, prolonged lying periods on an unsatisfactory floor type are unfavourable in terms of welfare, indicating difficulty in changing position (Müller et al., 1989). In the present study, heifers were housed in pens with different sizes of straw bedded areas (1.8, 2.7 and 3.6 $m^2$). The objective was to test the hypothesis that increasing the straw bedded area in a slatted floor system will improve animal welfare by increasing the synchronization of the resting behaviour and decreasing the occurrence of aggression (butting against another animal and forcing another heifer to stand up) and abnormal behaviour (biting or sucking the bar or leaning against another animal) in heifers.

## 2. Material and methods

### *2.1. Experimental design*

The experiment was conducted on two Danish commercial dairy farms (Farms A and B) using 20 Danish Friesian heifers (initial age approximately 18 months) from November 1994 to April 1995. The experimental period was 105 days for Farm A and 102 days for Farm B. Two pens were located on both Farm A and Farm B. Each of the four experimental pens was made from three conventional pens (9 $m^2$) with fully slatted floor. The total area of the experimental pen was 27 $m^2$ or 5.4 $m^2$ per heifer as the group size was five heifers per pen. Straw was placed on the slats in the lying area. The bedded lying area was separated from the slatted floor by a wooden partition of 40 cm height. In each pen the straw bedded lying area was changed from 1.8 to 2.7 and 3.6 $m^2$ per heifer or from 3.6 to 2.7 and 1.8 $m^2$ per heifer during three consecutive periods of 5 weeks, as illustrated in Table 1. The assumption was that the effect of space allowance

Table 1
Experimental design: the order of different periods and the different sizes of the straw bedded area in each pen

| Farm | Pen | Size of bedded area ($m^2$ per heifer) | | |
|---|---|---|---|---|
| | | 1.8 | 2.7 | 3.6 |
| A | 1 | Period 3 | Period 2 | Period 1 |
| | 2 | Period 1 | Period 2 | Period 3 |
| B | 1 | Period 3 | Period 2 | Period 1 |
| | 2 | Period 1 | Period 2 | Period 3 |

on behaviour would be stabilized after a period of 5 weeks. The layout of the experimental pen is illustrated in Fig. 1. The straw bedded area was altered by cleaning the pen and moving the partition. About 3 kg of straw per heifer was provided every day in the lying area to ensure a dry and clean surface. Eating places were standardized to approximate 60 cm per animal. The ten heifers on each farm were grouped in pairs according to weight, age and state of pregnancy. The heifers in each pair were then randomly assigned to two pens on each farm.

### 2.2. Experimental animals

All heifers had been on pasture before the experiment. The average weight of the heifers at the beginning and end of the experimental period were 371 and 480 kg on Farm A and 363 and 429 kg on Farm B. The heifers were fed according to the Danish standard for heifers (Ingvartsen and Sørensen, 1987). Feeding was standardized between treatment within farms. On Farm A an ad libitum total mixed ration was fed in the morning. On Farm B an equal amount of concentrates and silage was fed to each pen in

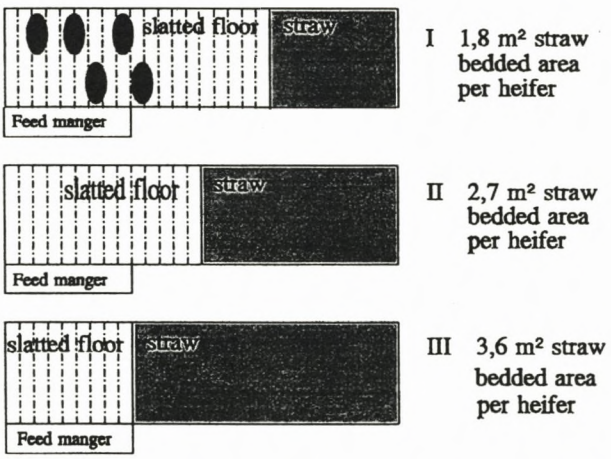


Fig. 1. An illustration of the different sizes of the straw bedded area in an experimental pen during the three periods (I, II and III). The dimensions of the straw bedded areas were: Period I: 3 m × 3 m; Period II: 4.5 m × 3 m; Period III: 6 m × 3 m.

the morning and ammonium-treated straw was fed in the afternoon for ad libitum consumption. The ad libitum feeding ensured that there were always on both farms leftovers at the next feeding. Unbred heifers were bred during the experiment according to a preplanned reproduction strategy. None of the heifers were in heat during the days of behavioural observation. Treatment and management were controlled weekly by a technician from the Danish Institute of Animal Science.

### 2.3. Behaviour observations

Position, posture and behaviour were recorded using direct observations for 24 h at the end of each 5 week treatment period. The position in the pen (either in the resting area or in the unstrawed area) and posture (lying or standing) of individual heifers were recorded at 5 min intervals using scan sampling. For each heifer in the pen social behaviour and abnormal behaviour were recorded for 1.5 min at 5 min intervals using one–zero recording, i.e. whether or not the behaviour pattern occurred during the preceding sample interval of 1.5 min (each heifer was observed for a total of 432 min). Behavioural elements are defined in Table 2. Total lying time per day, number of lying

Table 2
Resting, social and abnormal behaviours observed and calculated from observations in the experiment

| | |
|---|---|
| *Resting behaviour* | |
| Position[a] | In the resting area or the unstrawed area |
| Posture[a] | A lying or standing posture |
| Total lying time[b] | Sum of 5 min intervals with the heifer lying at the beginning of the interval |
| Lying time in the straw bedded lying area[b] | Sum of 5 min intervals with the heifer lying in the straw bedded lying area at the beginning of the interval |
| Number of lying periods[b] | An interruption of a lying period can last up to 5 min if the heifers are lying at the beginning of two subsequent intervals |
| Total synchronization of resting behaviour[b] | Sum of 5 min intervals with all five heifers in the pen lying at the beginning of the interval |
| Synchronization of the resting behaviour in the straw bedded lying area[b] | Sum of 5 min intervals with all five heifers in the pen lying in the straw bedded lying area at the beginning of the interval |
| *Social behaviour* | |
| Butting against another animal's body or neck[a] | Forehead is pushed with force |
| Butting against another animal's head[a] | Forehead is pushed with force |
| Forcing to stand up[a] | By butting another animal or by walking over or treading on another animal |
| Social grooming[a] | Licking another animal's head, neck or body |
| Mounting[a] | Head or neck against another animal's loin and mounting |
| *Abnormal behaviour* | |
| Biting or sucking at bar[a] | The animals have the bar in their mouth; sucking or biting movement |
| Leaning against another animal[a] | Resting forehead against another animal for more than 20 s |

[a]Observed.
[b]Calculated.

periods per day and total time of synchronization of the resting behaviour per day were calculated from the posture recordings as defined in Table 2.

The behaviour of individual heifers was recorded by the same staff from the Danish Institute of Animal Science. The heifers were marked with colours to ensure accurate identification. Lights were turned on for 3 days and nights before the experiment to allow the heifers to adjust to the 24 h light period.

### 2.4. Statistical methods

Lying time per day, number of lying periods, frequency of butting per day and time with synchronization of resting behaviour per day were tested by Shapiro–Wilk Statistics (SAS Institute, Inc., 1989), and each variable was normally distributed.

Lying time, number of lying periods and frequency of butting were analysed by the initial statistical model shown in Eq. (1). This model was reduced by partial tests (Type 3). If the $P$ value of any variable exceeded 0.2, the variable was removed from the initial model (Eq. (1)):

$$Y_{ijkl} = b_0 + F_i + B_{ij} + b_1 X_{ijkl} + T_k + FT_{ik} + A_{ijkl} \quad (1)$$

where $Y_{ijkl}$ is the response variable of the individual, $b_0$ is effect common to all animals, $F_i$ is effect of farm ($i = 1,2$), $B_{ij}$ is effect of pen nested within farm ($j = 1,2$), $b_1$ is effect of period, $T_k$ is effect of treatment (1.8, 2.7 and 3.6 $m^2$ straw bedded area per heifer; $k = 1,2,3$), $FT_{ik}$ is effect of interaction between farm and treatment, $A_{ijkl}$ is random effect of heifer nested within pen, farm and treatment ($l = 1,2, \cdots 5$).

The model for analysing the treatment effect on total lying time, lying time in the straw bedded area and frequency of butting is shown in Eq. (2):

$$Y_{ijkl} = b_0 + F_j + P_{ijkl} X_1 + T_k + FT_{jk} + A_{ijkl} \quad (2)$$

In the analysis for the treatment effect on number of lying periods, $B_{ij}$ was included in the model shown in Eq. (2).

The effects of the size of the straw bedded lying area on lying time, number of lying periods and frequency of butting were tested by analysis of variance using means square (MS) for interaction between treatment and farm (MS(FT)) as denominator (error term) in the $F$-test on the assumption that heifer within farm is dependent. The $P$ values for test with MS(FT) as well as with MS(error) as denominator are presented, as the assumption of dependence is debatable. Testing for differences in variance of lying time between the three different sizes of straw bedded lying area was done using an $F$-test.

The model for analysing the treatment effect on synchronization of lying time using pen as the statistical unit is shown in Eq. (3):

$$Y_{jkl} = b_0 + F_j + b_1 X_{jkl} + T_k + b_2 X_{jkl} + V_{jkl} \quad (3)$$

where $V$ is pen ($l = 1,2$) and $b_2$ is mean lying time or mean lying time in the straw bedded area.

Effects of treatment on forcing another heifer to stand up and leaning were analysed by Kruskal–Wallis one-way analysis of variance (Siegel and Castellan, 1988), as these traits could not be assumed to be normally distributed.

## 3. Results

The synchronization of the resting behaviour, shown in Fig. 2, increased as the size of the bedded lying area was increased. The duration of the synchronized lying time for all five heifers on the bedded lying area was longer with 2.7 $m^2$ and 3.6 $m^2$ than with 1.8 $m^2$ bedded lying area per heifer ($P = 0.002$) but between 2.7 $m^2$ and 3.6 $m^2$ no statistical difference was found. When housed with 1.8 $m^2$ bedded lying area per heifer, the heifers were lying together for 256 min less during 24 h than with 3.6 $m^2$ bedded lying area per heifer, and heifers housed with 2.7 $m^2$ bedded lying area per heifer were lying together for 19 min less than with 3.6 $m^2$ bedded lying area per heifer.

There was no significant difference in lying time between the three different sizes of bedded lying area, as shown in Table 3. However, heifers with 1.8 $m^2$ bedded lying area per animal tended to lie down less in the bedded lying area than heifers with 2.7 or 3.6 $m^2$ lying area per heifer ($P_1 = 0.12$) if heifer within farm is assumed to be independent. However, on the assumption that heifer within farm is dependent, no effect was found ($P_2 = 0.6$). In addition, heifers were observed lying on the slatted floor only with 1.8 $m^2$ bedded lying area per heifer. Comparing access to 1.8 or 3.6 $m^2$ straw bedded lying area per heifer, the variance of lying time in the bedded lying area was higher among heifers with 1.8 $m^2$ bedded lying area per heifer ($P = 0.03$). There was a tendency toward fewer lying periods when the bedded lying area was 2.7 or 3.6 $m^2$ per heifer compared with 1.8 $m^2$ per heifer ($P_1 = 0.12$). However, on the assumption that heifer within farm is dependent, no effect was found ($P_2 = 0.5$).

The effect of different space allowances in the straw bedded lying area on frequency of aggressive behaviour is shown in Fig. 3. The size of the straw bedded area had a

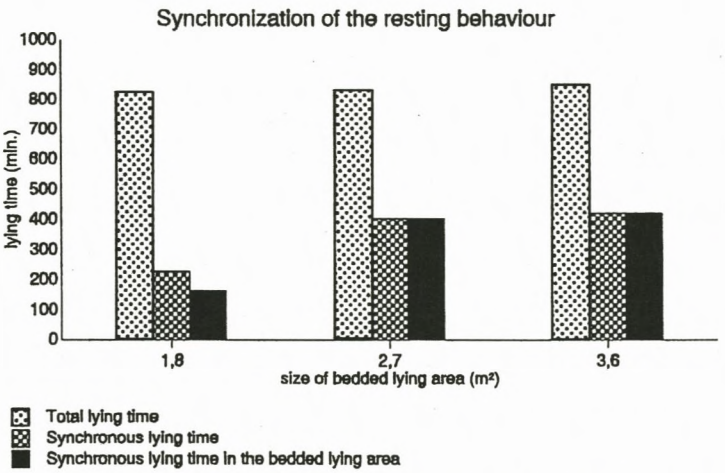


Fig. 2. Synchronization of the resting behaviour (average minutes per day). The first column shows the total average lying time. The second column shows the total average time that all five heifers in the pen are lying at the same time either in the straw bedded area or on the slatted floor. The third column shows the average time that all five heifers in the pen are lying at the same time in the straw bedded area.

Table 3
Effect of space allowance in the bedded lying area on resting behaviour and frequency of leaning per day

| Behaviour | Farm | Size of bedded lying area ($m^2$ per heifer) | | | | $P_1$ | $P_2$ |
|---|---|---|---|---|---|---|---|
| | | 1.8 | | 2.7 | 3.6 | | |
| Lying time (min) | A | 886 | 100[a] | 97[a] | 102[a] | | |
| | B | 769 | 100 | 105 | 102 | | |
| | Mean | | 100 | 101 | 102 | 0.32 | 0.62 |
| Lying time in the bedded area (min) | A | 886 | 100 | 97 | 102 | | |
| | B | 739 | 100 | 109 | 109 | | |
| | Mean | | 100 | 103 | 106 | 0.12 | 0.59 |
| Lying periods | A | 12.4 | 100 | 72 | 91 | | |
| | B | 10.9 | 100 | 101 | 102 | | |
| | Mean | | 100 | 87 | 97 | 0.12 | 0.51 |
| Leaning against another heifer | A | 1.1 | 100 | 18 | 9 | | |
| | B | 1.3 | 100 | 100 | 0 | | |
| | Mean | | 100 | 59 | 5 | 0.05 | $P_3$ |

$P_1$, $P$ value for the $F$-test with MS(error) as denominator (error term); $P_2$, $P$ value for the $F$-test with MS(FT) as denominator (error term); $P_3$, $P$ value for Kruskal–Wallis one-way analysis of variance.
[a]Index with 1.8 $m^2$ per heifer as reference.

significant effect on the level of aggressive behaviour, as heifers with 1.8 $m^2$ bedded lying area exhibited more aggressiveness than heifers with 2.7 or 3.6 $m^2$. Butting was observed more at 1.8 than at 3.6 $m^2$ bedded lying area per heifer ($P_1 = 0.007$), but on

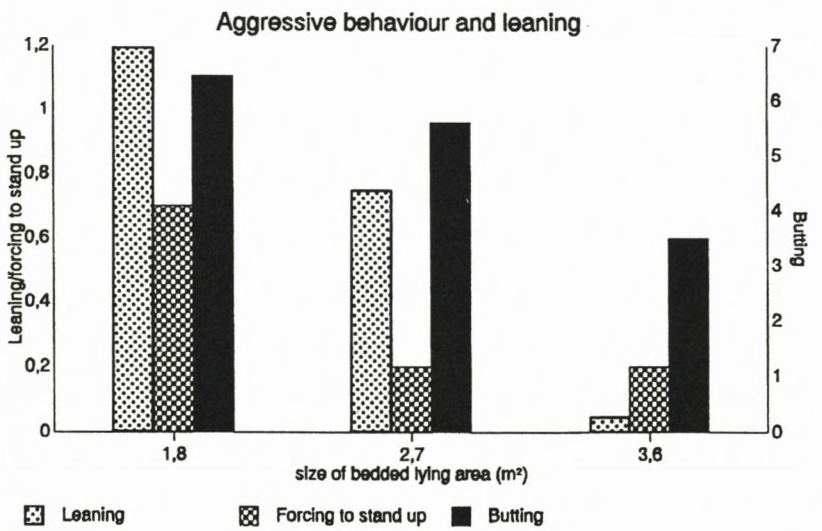


Fig. 3. Effect of different space allowances in the straw bedded lying area on frequency of aggressive behaviour, i.e. average frequency of forcing to stand up, butting per day and leaning. Measured using one–zero recording with sample periods of 1.5 min at intervals of 5 min.

the assumption that heifer within farm is dependent, no effect was found ($P_2 = 0.3$). The frequency of forcing another heifer to stand was lower at 3.6 and 2.7 $m^2$ than at 1.8 $m^2$ bedded lying area per heifer ($P = 0.02$). As shown in Table 3, more leaning against another animal was observed when the heifers were housed with the small bedded area ($P = 0.05$). The frequencies of social grooming and biting or sucking at the bar were very low across treatments.

## 4. Discussion

The results show that heifers weighing about 365 kg were not able to lie down together at the same time when offered 1.8 $m^2$ bedded lying area per heifer, and their resting behaviour was less synchronized. Wierenga (1983) also reported decreased synchronization of resting behaviour with overcrowding in a cubicle systems for cows. In addition, Müller (1988) noted decreased synchronization of resting behaviour when the total space allowance for heifers was reduced. In the present experiment the lying time on the straw bedded area was slightly longer with 3.6 $m^2$ than with 1.8 and 2.7 $m^2$ bedded lying area per heifer. However, the total lying time was not affected, owing to heifers lying on the slatted floor when housed with 1.8 $m^2$ straw bedded lying area per heifer. Other experiments have demonstrated that a reduction of total space allowance from 3.0 to 1.5 $m^2$ per heifer in slatted floor systems reduces lying time (Müller, 1988; Jensen et al., 1995). This discrepancy was probably due to the higher total space allowance of the pen (5.4 $m^2$ per heifer in the present experiment). Thus, synchronization of the resting behaviour appears in the present experiment to be more sensitive to change in space allowance in the lying area than lying time, indicating that synchronization of resting behaviour may be a more sensitive measure of welfare than lying time. In pens with 1.8 $m^2$ straw bedded lying area one heifer was lying on the slatted floor while the other heifers were lying in the bedded area. The explanation for this may be that resting during the resting periods has a high priority and that it can make the animals overcome their aversion to lying and getting up and down on the slatted floor (Müller, 1988). There were fewer lying periods when heifers were housed with a high space allowance in the lying area, and this was probably due to the lower frequency of forcing other heifers to stand up. The larger variance of lying time among animals with 1.8 $m^2$ bedded lying area per heifer suggests that the lying time is reduced, particularly among some individuals within the group, probably the lowest ranging heifers. Larsson et al. (1984) and Jensen et al. (1995) found similar results.

The higher frequency of aggressive behaviour in the present experiment at 1.8 $m^2$ bedded lying area per heifer can be explained according to Wierenga (1983) by the high animal density. The individual distance was often compromised; in addition, the small bedded area led to a higher frequency of forcing other heifers to stand up because of social disturbance. Wierenga (1983) also found more aggressive behaviour at low than at high space allowance.

Our results showing a higher frequency of heifers leaning against others when there was a low space allowance in the bedded area are in agreement with previous studies on heifers by Fisher et al. (1994), and on cows by Wierenga (1983) and Henneberg et al.

(1986). It is not possible to give a definite explanation for the increase in leaning, but Wierenga (1983) suggested that leaning may be a sign of problems in coping with overcrowding.

## 5. Conclusion

The results showed that increasing the bedded lying area from 1.8 to 2.7 $m^2$ per heifer in group housed heifers weighing about 365–450 kg increased the synchronization of the resting behaviour, decreased the incidence of aggression and decreased the frequency of leaning. These results suggest that welfare is enhanced by increasing the bedded lying area from 1.8 to 2.7 $m^2$ per heifer, but welfare is not affected when the bedded lying area is increased from 2.7 to 3.6 $m^2$ per heifer.

## Acknowledgements

The National Committee on Danish Cattle Husbandry provided financial support for the experiment. The assistance of Erik L. Decker, Gynter Nielsen, Margit B. Jensen, Orla Nielsen and Lene Munksgaard with the behavioural observations is highly appreciated.

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Kapitel 4:

# Effect of Space Allowance in Deep Bedding Systems on Resting Behaviour, Production and Health of Dairy Heifers

*Acta Agric. Scand., Sect. A, Animal Sci. 1997: 47, 178–186*
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ACTA AGRICULTURÆ
SCANDINAVICA
*ISSN 0906-4702*

# Effect of Space Allowance in Deep Bedding Systems on Resting Behaviour, Production, and Health of Dairy Heifers

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An experiment was conducted on three Danish commercial dairy farms using 70 Danish Friesian heifers over a period of 141 to 162 days beginning in November. Average body weight of the heifers was 315 kg at the beginning of the experiment. Fourteen experimental pens were established with a flock size of five and different space allowance in the deep bedding area: 1.8, 2.7, and 3.6 $m^2$ resting area per heifer. The total space allowance inclusive of an unstrawed area at the feed manger was 3.6, 4.5, or 5.5 $m^2$ per heifer in herd 1, 3.6 or 4.5 $m^2$ per heifer in herd 3, and 3.0 or 4.9 $m^2$ per heifer in herd 2. Eating space was standardized within pens to 60 cm per animal. Feed was available *ad libitum*. At 1.8 $m^2$ resting area per heifer, the heifers were unable to synchronize their resting behaviour, and the variance of the daily lying time was higher compared with heifers at 2.7 or 3.6 $m^2$ resting area. None of the heifers were lying on the unstrawed area. Total lying time was not affected by the space allowance of resting area. There was a tendency towards more aggressive interactions at the lowest resting area of 1.8 $m^2$ per heifer. Frequency of abnormal behaviour was very low and was not affected by the space allowance. Daily gain and feed intake were increased in heifers with a resting area of 2.7 or 3.6 $m^2$ compared with 1.8 $m^2$, but the feed conversion ratio was unaffected. The prevalence of heel horn erosion was higher at 1.8 $m^2$ resting area compared with 2.7 and 3.6 $m^2$. For heifers with access to 2.7 or 3.6 $m^2$ compared with 1.8 $m^2$ resting area per heifer both welfare (behaviour and health) and production were improved.

Key words: Daily gain, feed intake, heel horn erosion, resting area, social behaviour.

## Introduction

Deep bedding systems for young stock have received increased attention in recent years as the interest in animal welfare has increased. A system with deep bedding in the resting area ensures the heifer a comfortable rest (Jensen et al., 1995), and an unstrawed area at the feed manger is suitable. Without an unstrawed area at the feed manger the surface of the deep bedding will be trotted out easily and claw length may be increased because of little wear (Müller, 1988). Furthermore, a housing system with partly deep bedding and an unstrawed area at the feed manger allows the farmer to utilize existing fully slatted pens as the area at the feed manger in case of rebuilding.

Jensen et al. (1995) demonstrated that heifers preferred a straw bedded area to an area with slatted floor while lying. A straw bedded area of 1.5 $m^2$ per 400 kg heifer did not allow all heifers to lie down at the same time (Jensen et al., 1995). As space allowance for young bulls was increased, level of aggression (Kondo et al., 1989) and level of abnormal behaviour (Wierenga, 1987) was decreased. Further, as space allowance was increased, Larsson et al. (1983) observed a decreased frequency of forcing another animal to stand up, which in turn decreased the number of lying periods.

Mossberg & Törnquist (1988) have performed an experiment using young bulls housed in partly deep bedded pens with an unstrawed area at the feed manger. They found that bulls at a high stocking density had lower live weight gains than animals at a low stocking density. Experiments using pens with fully slatted floors have shown improved production in heifers by increasing space allowance up to 3.0 $m^2$ per heifer (Müller, 1988; Fisher et al., 1994; Hindhede et al., 1996). Based on results for young bulls Ingvartsen & Andersen (1993) have extrapolated that a space allowance of approximately 4.5 $m^2$ will ensure optimal production in young bulls at a live weight of 250–500 kg. However, there have been no experiments on heifers housed in partly deep bedded pens and an unstrawed area at the feed manger with the aim of estimating the effect of space allowance on behaviour and production.

Hindhede et al. (1996) could not detect any difference in number of skin lesions or traumatic injuries to heifers housed in different pen types. According to Kirchner & Boxberger (1987), damage of claws is an important problem in housing systems with a fully slatted floor. In a review, Jensen (1992) indicated that there was a higher incidence of heel horn erosion and skin traumas (decubitus) in heifers housed on fully slatted floors compared with bedding, but heifers housed on bedding had a significant increase in the percentage of long claws. However, it is still unknown if the health of heifers is influenced by the space allowance.

The purpose of this experiment was to test the hypothesis that increasing space allowance in the deep bedded resting area will improve behaviour (decrease abnormal and aggressive behaviour, increase synchronization of the resting behaviour), production (increase daily gain and decrease feed conversion ratio) and health (decrease prevalence of horn erosion and sole ulcers) of heifers.

## Material and methods

### *Experimental design*

The experiment was conducted using 70 Danish Friesian heifers on three Danish commercial dairy farms during the period from November 1994 to April 1995. All heifers had been on pasture prior to the experiment and were at least 10 months old at the beginning of the experiment with an average weight of about 315 kg. Table 1 shows the number of pens, the average live weight at the start of the experiment and length of the experiment.

The experimental pen types are illustrated in Fig. 1. Pens were established with different space allowance in the resting area: 1.8, 2.7, or 3.6 $m^2$ per heifer. The total space allowance was 3.6, 4.5, or 5.5 $m^2$ per heifer in herds 1 and 3, and 3.0 or 4.9 $m^2$ per heifer in herd 2. The pens with 1.8 $m^2$ per heifer were used as a reference on all three farms.

In all pens, the feeding space was 3.0 m, equivalent to 0.60 m per heifer. The floor type in front of the feed manger was slatted floor in herds 1 and 3, and concrete floor in herd 2. The area per heifer was 1.8 $m^2$ in herds 1 and 3 and 1.2 $m^2$ in herd 2. In herd 1, there were steps between the area at the feed manger and the resting area. In herd 2, the solid concrete floor in front of the feed manger was 6 $m^2$.

Table 1. Experimental design with number of pens per herd, average live weight of heifers at the beginning of the experimental period, and experimental period

| | Resting area $m^2$ per heifer | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1.8 | 2.7 | 3.6 | Unstrawed area at the manger | | | |
| Herd | Number of heifers per pen | | | Type | $m^2$ per heifer | Average live weight kg (SD) | Experimental period (days) |
| 1 | 2 | 2 | 2 | Slats | 1.8 | 322 (53) | 158 |
| 2 | 2 | | 2 | Slats | 1.2 | 327 (78) | 141 |
| 3 | 2 | 2 | | Concrete | 1.8 | 296 (49) | 162 |

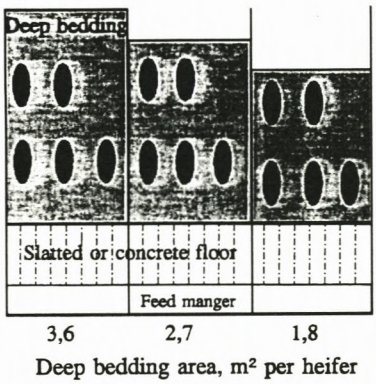


*Fig. 1.* Layout of the experimental pens. The area at the feed manger is 3 m wide in all herds, 3 m deep in herd 1 and 3, and 2 m in herd 2.

In each herd, experimental heifers were selected according to similarity in weight, age and state of pregnancy, and then assigned randomly to the available pens.

### *Behavioural observations*

Position, posture and behaviour were recorded during 24 h using direct observations once per pen during the last month of the experiment. The position in the pen (either in the resting area or in the unstrawed area), posture (lying or standing) and lying position of individual heifers were recorded at 10 min intervals using scan sampling. For each heifer in the pen, social behaviour and abnormal behaviour were recorded for 1.5 min at 10 min intervals using one-zero recording, i.e. whether or not the behaviour pattern occurred during the preceding sample interval of 1.5 min. Each heifer was observed for a total of 216 min. Lying position and behavioural elements are defined in Table 2. From the registrations of posture, total lying time, number of lying periods and duration of the synchronization of the resting behaviour were calculated. Total lying or standing time was calculated as the sum of 10 min intervals, with the heifer lying or standing at the beginning of the interval. Number of lying periods was counted. An interruption of a lying period could last up to 10 min, if the heifer was lying at the beginning of two subsequent intervals. Synchronization of the resting behaviour is the sum of 10 min intervals with all five heifers in the pen lying at the beginning of the interval.

The behaviour of individual heifers was recorded by the same eight observers from the Danish Institute of Animal Science. The heifers were marked with colours to ensure individual identification. Light was necessary for observations during night. The light was turned on for 3 days and nights prior to the experiment to allow adjustment of the heifers to the 24-h light period.

### *Recording of production and health*

Live weight was recorded at the beginning and end of the experiment. Feed intake (kg raw material) was measured per pen for 24 h every second week. Animals were fed according to the Danish Standard for heifers (Strudsholm et al., 1992) and were planned to have an average daily gain of about 700 g. Concen-

Table 2. Definition of behavioural elements

| Lying position | Social behaviour |
|---|---|
| Lying with raised head—resting on the chest, head up | Butting head/shoulder of another heifer—forehead is pushed with force |
| Lying with resting head—on the chest and with the head down | Butting body of another heifer—forehead is pushed with force |
| Lying on one side—lying flat on one side, outstretched | Forcing to stand up—by shoving another animal or walking over its body |
| | Licking others—licking the head, neck or body of another heifer |
| | Mounting another heifer—head or neck against another animals loin and mounting |
| | Abnormal behaviour: |
| | Licking/biting objects—the animal takes fittings into its mouth and bites or sucks them |
| | Leaning—forehead or muzzle is kept against another heifer. Duration of at least 20 s |

trates were fed restrictively to each pen and ammonium treated straw was fed for *ad libitum* consumption. The *ad libitum* feed was at least 1.5 SFU (Scandinavian Feed Unit) per heifer per day.

In the bedding area, 3 kg of straw per heifer were supplied daily. The bedding was not removed from the pens during the experimental period.

Unbred heifers were bred during the experiment according to a preplanned reproduction strategy. All recording of production was conducted by technicians from the Danish Institute of Animal Science.

All 70 heifers were examined systematically for skin lesions, angle of the hock, and leg position by the same veterinarian at the beginning and end of the experiment. Each heifer was hoof trimmed by the same hoof trimmer at the end of the experiment. Digital disorder, hoof quality, and claw length were recorded at the hoof trimming.

Angle of the hock (1 = very straight, 5 = normal, 9 = very gnarled), leg position (1 = hocks touch, 5 = normal, 9 = bow-legged), and quality of the hoof (1 = good, 4 = bad) were all measured on an arbitrary scale. Claw length was measured by measuring the angle between hoof wall (dorsal) and hoof sole (Schlichting, 1987). Normally this angle is around 45°. An angle of 25° or less indicates that the claw is extremely long and needs to be trimmed.

### *Statistical methods*

Lying time, standing time, and number of lying periods were analysed by analysis of variance with the statistical model shown in Eq. (1).

$$Y_{ijkl} = b_0 + T_i + H_j + (HT)_{ij} + P_{ijk} + e_{ijkl} \quad (1)$$

where $b$ is the general mean, $T$ is the treatment (1.8, 2.7, or 3.6 $m^2$ resting area per heifer, $i = 1, 2, 3$), $H$ is the herd ($j = 1, 2, 3$), $HT$ is the interaction between herd and treatment, $P$ is the pen within herd and treatment ($k = 1, 2$ pens), and $e$ is the rest term (animal within pen, herd and treatment ($l = 1, 2 \ldots 5$).

Synchronization of resting behaviour per pen was analysed with the statistical model shown in Eq. (2).

$$Y_{ijm} = b_0 + T_i + H_j + (HT)_{ij} + X_1 * L_{ijm} + B_{ijm} \quad (2)$$

where $X_1$ is the effect of the covariate, average lying time in the pen ($L$), and $B$ is the pen within herd and treatment ($m = 1, 2$).

Lying time in different lying positions, butting, forcing other heifers to stand up, licking of others, leaning and licking/biting of objects were analysed by Kruskal–Wallis one-way analysis of variance (Siegel & Castellan, 1988).

Live weight gain was analysed by the statistical model shown in Eq. (3):

$$Y_{ijkl} = b_0 + T_i + H_j + (HT)_{ij} + P_{ijk} + X_{ij} * W_{ijkl} + e_{ijkl} \quad (3)$$

where $X_{ij}$ is the effect of covariate within herd and treatment, live weight at the beginning of the experiment ($W$).

The daily weight gain was corrected for the part of the gain caused by the foetus (Sørensen, 1987):

$$\text{gain of the foetus (kg)} = 0.251 * \exp(0.02 * \text{days after conception}) \quad (4)$$

Feed intake (SFU) and feed conversion ratio (SFU kg weight $\text{gain}^{-1}$) were analysed by the statistical model shown in Eq. (5) using the pen as the statistical unit:

$$Y_{ijm} = b_0 + T_i + H_j + (HT)_{ij} + B_{ijm} \quad (5)$$

Claw length at the end of the experiment was analysed by the statistical model shown in Eq. (6):

$$Y_{ijkl} = b_0 + T_i + H_j + (HT)_{ij} + P_{ijk} + X_1 * C_{ijkl} + X_2 * S_{ijkl} + A_{ijkl} \quad (6)$$

where $X_1$ is the effect of the covariate, claw length at the beginning of the experiment ($C$) and $X_2$ is the effect of the covariate, standing time or lying time (S).

Effects of treatment on digital disorders and skin lesions were analysed by the McNemar non-parametric Change Test (Siegel & Castellan, 1988).

The effect of space allowance in the resting area on lying time, standing time, number of lying periods, live weight gain, and claw length was tested by analysis of variance using means square (MS) for the interaction between treatment and herd (MS(FT)) as the denominator in the F-test. On the assumption that heifer within farm is dependent. The $P$ values for tests with MS(FT) as well as with MS(error) as the denominator are presented, because the assumption of dependence is debatable.

## Results

Effect of space allowance in the resting area on resting behaviour is illustrated in Fig. 2 and Tables 3 and 4 . The results in Fig. 2 show that a reduction in space allowance in the resting area reduced the synchronization of the resting behaviour ($P = 0.007$). With 1.8 $m^2$ resting area per heifer, all heifers were lying down at the same time for 78 min less compared with 3.6 $m^2$ resting area. In addition, all heifers were lying down at the same time for 27 min less with 2.7 $m^2$ compared with 3.6 $m^2$ resting area per heifer. There was a tendency towards a larger ($P = 0.14$) variance in lying time among heifers with space allowance of 1.8 $m^2$ compared with 3.6 $m^2$ (Table 3). However, it appears that the duration of lying time was not

Table 3. Effect of space allowance on lying and standing behaviour

| Behaviour | Herd | Space allowance at the deep bedding ($m^2$) 1.8 | 2.7 | 3.6 | $P_1$[1] | $P_2$[2] |
|---|---|---|---|---|---|---|
| Lying time, minutes | 1 | 707 | 769 | 756 | | |
| | 2 | 739 | | 746 | | |
| | 3 | 912 | 847 | | | |
| | Average | 100[3] | 101 | 104 | 0.80 | 0.95 |
| Standing time on the deep bedding, minutes | 1 | 149 | 130 | 157 | | |
| | 2 | 309 | | 238 | | |
| | 3 | 105 | 125 | | | |
| | Average | 100[3] | 103 | 91 | 0.46 | 0.80 |
| Number of lying periods on the deep bedding | 1 | 10.8 | 10.0 | 9.5 | | |
| | 2 | 10.6 | | 10.0 | | |
| | 3 | 11.5 | 9.9 | | | |
| | Average | 100[3] | 90 | 91 | 0.13 | 0.17 |

[1] Test with mean square for error as denominator in the F-test.
[2] Test with mean square for the interaction between pen type and farm as denominator in the F-test.
[3] Index with 1.8 $m^2$ as reference.

affected by space allowance ($P_1 = 0.80$). There was a tendency towards fewer ($P_1 = 0.13$) lying periods among heifers housed at a high space allowance. There were no observations of heifers lying on the unstrawed area at the feed manger. Effect of space allowance in the resting area on lying positions is described in Table 4. Heifers with a space allowance of 1.8 $m^2$ per heifer had a prolonged ($P = 0.05$) resting time, lying on the chest with the head down compared with heifers with 2.7 or 3.6 $m^2$ per heifer. Observations of heifers in the lying position on one side were rare.

The effect of space allowance in the resting area on aggressive interactions is shown in Fig. 3 and Table 4. The number of aggressive interactions tends (NS) to be lower in pens with high space allowance. Abnormal behaviour (leaning and licking/biting objects) and licking of others were observed very rarely and were not affected by space allowance. The average was 0.1, 0.2, and 2.9 observations per heifer per 216 min of observation of leaning, licking/biting objects and licking of others.

The treatment effects on live weight gain, feed intake (SFU) and feed conversion ratio (SFU kg weight gain$^{-1}$) are shown in Table 5. There was an increase ($P_2 = 0.05$) in live weight gain by increasing the space allowance in the resting area from 1.8 to 3.6 $m^2$ per heifer, and an increase ($P_1 = 0.04$) in feed intake by increasing the space allowance in the resting area. The space allowance had no significant effect on the feed conversion ratio ($P_1 = 0.15$). In herd 2 the lower daily weight gain than in the other herds was caused by a very high feed conversion ratio.

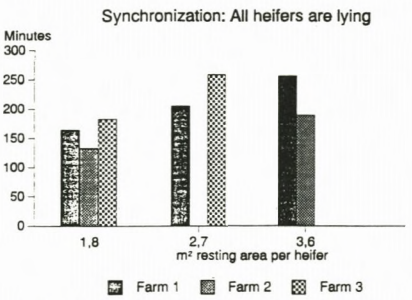


*Fig. 2.* Effect of space allowance on the synchronization of the resting behaviour in the three herds, i.e. min per 24 h when all five heifers in the pen are lying at the same time.

The McNemar Change Test showed no change during the experiment in skin lesions or leg position. As seen in Table 6, there were more ($P = 0.01$) heifers with heel horn erosion among heifers housed at 1.8 $m^2$ resting area per heifer than at 2.7 or 3.6 $m^2$ resting area at the end of the experiment. The incidence of sole ulcers was not affected by space allowance (Table 6).

The claw length was negatively correlated ($P = 0.001$) to the time of standing on the unstrawed area at the food manger (correlation coefficient $r = -0.4$) and positively correlated ($P = 0.01$) to the lying time in the resting area ($r = 0.3$).

Table 4. Effect of space allowance on lying position and aggressive interactions

| Behaviour | Herd | Space allowance at the deep bedding ($m^2$) 1.8 | 2.7 | 3.6 | *P* |
|---|---|---|---|---|---|
| Lying with raised head (min) | 1 | 600 | 672 | 672 | |
| | 2 | 630 | | 658 | |
| | 3 | 780 | 708 | | |
| | Average | 100[1] | 102 | 108 | NS |
| Lying with resting head (min) | 1 | 107 | 90 | 80 | |
| | 2 | 109 | | 83 | |
| | 3 | 120 | 121 | | |
| | Average | 100[1] | 93 | 76 | 0.05 |
| Lying on one side (min) | 1 | 0 | 7 | 3 | |
| | 2 | 0 | | 5 | |
| | 3 | 12 | 18 | | |
| | Average | | | | NS |
| Butting | 1 | 1.55 | 0.7 | 0.6 | |
| | 2 | 1.15 | | 0.4 | |
| | 3 | 0.4 | 0.75 | | |
| | Average | 100[1] | 117 | 38 | NS |
| Forcing to stand up | 1 | 0.3 | 0.1 | 0.2 | |
| | 2 | 1.1 | | 0.3 | |
| | 3 | 0.6 | 0.3 | | |
| | Average | 100[1] | 42 | 47 | NS |

[1] Index with 1.8 $m^2$ as reference.

## Discussion

A resting area of 1.8 $m^2$ compared with 3.6 $m^2$ was enough to sufficient the same lying time of heifers of an average live weight at 398 kg at the time of observation. Contrary to findings in the present experiment, Beneke (1985) and Jensen et al. (1995) found, using heifers in fully slatted pens, that the duration of lying down was extended when space allowance was increased from 1.5 to 3.0 $m^2$ per heifer. The lack of

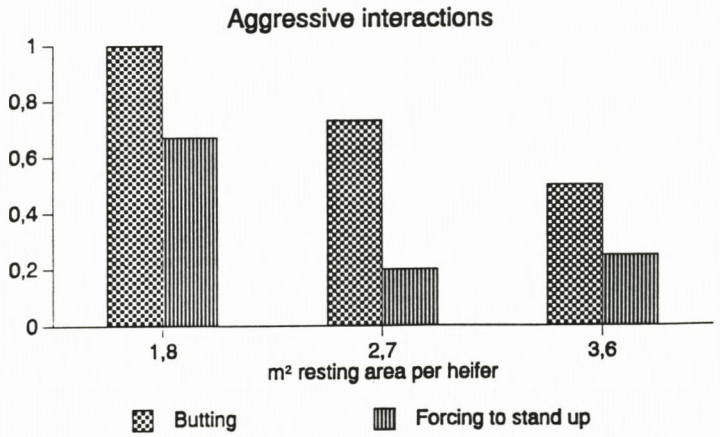


*Fig. 3.* Effect of space allowance in the resting area on the aggressive interactions of "butting" and "forcing to stand up". Average frequency during 216 min of observation per heifer.

Table 5. Effect of space allowance on daily weight gain, feed intake and feed conversion ratio

| | | Space allowance in the resting area ($m^2$) | | | | |
|---|---|---|---|---|---|---|
| | Herd | 1.8 | 2.7 | 3.6 | $P_1$[1] | $P_2$[2] |
| Daily weight gain (g) | 1 | 653 | 648 | 698 | | |
| | 2 | 414 | | 474 | | |
| | 3 | 753 | 774 | | | |
| | Average | 100[3] | 101 | 111 | 0.35 | 0.05 |
| Daily feed intake (SFU)[4] | 1 | 5.35 | 5.50 | 5.62 | | |
| | 2 | 5.22 | | 5.30 | | |
| | 3 | 4.96 | 4.98 | | | |
| | Average | 100[3] | 102 | 104 | 0.04 | 0.24 |
| FCR (SFU kg weight gain$^{-1}$) | 1 | 8.23 | 8.51 | 8.06 | | |
| | 2 | 12.63 | | 11.20 | | |
| | 3 | 6.59 | 6.44 | | | |
| | Average | 100[3] | 101 | 94 | 0.15 | 0.36 |

[1] Test with mean square for error as denominator in the F-test.
[2] Test with mean square for the interaction between pen type and farm as denominator in the F-test.
[3] Index with 1.8 $m^2$ as reference.
[4] Scandinavian feed unit.

effect of space allowance on lying time in the present experiment can be explained by the high total space allowance of 3.0 to 5.5 $m^2$ per heifer. At 1.8 $m^2$ per heifer, five heifers were not able to lie down at the same time in the resting area. At a space allowance of 2.7 or 3.6 $m^2$ per heifer, resting behaviour became more synchronized than at 1.8 $m^2$ per heifer. Similar results were found by Müller (1988) in studies with heifers in pens with fully slatted floors or deep bedding. Thus, synchronization of the resting behaviour in the present experiment appears to be more sensitive to change in space allowance than lying time. This indicates that synchronization of resting behaviour may be a more sensitive measure of welfare than lying time. The relatively high variance of lying time among heifers in pens with low space allowance in the resting area was caused by a reduced lying time for some individuals within the group. Jensen et al. (1995) and Larsson et al. (1984) found similar results by comparing 1.5 $m^2$ versus 3.0 $m^2$ per heifer and 1.5 $m^2$ versus 2.4 $m^2$ per bull, respectively. The tendency towards fewer lying periods in pens with high compared with low space allowance was also reported by Larsson et al. (1984) and can be explained by a reduction in forcing to stand up. At a low space allowance, heifers could not lie flat on one side; instead, they were lying on the chestbone and resting their heads. Müller (1988) found similar results in an experiment with space allowances of 1.6 or 3.0 $m^2$ per heifer. The longer standing time at the deep bedding in herd 2 may be due to the smaller area at the feed manger in herd 2 compared with herd 1 and 3. The tendency towards more aggressive interactions in pens with low compared with high space allowance could be explained by the fact that the individual distance is often crossed, which increases the number of aggressive interactions (Wierenga, 1983). There was no effect of space allowance on the incidence of abnormal beha- viour. Leaning is observed in animals when there is a perceived lack of safety (Krohn &

Table 6. Prevalence of heel horn erosion and sole ulcers at different space allowances in the deep bedding area

| | Space allowance per heifer | | |
|---|---|---|---|
| | 1.8 $m^2$ | 2.7 $m^2$ | 3.6 $m^2$ |
| Number of heifers (%): | | | |
| with light heel horn erosion | 12 (40) | 3 (15) | 2 (10) |
| with severe heel horn erosion | 1 (3) | 1 (5) | 0 (0) |
| with sole ulcers | 2 (7) | 4 (20) | 3 (15) |

Rasmussen, 1990), or when the animals are frustrated by an inability to cope with the surroundings (Wierenga, 1983; Foldager et al., 1993).

An increase in total space allowance from 3.0 to 5.5 $m^2$ per heifer was associated with increased feed intake and live weight gain, but the feed conversion ratio was not affected. Other studies have reported an effect of increasing the space allowance from 1.5 to 3.0 $m^2$ on feed conversion ratio in heifers on fully slatted floors (Müller, 1988; Fisher et al., 1994; Hindhede et al., 1996). In an experiment with heifers in pens with partly concrete and slatted floors, there was an effect on both feed intake and feed conversion ratio of increasing the space allowance from 1.9 to 3.6–5.6 $m^2$ per heifer (Morrison et al., 1970). The lack of effect of space allowance on the feed conversion ratio in the present experiment can be explained by the high total space allowance of 3.0 to 5.5 $m^2$ per heifer. At a low space allowance the animals will be more stressed, which may be the explanation for a poor feed conversion ratio at a relatively low space allowance (Andersen & Ingvartsen, 1991).

A relatively high incidence of heel horn erosion in heifers housed at a low space allowance may be attributed to a more humid environment and more pollution around the claws (Schmidt et al., 1985). Müller (1988) found similar results with a higher incidence of heel horn erosion for heifers housed at low space allowance (1.6 $m^2$) compared with high space allowance (3.0 $m^2$) in pens with fully slatted floors. In the present experiment, heifers that had a longer standing time on the unstrawed area at the feed manger also showed a higher degree of claw wear. The heifers were only hoof trimmed at the end of the experiment, which corresponds to ordinary practice and gives the cumulative effect of experimental treatment.

A larger resting area per heifer will therefore be advantageous for the behaviour as well as production of heifers.

## Acknowledgement

The National Committee on Danish Cattle Husbandry has funded the experiment. The assistance of Erik L. Decker, Gynter Nielsen, Margit B. Jensen, Orla Nielsen and Lene Munksgaard with the behavioural observations and the technical assistance of Erik L. Decker is highly appreciated.

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# 5. Floksammensætningens betydning for adfærd, produktion og sundhed hos kvier i dybstrøelsessystemer

**Jens Hindhede, Lisbeth Mogensen og Jan Tind Sørensen**

## 5.1 Indledning

Den stigende interesse for husdyrenes velfærd indenfor kommerciel husdyrproduktion, har øget opmærksomheden vedrørende husdyrenes opstaldning. Indenfor malkekvægsproduktion er der blevet fokuseret på opstaldning af kvier. Kvier har traditionelt været opstaldet i fuldspaltebokse. Disse bliver nu i stort omfang erstattet af systemer med et strøet liggeareal.

Forskning i nye, forenklede og fleksible lavomkostningssystemer, vil give mulighed for hurtigt at implementere nye forskningsresultater i praksis. Det er også vigtigt at udvikle fleksible styringssystemer med færrest muligt begrænsninger, samt at fremskaffe viden og løsninger som kan implementeres i eksisterende mælkeproduktionssystemer. Opstaldning af kvier i relativt store flokke giver fleksibilitet ved bygning eller renovering af stalde til opdræt og bidrager ofte til rationalisering af arbejdet vedrørende bl. a. fodring og udrensning. Men store flokke vil alt andet lige medføre færre og mere uensartede flokke, hvilket forventes at kunne forringe kviernes velfærd og produktion. Der er gennemført meget få forsøg, som vurderer virkning af floksammensætning (størrelse og homogenitet/ensartethed) på kviers velfærd og produktion.

Sørensen (1987a) undersøgte den gensidige påvirkning mellem størrelsen af kvier og deres placering i hhv. små homogene og små heterogene grupper. Forsøget blev udført i fire besætninger med spaltegulvsbokse (1,5 $m^2$ pr. kvie), og uden mulighed for individuel fodring, dog med mindst 50 cm ædeplads per kvie. I to besætninger blev der fodret med ensilage ad libitum og i to andre besætninger blev der fodret med kraftfoder to gange dagligt samt ammoniakbehandlet halm ad libitum. Der var ingen virkning af floksammensætning ved fodring med ensilage, men ved kraftfoder og halm havde de lette kvier størst tilvækst i de homogene grupper og de tunge kvier havde størst tilvækst i de heterogene grupper.

Hindhede et al. (1996) sammenlignede i to besætninger flokstørrelser på 5 og 10 kvier i homogene grupper i fuldspaltebokse. Forsøgskvierne havde en start vægt på 310 kg, den tildelte plads pr. kvie var 1,5 $m^2$ spaltegulv og 50 cm ædeplads. Der blev ikke fundet nogen virkning af flokstørrelsen på foderoptagelse, tilvækst og foderudnyttelse.

I udenlandske undersøgelser med flokstørrelser fra 5-20 dyr, er der heller ikke fundet nogen virkning af flokstørrelse (Morrison et al. 1981, Hanekamp et al. 1990). Det skal dog bemærkes, at disse forsøg var med stude eller tyre, samt at virkningen af flokstørrelse var sammenblandet med belægningsgrad.

Formålet med nærværende forsøg var at teste følgende 3 hypoteser:

En øget flokstørrelse og deraf følgende mindre homogenitet:

- vil ikke ændre dyrenes adfærd i negativ retning (øget unormal og aggressiv adfærd, mindre synkroniseret hvilemønster),
- vil ikke forringe dyrenes sundhed (øge udbredelse af balleforrådnelse, såleknusning og hudlæsioner),
- vil ikke forringe produktionen (reducere den daglige tilvækst eller foderudnyttelsen).

### 5.2 Materiale og metode

*Forsøgsdesign*
Forsøget blev gennemført i 8 private besætninger (SDM/RDM) med i alt 168 kvier i perioden november 1995 til april 1996, i alt 20-22 uger.

Der blev etableret 3 forsøgsbokse i hver besætning:

- En enkelt boks til en lille, Homogen gruppe med 5-6 Lette kvier (130-250 kg): ***Le-Hom***
- En enkelt boks til en lille, Homogen gruppe med 5-6 Tunge kvier (250-380 kg): ***Tu-Hom***
- En dobbeltboks til en stor, Heterogen gruppe med 10-12 lette og tunge kvier (130-380 kg): ***LT-Het***

Såvel fodring som plads per dyr blev standardiserede indenfor besætning og så vidt muligt mellem besætningerne. Den daglige pasning af dyrene blev gennemført uafhængig af forsøgsbehandling og blev ændret så lidt som muligt for at bibeholde realistiske produktionsvilkår.

Forsøget blev gennemført i et system som typisk anbefales i praksis, nemlig: Delvis dybstrøede bokse (ca. 2,7 $m^2$ pr. dyr) med fast gulv/spalter ved foderbordet og fodring med ét fodermiddel efter ædelyst. Dette system blev hovedsageligt valgt fordi:

- kvier foretrækker et strøet leje fremfor spaltegulv, når de ligger, da det er mere komfortabelt (Jensen et al., 1995)
- dybstrøelse ved foderbordet, trædes op og kan medføre problemer med lange klove på grund af formindsket klovslid (Müller, 1988)
- både velfærd (adfærd og sundhed) og produktion forbedres for kvier med adgang til 2,7 eller 3,6 $m^2$ hvileareal sammenlignet med 1,8 $m^2$ hvileareal pr. kvie (Mogensen et al., 1997)

- i staldsystemer, hvor dyrene går i flokke med stor variation i dyrenes størrelse, er dybstrøelsessystemet fleksibel i modsætning til systemer med enkeltbåse (senge)

Forsøgsboksene for alle 8 besætninger er beskrevet i tabel 5.1. Baseret på eksisterende dybstrøelses systemer blev 24 forsøgsbokse etableret. I 6 besætninger var gruppestørrelsen 5 og 10 og for 2 besætninger (nr. 6 og 7) var gruppestørrelsen 6 og 12.

**Tabel 5.1. Beskrivelse af kvægrace, floksammensætning (gruppestørrelse og flokkens homogenitet) samt bokstyper på samtlige 8 gårde fordelt på to fodringssystemer.**

| Gård Nr. | Race | Gruppe-størrelse, kvier pr. boks | Gruppe startvægt, kg pr.kvie | | | Boksbeskrivelse, pr. kvie | | |
|---|---|---|---|---|---|---|---|---|
| | | | Lille gruppe Homogen | | Stor gruppe Heterogen | Hvile-areal, $m^2$ | Fast gulv ved foderbord, $m^2$ og type[a] | Foder-bords-plads, m |
| | | | Lette 5/6 | Tunge 5/6 | Lette + Tunge 10/12 | | | |
| Separat fodring[b] | | | | | | | | |
| 1 | SDM | 5/10 | 198 | 310 | 252 | 2.70 | 1.80 S | 0.62 |
| 2 | SDM | 5/10 | 199 | 310 | 255 | 2.74 | 1.30 B | 0.72 |
| 3 | SDM | 5/10 | 202 | 310 | 258 | 2.79 | 1.50 S | 0.62 |
| 4 | SDM | 5/10 | 218 | 314 | 262 | 2.20 | 0.90 B | 0.63 |
| Èn foderration[b] | | | | | | | | |
| 5 | SDM | 5/10 | 196 | 293 | 250 | 2.85 | 1.08 B | 0.60 |
| 6 | SDM/RDM | 6/12 | 201 | 330 | 270 | 2.67 | 0.93 B | 0.67 |
| 7 | SDM | 6/12 | 197 | 348 | 271 | 2.70 | 1.00 B | 0.50 |
| 8 | SDM | 5/10 | 203 | 337 | 267 | 2.40 | 1.62 B | 0.60 |

a) Fast gulv ved foderbordet, type: Beton (B) eller spaltegulv (S) .
b) Separat fodring: Kraftfoder tildelt separat, restriktiv og halm tildelt ad-libitum.
Èn ration: Ensilage eller fuldfoder ad-libitum.

Der var samme belægningsgrad (hvileareal og ædeplads pr. kvie) i boksene indenfor besætning. Der var små forskelle mellem besætninger som vist i tabel 1. Generelt var der totalt ca. 4,5 $m^2$ pr. kvie og heraf et strøet hvileareal på ca. 2,7 $m^2$ pr. kvie. Ædepladsen var på ca. 0,60 m pr. kvie. Ved foderbordet var der spaltegulv i besætning 1 og 3 og betongulv i de øvrige besætninger. I alle besætninger, undtagen besætning nr. 6 og 7, var der trapper mellem foderbordet og hvileområdet.

Med henblik på også at belyse vekselvirkningen mellem floksammensætning og fodring er følgende fodringsssystemer/-principper anvendt:

1. Separat, restriktiv tildeling af kraftfoder pr. boks (samme mængde pr. kvie indenfor besætning) og ammoniakbehandlet halm ad libitum (SF)

2. Én ration (ensilage eller fuldfoder) fodret ad libitum (ER)

SF systemet blev anvendt i 4 besætninger (besætning nr. 1- 4) og halmoptagelse var planlagt til ca. 1,5 FE pr. kvie dagligt. ER systemet blev anvendt i 4 besætninger (besætning 5-8) , således at kvierne fik fuldfoder (besætning nr. 7-8) eller ensilage (besætning nr. 5-6). Dyrene blev fodret i henhold til dansk norm for kvier (Strudsholm et al., 1992) og der blev tilstræbt en daglig tilvækst på omkring 650 g. Den mængde strøelse, der blev ædt, regnes for ubetydelig.

Foderrationerne og foderoptagelsen for hver besætning er vist i tabel 5.2. I besætning nr. 4 var foderoptagelsen lidt lavere end planlagt, på grund af at halmens fordøjelighed var lavere end forventet. I besætning nr. 8 indeholdt fuldfoderet ensilage med en lav energikoncentration og større fylde end forventet.

**Tabel 5.2. Fodringssystemer og daglig foderoptagelse pr. kvie i samtlige 8 besætninger.**

| Besætn. Nr. | Fodermiddel tildelt ad libitum | FE pr. kvie pr. dag | | |
|---|---|---|---|---|
| | | Restriktiv kraftfoder | Ad libitum | Total |
| Separat fodring | | | | |
| 1 | Halm | 2.17 | 2.28 | 4.45 |
| 2 | Halm | 2.57 | 1.39 | 3.96 |
| 3 | Halm | 2.54 | 1.78 | 4.32 |
| 4 | Halm | 2.70 | 1.23 | 3.93 |
| Èn ration | | | | |
| 5 | Ensilage | - | 4.48 | 4.48 |
| 6 | Ensilage | - | 5.41 | 5.41 |
| 7 | Fuldfoder | - | 5.68 | 5.68 |
| 8 | Fuldfoder | - | 3.96 | 3.96 |

I hver besætning blev der udvalgt 10 (12) lette kvier i intervallet 130-250 kg og 10 (12) tunge kvier fra 250-380 kg, med det formål at have en jævn fordeling indenfor begge vægtintervaller. Kvier med ekstremt huld blev udeladt. Forsøgskvierne blev blokket efter vægt, alder og drægtighedsstatus og blev herefter tilfældigt fordelt mellem behandlinger: de små homogene grupper eller de store blandede grupper. Såvel flokstørrelse som gennemsnitlig startvægt for hver besætning og forsøgsgruppe fremgår af tabel 5.1.

I løbet af forsøget døde to tunge kvier fra små, homogene grupper af årsager, som var uafhængige af forsøget. Kvierne blev straks erstattet af tilsvarende kvier (besætning nr. 1 og 4). Data fra de afgåede kvier og de "nye" kvier er ikke inkluderet i de statistiske analyser.

*Adfærdsobservationer*
Adfærdsobservationer blev udført i løbet af den sidste måned af forsøget i 3 besætninger med separat fodring (besætning nr. 1, 2 og 3) og 3 besætninger med fuldfoder (besætning nr. 5, 6 og 7).

Position, stilling og adfærd blev registreret for hver boks over 24 timer ved brug af direkte observationer (skanning). Kviernes individuelle positioner i boksen (enten i hvileområdet

eller ved foderbordet), stilling (liggende eller stående) blev registreret i 5 minutters intervaller. Ligeledes blev social adfærd (slikken af de andre kvier), aggressiv adfærd (stangning og opjagning) og unormal adfærd (slikken/biden i inventar og leaning) registreret i 1,5 minut i 5 minutters intervaller, hvor der blev anvendt enten/eller observationer, for at se om adfærdsmønstret forekom i løbet af det foregående tidsinterval på 1,5 minutter. Hver enkelt kvie blev observeret i alt 216 minutter. Udfra registrering af stilling blev der beregnet total liggetid, antal liggeperioder og synkroniseret liggetid. Total ligge- eller ståtid blev udregnet som summen af 5 minutters intervallerne, hvor kvien enten stod eller lå ned ved intervallets start. Antallet af liggeperioder blev optalt. En afbrydelse af en liggeperiode kunne vare op til 5 minutter, hvis kvien lå ned i begyndelsen af to på hinanden følgende intervaller. Synkronisering af hvileadfærd er summen af 5 minutters intervaller, hvor alle 5 kvier ligger ned i begyndelsen af intervallet. Ædeperioder og ædetid blev registreret og udregnet efter samme princip som liggeperiode bortset fra kraftfoder, hvor der blev anvendt 20 sekunders intervaller i stedet for 5 minutters intervaller.

Adfærdsregistreringerne udførtes af i alt 8 observatører fra DJF. Kvierne blev markeret med farver for at sikre individuel identifikation. Lyset var tændt i tre døgn før registreringernes påbegyndelse, for at vænne kvierne til lys i døgndrift.

*Registrering af produktion og sundhed*
Kvierne blev vejet to gange ved start og to gange ved slutningen af forsøget. Foderoptagelse blev registreret pr. boks over et døgn hver anden uge. Af strøelse blev der anvendt ca. 3 kg halm dagligt pr. kvie. Dybstrøelsen blev fjernet fra boksene, senest én måned før adfærdsobservationerne blev gennemført. Forsøgsteknikere fra DJF gennemførte alle registreringer af produktionen.

Alle kvier blev undersøgt for hudlæsioner og lemmelidelser af en dyrlæge i begyndelsen og ved slutningen af forsøget. Alle forsøgskvierne blev klovbeskåret/fik klovene rettet til af den samme klovbeskærer i begyndelsen og i slutningen af forsøget. Lemmelidelser, klovkvalitet samt klovlængde blev registreret ved klovbeskæring.

*Statistiske metoder*
Tilvæksten (g pr. dag) blev analyseret efter model (1).

$$Y_{ijklm} = b_0 + R_i + T_j + S_k + (RT)_{ij} + (TS)_{jk} + (RS)_{ik} + R_i(H)_l + A_{ijklm}, \text{ hvor} \quad (1)$$

$b_0$= generel middelværdi, R = Virkning af Ration (separat eller én, i=1, 2),
T = Behandling (små homogene eller store heterogene grupper, j=1,2),
S = Kviers Størrelse (lette eller tunge, k=1,2), RT = vekselvirkning mellem Ration og Behandling, ST = vekselvirkning mellem Størrelse og Behandling, RS = vekselvirkning mellem Ration og Størrelse, R (H) = effekten af Ration indenfor besætning, A = dyr indenfor ration, behandling, størrelse og besætning.

Kviernes vægt ved forsøgets start og slut var korrigeret for vægt af evt. foster (Sørensen, 1987b):

$$\text{Fostervægt (kg)} = 0.251 * \exp(0.02 * \text{dage efter ikælvning}) \quad (2)$$

Foderoptagelse (FE daglig pr. dyr) og foderudnyttelse (FE pr. kg tilvækst) blev analyseret efter model 3, idet boks anvendtes som forsøgsenhed:

$$Y_{ijln} = b_0 + R_i + T_j + (RT)_{ij} + R_i (H)_{l,} + P_{ijln} \text{ , hvor} \quad (3)$$

P = Boks indenfor ration, behandling og besætning.

Liggetid, ståtid, antal liggeperioder, ædetid (minutter), ædeperioder og social adfærd blev analyseret med model 4:

$$Y_{ijkl} = b_0 + R_i + T_j + S_k + (TS)_{jk} + H(R)_{jli} + (RTS)_{ijk} \quad (4)$$

Synkronisering af hvileadfærd blev analyseret med model 5, med boks som forsøgsenhed:

$$Y_{ijkl} = b_0 + R_i + T_j + (TS)_{jk} + H(R)_{ikl} \quad (5)$$

Ædetid (sekunder) og ædeperioder vedrørende kraftfoder analyseredes med model 6:

$$Y_{ijkl} = b_0 + T_i + S_j + H_l + T_i (S)_j \quad (6)$$

Summen af aggressiv adfærd (stangning, opjagning) og social adfærd (slikken) blev analyseret med model 7:

$$Y_{ijk} = b_0 + R_i + T_j + S_k + (RTS)_{ijk} \quad (7)$$

Da slikken og biden i inventar forekom sjældent, blev det ændret til binære data (0 -1) svarende til ikke-observeret og observeret for hvert dyr og testet ved Chi-square. Behandlingens effekt på lemmelidelser og hudlæsioner analyseredes ved McNemar non parametric Change Test (Siegel & Castellan, 1988).

### 5.3 Resultater

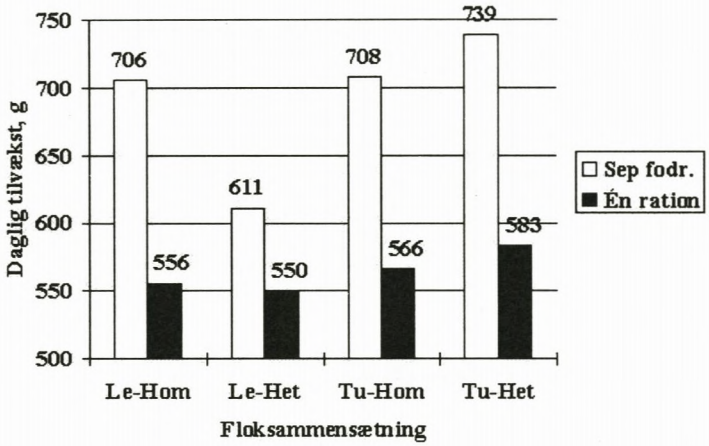
*Produktion*

Behandlingens virkning på tilvækst, foderoptagelse og foderudnyttelse (FE pr. kg tilvækst) er vist i tabel 5.3. Den gennemsnitlige daglige tilvækst på 624 g afhang af kviens størrelse (P=0,03) samt fodringssystem (P=0,0001). De lette kvier havde en tilvækst på 603 g dagligt og de tunge kvier 644 g dagligt. Floksammensætningen havde ingen signifikant indflydelse på tilvæksten (P=0,48). Der var en tendens til vekselvirkning mellem floksammensætning og kviestørrelse (P=0,075), men hverken imellem floksammensætning og fodringssystem eller fodringssystem og kviestørrelse (P>0,22). Den daglige tilvækst for lette og tunge kvier ved forskellige floksammensætninger og fodringssystemer er vist i figur 5.1. Når der anvendtes separat fodring og kvierne var opstaldede i store heterogene grupper sammenlignet med små homogene grupper, faldt tilvæksten for de lette kvier med 95 g, hvorimod tilvæksten for de tunge kvier steg med 31 g.

Som det kan ses i tabel 5.3, var foderoptagelsen lavere (P=0,02) for de store blandede grupper end for de små homogene grupper, nemlig 0,32 FE pr. kvie dagligt eller 7%. Der var en tendens til at foderudnyttelsen var lavere (P=0,12), eftersom tilvæksten ikke var forskellig.

**Tabel 5. 3. Virkning af floksammensætning (gruppestørrelse og homogenitet) på tilvækst, foderoptagelse og fodereffektivitet for kvier i dybstrøelsessystemer og forskellige fodringssystemer.**

| Behandling | Tilvækst, g pr. dag | Foderoptagelse, FE pr. dag | Fodereffektivitet, FE pr. kg tilvækst |
|---|---|---|---|
| **Fodringssystem** | | | |
| Separat fodring (SF) | 690 | 4.17 | 6.04 |
| Én ration (ER) | 563 | 4.89 | 8.69 |
| ER-SF | -127 | 0.72 | 2.65 |
| P | 0.0001 | 0.0001 | 0.0001 |
| **Floksammensætning** | | | |
| Lille homogen | 629 | 4.68 | 7.64 |
| Stor heterogen | 618 | 4.36 | 7.27 |
| L, Het -S, Hom | -11 | -0.32 | -0.37 |
| P | 0.48 | 0.02 | 0.12 |
| **Floksammensætning x Fodringssystem** | | | |
| Homogen SF | 707 | 4.35 | 6.19 |
| Homogen ER | 561 | 5.02 | 9.09 |
| Heterogene SF | 675 | 3.99 | 5.95 |
| Heterogen ER | 567 | 4.74 | 8.58 |
| P | 0.32 | 0.72 | 0.53 |
| **Floksammensætning x kviestørrelse** | | | |
| Lille Homogen Lette | 627 | - | - |
| Lille Homogen Tunge | 630 | - | - |
| Stor Heterogen Lette | 579 | - | - |
| Stor Heterogen Tunge | 658 | - | - |
| P | 0.075 | | |




**Figur 5.1. Daglig tilvækst, g for Lette og Tunge kvier i små Homogene eller Store Heterogene flokke og fodret separat eller én ration.**

*Adfærd*
Floksammensætningens indvirkning på æde- og hvileadfærd for lette og tunge kvier ved de to fodringssystemer er vist i tabel 5.4.

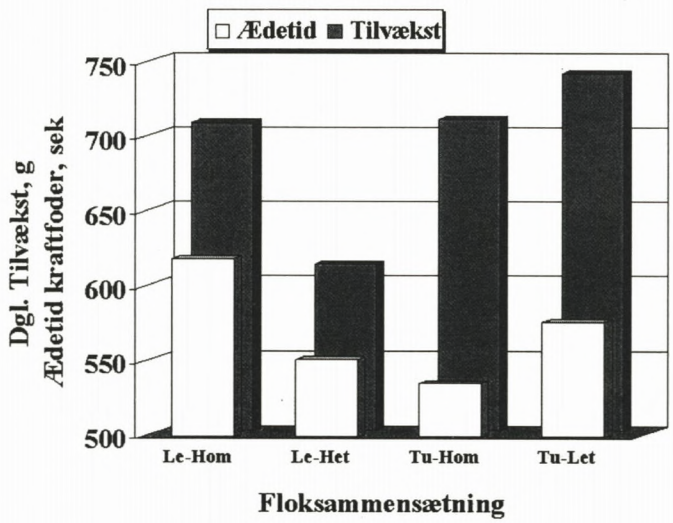
Generelt brugte separat fodrede kvier længere tid på at æde end kvier, som blev fodret med én ration (P=0,005). Den sammenlagte ædetid var påvirket af samspillet mellem fodringssystem, kviens størrelse samt floksammensætning (P=0,05).

Når kvierne blev fodret separat, brugte de lette kvier mindre tid på at æde kraftfoder (P=0,01) i en stor blandet gruppe sammenlignet med en lille homogen gruppe, selvom den totale ædetid var uændret. Der var en tendens til at tunge kvier brugte længere tid til at æde kraftfoder (P=0,10), men mindre ædetid totalt (P=0,06) og færre ædeperioder (P=0,04) i en stor blandet gruppe sammenlignet med en lille homogen gruppe.

**Tabel 5.4. Virkning af floksammensætning på æde,- og hvileadfærd for kvier ved forskellige fodringssystemer i dybstrøelsessystemer.**

| Kvie størrelse | Let | | | Tung | | |
|---|---|---|---|---|---|---|
| Flokstørrelse<br>Flok homogenitet | 5 -6<br>Homogen | 10 -12<br>Heterogen | P | 5 -6<br>Homogen | 10 -12<br>Heterogen | P |
| *Separat- fodring* | | | | | | |
| | a | b | a-b | c | d | c-d |
| Ædeperioder | 18.2 | 16.1 | 0.09 | 17.3 | 14.7 | 0.04 |
| Ædetid, Total minutter | 367 | 380 | 0.53 | 386 | 347 | 0.06 |
| Ædetid, kraftfoder, min. | 10.3 | 9.20 | 0.01 | 8.90 | 9.60 | 0.10 |
| Liggetid, minutter | 780 | 833 | 0.18 | 708 | 852 | 0.0001 |
| Antal liggeperioder | 11.5 | 9.5 | 0.03 | 11,1 | 10.1 | 0.28 |
| *En ration* | | | | | | |
| Ædeperioder | 21.4 | 20.1 | 0.28 | 18.7 | 18.9 | 0.88 |
| Ædetid, Total, minutter | 336 | 353 | 0.36 | 319 | 359 | 0.04 |
| Ligge tid, minutter | 773 | 762 | 0.62 | 807 | 756 | 0.03 |
| Antal liggeperioder | 15.4 | 13.5 | 0.04 | 12.8 | 13.6 | 0.38 |

Der var en tendens til, at ædetiden for kraftfoder reduceres for de lette kvier og forøges for de tunge kvier i blandede grupper sammenlignet med de homogene grupper. Dette er vist i figur 5.2., hvor den daglige tilvækst ses at vise samme tendens.




**Figur 5.2. Daglig Tilvækst (g) og ædetid (sekunder) til kraftfoder for Lette og Tunge kvier i små Homogene eller Store Heterogene flokke og fodret separat.**

Lette kvier havde generelt færre liggeperioder (P=0,04) i de heterogene grupper end i de homogene grupper (dog samme liggetid). Tunge kvier fodret med ER og opstaldet i store

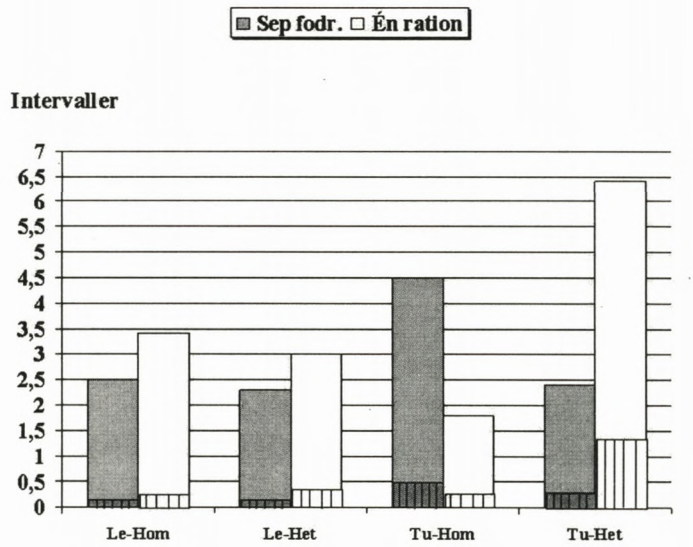
blandede grupper havde mindre liggetid (P=0,03) sammenlignet med små homogene grupper. Ved separat fodring havde de tunge kvier i store blandede grupper længere liggetid (P=0,0001) i forhold til de små homogene grupper.

Floksammensætningens indflydelse på synkronisering af hvileadfærd (minutter hvor alle kvier ligger ned samtidigt) er vist i tabel 5.5. Der ses en tendens til mindre synkronisering i de store blandede grupper sammenlignet med små homogene grupper, mest udtalt når de blev fodret èn ration (P=0,09).

**Tabel 5.5. Floksammensætningens indflydelse på synkronisering af hvileadfærd ved forskellige fodringssystemer.**

| Flokstørrelse<br>Kvier per boks<br>Flok homogenitet | Små<br>5 -6<br>Homogen | Store<br>10 -12<br>Heterogen | P |
|---|---|---|---|
| Fodringssystem | a | b | a -b |
| Separate (SF) | 328 | 246 | 0.16 |
| Èn ration (ER) | 284 | 138 | 0.09 |

Behandlingens indvirkning på aggressiv adfærd er vist i figur 5.3. Ved opstaldning i en stor heterogen gruppe sammenlignet med en lille homogen gruppe, viste de tunge kvier tilbøjelighed til større aggressivitet, stangning og opjagning (P=0,0001), når de fik ER, men udviste mindre aggressiv adfærd (P=0,02) når de blev fodret separat. Det fremgår i øvrigt af figur 5.3, at opjagning (lodret skraveret) forekommer langt sjældnere end stangning i uanset behandling.




**Figur 5.3. Antal intervaller med aggressiv adfærd (opjagning = III og stangning = ☐ blank) for Lette og Tunge kvier i små Homogene eller Store Heterogene flokke og fodret separat eller én ration.**

Ved separat fodring havde floksammensætningen indflydelse på forekomsten af unormal adfærd (P=0,02). Denne effekt kunne til gengæld ikke observeres, når kvierne blev fodret med ER (P=0,16). Lette kvier fodret separat, viste større grad af unormal adfærd (sutten og bidden i inventar) i en blandet gruppe sammenlignet med en homogen gruppe. De tunge kvier udviste mindre unormal adfærd i en blandet gruppe sammenlignet med en homogen gruppe, når de blev fodret separat.

Floksammensætningen havde ingen virkning på forekomsten af social adfærd og forekomst af leaning blev ikke observeret.

*Sundhed*

Forekomst af balleforrådnelse, såleknusning/rød sål, lange klove og hudskader/trykninger ved forsøgets start og slutning, fremgår af tabel 5.6. Forekomst af såleknusning blev forøget fra 12 til 28 procent i gennemsnit for alle besætninger i løbet af forsøgsperioden, pga. en forøgelse hos de tunge kvier fra 13 til 48 procent. McNemar Chance Test, viste ingen signifikante forskelle mellem forsøgsbehandlingerne mht. såleknusning, balleforrådnelse/rødsål, lange klove eller hudskader/trykninger.

**Tabel 5.6. Prevalensen af balleforrådnelse, såleknusning/rød sål, lange klove og hudlæsioner i små homogene gupper og store heterogene grupper ved forsøgets start samt slutning. Procent af dyrene.**

| | Små homogene grupper | | Store heterogene grupper | |
|---|---|---|---|---|
| Tidspunkt | Start | Slut | Start | Slut |
| Balleforrådnelse | 10 | 26 | 11 | 30 |
| Såleknusning/rød sål | 12 | 10 | 16 | 7 |
| Lange klove | 3 | 5 | 2 | 5 |
| Hudlæsioner | 4 | 7 | 6 | 9 |

## 5.4 Diskussion

Forsøgets design tillod ikke at skelne mellem virkningen af flokstørrelse og af flokhomogenitet, men beskrev derimod den samlede virkning af floksammensætning. Det forventes dog, at flokhomogenitet er vigtigere end flok størrelse, således at der kan forventes en lavere tilvækst for lette kvier i heterogene grupper, specielt når der fodres med separate rationer (SF).

Floksammensætning (blandede eller homogene) havde ingen signifikant indflydelse på kviernes tilvækst. Samspillet mellem fodringssystemer, floksammensætningskriterier og kviernes størrelser var beskedne, sammenlignet med de resultater Sørensen (1987a) fandt ved forsøg med små grupper kvier i fuldspaltebokse med høj belægningsgrad.

Den tydelige tendens i nærværende forsøg med hensyn til tilvækst, hvor lette kvier havde den største tilvækst i små homogene flokke og tunge kvier størst tilvækst i store blandede flokke, er i overensstemmelse med Sørensen (1987a).

Observationerne vedrørende ædeadfærd underbygger tilvækst resultaterne. Med det separate fodringssystem brugte lette kvier længere tid på at æde kraftfoder end tunge kvier, når de befandt sig i små homogene grupper. Tendensen til at lette kvier brugte mindre tid på at æde kraftfoder og tunge kvier mere tid i de blandede grupper sammenlignet med de homogene grupper, skyldes sandsynligvis at tunge kvier "stjælero kraftfoder fra de lette kvier, når de bliver fodret sammen i de heterogene grupper. Herudover må det forventes, at foderoptagelse pr. minut er større for tunge kvier end lette kvier. Beregnes den forventede foderoptagelse efter formler udarbejdet af Ingvartsen (1994) for kvier med en vægt på 200 kg (den gennemsnitlige startvægt for de lette kvier) og en ration som den separate (mindre end 50 procent kraftfoder på tørstof basis), fås at en reduktion på 0,5 kg kraftfodertørstof, forhøjer optagelsen af halmtørstof med omkring 0,38 kg. Hvis tunge kvier stjæler 0,5 kg kraftfoder fra lette kvier, medfører det en reduktion i total foderoptagelse på 0,4 FE eller omkring 9 procent for de lette kvier. Dette medfører en reduktion i den forventede tilvækst på ca. 70 g hos de lette kvier. Den totale ædetid var som forventet betydeligt reduceret for tunge kvier i de heterogene grupper sammenlignet med tunge kvier i homogene grupper. Dette skyldes, at tunge kvier i de heterogene grupper æder mere kraftfoder (stjæler fra de lette) og derfor mindre halm.

Den signifikant lavere foderoptagelse i de store blandede grupper sammenlignet med de små homogene grupper kan være et resultat af konkurrence imellem de lette og de tunge kvier. Ved forudsigelse af den totale foderoptagelse (Ingvartsen, 1994), for de blandede grupper og de små homogene grupper ved separat fodring forudsættes, at de tunge kvier i de blandede grupper "stjæler" omkring 0,50 kg kraftfoder fra de lette kvier, hvilket ikke forventes at forårsage nogen betydelig ændring i gruppens totale foderoptagelse.

Den noget større foderoptagelse og daglige tilvækst (33 og 128 g ved hhv. én ration og separat fodring) for tunge kvier sammenlignet med lette kvier i de store blandede grupper kan være hensigtsmæssig. Et højt foderniveau fra 3 måneders alderen og til kønsmodenhed, har en negativ indflydelse på mælkeproduktionen (Sejrsen, 1978). Med hensyn til fodring efter kønsmodenhed og i drægtighedsperioden, øges mælkeproduktionen i første laktation ved øget tilvækst (Foldager & Sejrsen, 1991). Således kan en relativt lavere daglig tilvækst hos kvier indtil en vægt på ca. 300 kg samt en højere daglig tilvækst herefter, øge mælkeproduktionen i forhold til en jævn tilvækst igennem hele opdrætningsperioden.

Synkronisering af hvileadfærd kan være et mere følsomt udtryk for velfærd end gennemsnitlig liggetid (Müller, 1988 og Mogensen et al., 1997). Der var en tendens til mindre synkronisering af hvileadfærd i de blandede grupper sammenlignet med de homogene grupper, især når kvierne blev fodret med ER, hvorimod synkroniseringen var mere ens, når der blev fodret separat. Ved separat fodring viste de tunge kvier mindre unormal adfærd og mindre forekomst af aggression i blandede grupper sammenlignet med homogene grupper. De blandede grupper udviste imidlertid mere aggression, stangen og opjagning end de homogene grupper, når der blev fodret med èn ration. Med undtagelse af stangen, er frekvenserne generelt lave og i overensstemmelse med resultaterne fundet af Mogensen et al. (1997) i lignende systemer med små homogene grupper, hvor der også observeredes en meget lav frekvens af unormal adfærd og lav forekomst af opjagning.

Det faktum, at tunge kvier opfører sig anderledes end lette kvier afhængig af fodringssystemet, kan forklares med, at de ved separat fodring sandsynligvis "stjælero kraftfoder fra de lette kvier. Dette resulterer i mere mætte kvier og længere hviletid og mindre aggression. Det modsatte er tilfældet ved én ration, hvor de tunge kvier bruger længere tid ved foderbordet, hvor der er større risiko for aggression, specielt hvis kvierne er meget sultne.

Der var generelt en høj forekomst af balleforrådnelse i dette forsøg på trods af velstrøede hvilearealer i alle besætningerne. Udviklingen i forekomst af balleforrådnelse i forsøgsperioden var ikke påvirket af floksammensætningen. På trods af længere ståtid på det ustrøede areal ved foderbordet i de små homogene grupper sammenlignet med de blandede grupper ( specielt for store kvier), blev der ikke observeret forskelle på klovslid, som observeret af Mogensen et al. (1997). Muligvis kan den indledende klovbeskæring, kombineret med fast gulv (spalter eller beton) ved foderbordet have forårsaget det nødvendige slid på klovene og dermed forebygget for lange klove.

Opstaldning af kvier i store heterogene flokke i dybstrøelsessystemer (pr. kvie: ca. 4,5 $m^2$ og heraf et strøet hvileareal på ca. 2,7 $m^2$ og mindst 0.50 m ædeplads samt fodring efter

ædelyst) medfører ikke specielle problemer vedrørende produktion og sundhed. I store heterogene flokke kan aggressiv adfærd i nogen grad være belastende for de lette kviers velfærd. Dette kan i modsætning til forventningerne heller ikke undgås ved fodring med èn ration.

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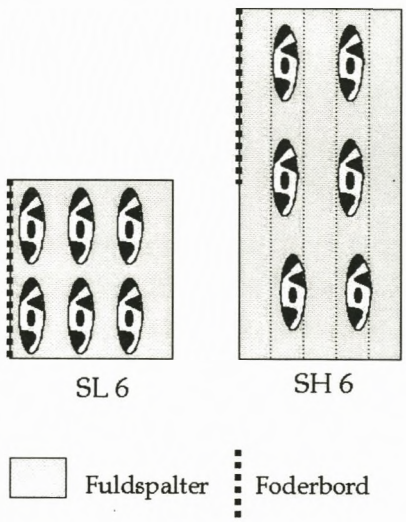
# 6. Sammendrag og konklusion

I det følgende gives et sammendrag af forsøgsseriens resultater efterfulgt af forsøgsseriens hovedkonklusioner.

## 6.1 Belægningsgrad i fuldspaltebokse

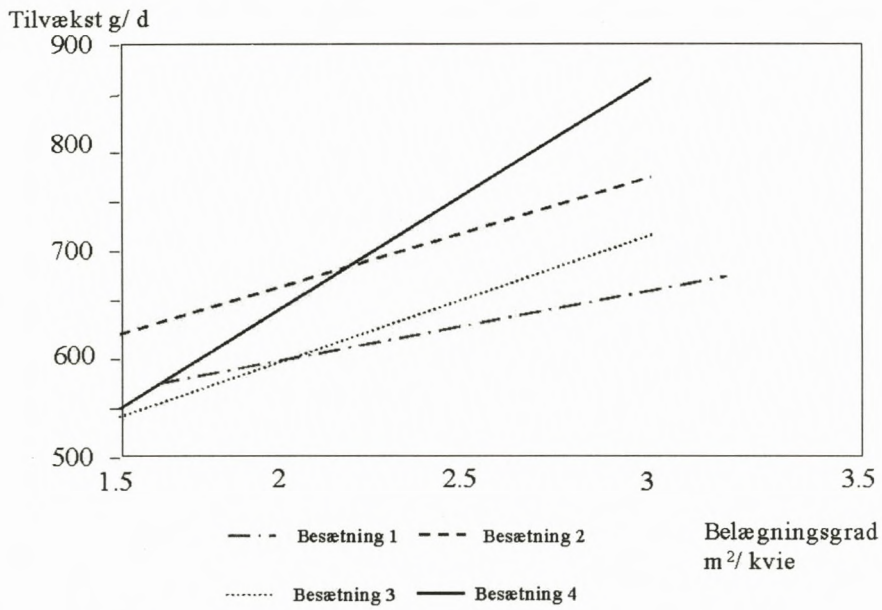
*Formål*
Forsøgets formål var at undersøge virkningen af at forøge arealet per kvie fra det normale ca. 1.5 $m^2$ per kvie til 3.0 $m^2$ per kvie på produktion, sundhed og adfærd.

*Materiale og metode*
Forsøget blev gennemført i 1993/94 i 4 besætninger med en bokstype på 9 $m^2$ ( 3 X 3 m) til 6 kvier som udgangspunkt (1.5 $m^2$ per kvie). Denne belægningsgrad blev sammenlignet med en fordobling af arealet til 3.0 $m^2$ per kvie. Forøgelsen af arealet blev opnået ved at lægge to bokse sammen og blænde foderbordet i den ene boks. Boksdesign er vist i figur 6.1. I hver besætning blev belægningsgraderne sammenlignet til kvier på omkring 320 kg ved indsættelse. Der var 2 bokse af hver belægningsgrad i hver besætning. Adfærdsundersøgelser blev gennemført i 2 besætninger.




**Figur 6.1. Udformning af bokse til undersøgelse af virkning af belægningsgrad på fuldspalter på kviers produktion, sundhed og adfærd**

*Resultater*
En forøgelse af arealet påvirkede ikke foderoptagelsen men forøgede tilvæksten med i gennemsnit 31 %. Som det fremgår af figur 6.2. blev tilvæksten øget betydeligt i alle fire besætninger, der deltog i forsøget.




**Figur 6.2 Kviernes gennemsnitlige daglige tilvækst i fire besætninger med fuldspaltebokse ved 1.5 og 3.0 m² per kvie**

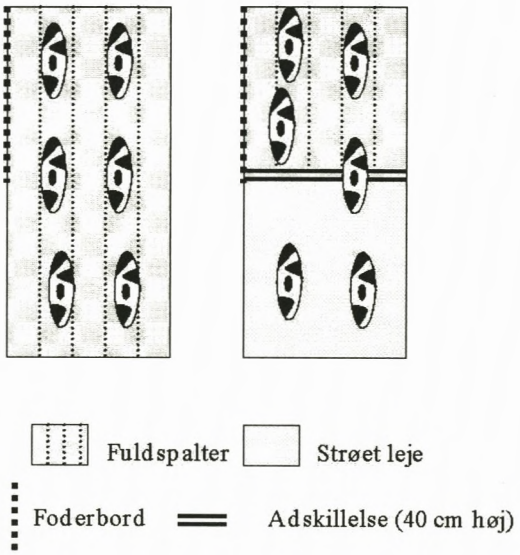
En forøgelse af arealet fra 1.5 til 3.0 m² øgede liggetiden. Enkelte kvier ved det lave areal havde en meget lav liggetid. Ved den høje belægningsgrad var der desuden en positiv sammenhæng mellem antal liggeperioder og daglig tilvækst dvs., færre liggeperioder lavere daglig tilvækst. Der var en tendens til færre trykninger ved en lav en forøgelse af arealet.

### 6.2 Opstrøet liggeareal i fuldspaltebokse

*Formål*
Forsøgets formål var med udgangspunkt i et stort areal per kvie (3.0 m²) i en fuldspalteboks at opstrø halvdelen af arealet således at kvierne fik et opstrøet liggeareal på 1.5 m² per kvie.

*Materiale og metode*
Forsøget blev gennemført i 1993/94 i 4 besætninger med en bokstype på 18 m² ( 3 X 6 m) til 6 kvier som udgangspunkt (3.0 m² per kvie). Fuldspalter blev sammenlignet med en boks hvor halvdelen af arealet var opstrøet. I hver besætning blev opstrøet versus ikke-opstrøet sammenlignet til kvier på omkring 320 kg ved indsættelse over en periode på 5

mdr. Der var 2 bokse af hver bokstype i hver besætning. Adfærdsundersøgelser blev gennemført i 2 besætninger. Boksdesign er vist i figur 6.3.




**Figur 6.3 Boksudformning til undersøgelse af virkning af opstrøet underlag i fuldspalter på kviers produktion, sundhed og adfærd**

*Resultater*
Et opstrøet lejeareal i fuldspalteboksen påvirkede hverken foderoptagelse eller tilvækst. Kvierne på fuldspalter havde færre liggeperioder end kvier med adgang til strøet liggeareal, hvilket er et udtryk for at kvierne havde problemer med at rejse og lægge sig på spaltegulvet. Adfærdsundersøgelserne viste klart at kvierne foretrak at ligge på det opstrøede areal. Det blev på den baggrund konkluderet at fuldspalter ikke gav mulighed for en tilfredsstillende velfærd og at der derfor i projektet skulle arbejdes videre med systemer med et opstrøet liggeareal. Undersøgelserne viste samtidig at 1.5 $m^2$ opstrøet liggeareal var for lidt til kvier på 300-400 kg.

Forekomst af balleforrådnelse var lavere og klovene blev længere ved adgang til strøet liggeunderlag sammenlignet med fuldspalter.

### 6.3 Varierende størrelse af opstrøet liggeareal i fuldspaltebokse

*Formål*
Forsøget tog udgangspunkt i resultaterne fra forsøget i 1993/94, der viste at et opstrøet liggeareal på 1.5 $m^2$ var for lidt til at alle kvierne kunne ligge ned på samme tid. Formålet var derfor at undersøge virkningen, af forskellige arealer med opstrøet liggeunderlag, på kviers liggeadfærd ved lav belægning i fuldspaltebokse.

*Materiale og metode*
Forsøget blev gennemført i 1994/95 i 2 besætninger med en bokstype på 27 $m^2$ ( 3 X 9 m) til 5 kvier (4.5 $m^2$ per kvie). Tre forskellige opstrøede arealer blev sammenlignet: 1.8 $m^2$, 2.7 $m^2$ og 3.6 $m^2$ per kvie. Forsøget blev gennemført i 3 perioder a ca. 5 uger. I hver periode var 2 bokse per gård opstrøet med enten 1.8, 2.7 eller 3.6 $m^2$. Adfærdsundersøgelserne blev gennemført efter at kvierne havde været i forsøgsboksen i 4 uger. Der var 2 forsøgsbokse i hver besætning og i alt 20 forsøgsdyr.

*Resultater*
Den samlede liggetid var ikke påvirket af størrelsen af det opstrøede liggeareal, men variationen i liggetid var størst ved det mindste areal. Frekvensens af leaning, samt udvisning af aggressiv adfærd (stangen og opjagninger) var størst ved et opstrøet ligge areal på 1.8 $m^2$. Den tid hvor alle dyr lå ned samtidig (synkron liggeadfærd) var signifikant lavere i gruppen med 1.8 $m^2$ i forhold til de to øvrige liggearealer.

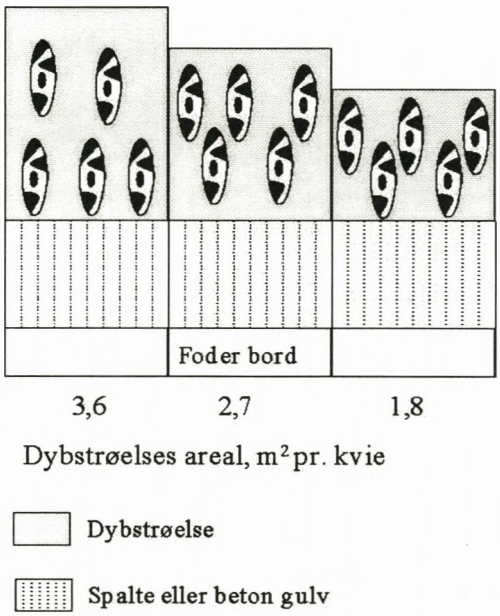
### 6.4 Belægningsgrad i dybstrøelsesbokse med fast gulv ved foderbordet

*Formål*
I erkendelse af at kvier foretrækker et strøet liggeunderlag er dybstrøelsesstalde med fast gulv ved foderbordet et interessant staldsystem. Det er her muligt at opstalde kvierne hele vinteren uden at skulle fjerne gødningsmåtten. Formålet med dette forsøg var at afdække virkningen af forskellige størrelse liggeareal til kvier i et dybstrøelsessystem på kviernes produktion, adfærd og sundhed.

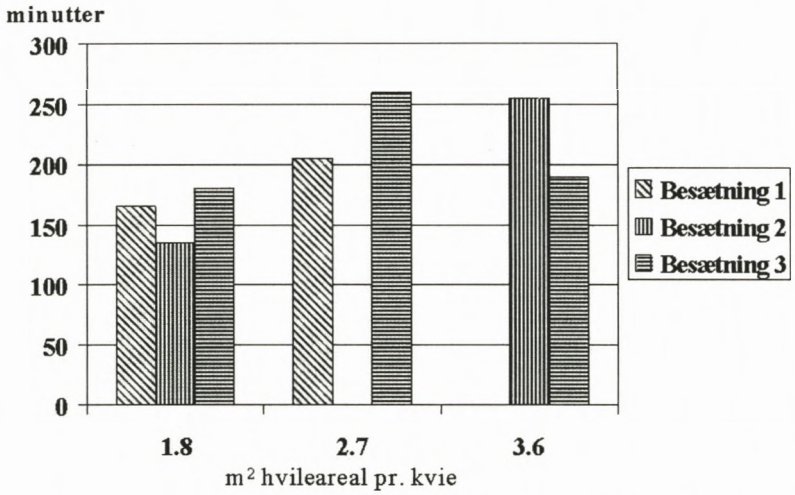
*Materiale og metoder*
Forsøget blev gennemført i 1994/95 i 3 besætninger. Forsøgsboksene havde henholdsvis 1.8, 2.7 og 3.6 $m^2$ strøet liggeareal. Fælles for alle forsøgsbokse var et fast foderbordsareal på 1.8 $m^2$ per kvie. Der var 2 bokse af hver (6 bokse pr. besætning) i en besætning, samt 2 bokse af 2 forsøgsbehandlinger (4 bokse pr. besætning) i 2 besætninger. I alt indgik 14 bokse og 70 kvier i forsøget. Boksdesign er vist i figur 6.4. Kvierne, der indgik i forsøget, var ikke-drægtige/lav drægtige med en gennemsnitlig vægt på 320 kg.

*Resultater*

Der var en tendens til en lavere foderoptagelse og en lavere tilvækst ved et hvileareal på 1.8 $m^2$. Foderudnyttelsen var uændret. Ved 1.8 $m^2$ liggeareal var den tid hvor alle kvier lå ned samtidig lavere end ved henholdsvis 2.7 og 3.6 $m^2$ liggeareal. Resultatet er vist i figur 6.5. Der var endvidere en tendens til mere aggressiv adfærd (stangen og opjagninger) ved 1.8 $m^2$ end ved de øvrige behandlinger. Forekomst af balleforrådnelse var højere ved et liggeareal på 1.8 $m^2$ per kvie end ved henholdsvis 2.7 og 3.6 $m^2$.




**Figur 6.4 Boksudformning til undersøgelse af virkning af belægningsgrad i dybstrøelse med fast gulv ved foderbordet.**




**Figur 6.5 Gennemsnitlig periode pr. døgn hvor alle kvier lå ned samtidig vist som funktion af strøet liggeareal**

### 6.5 Floksammensætning og flokstørrelse

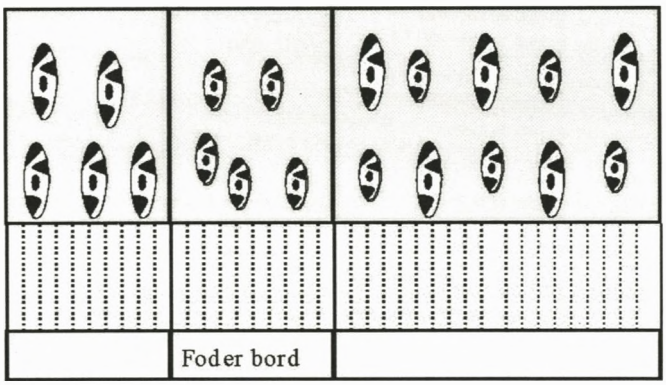
*Formål*
Forsøgsseriens hidtidige resultater viste at kvierne foretrækker et strøet leje. For at gøre dybstrøelsessystemer mere rationelle vil det være en fordel at der kan anvendes større grupper end der traditionelt har været anvendt i fuldspaltesystemerne. Derved vil der kunne spares arbejdstid ved strøelse, gødningshåndtering og fodring. Det vil alt andet lige medføre at floksammensætningen bliver mindre homogen. Der vil være større variation i vægt og alder mellem kvier i samme gruppe når gruppestørrelsen forøges. Formålet med forsøget var at undersøge virkningen af floksammensætning og flokstørrelse på produktion, sundhed og adfærd hos kvier i dybstrøelsessystemer.

*Materiale og metode*
Forsøget blev gennemført i 1995/96 i 8 besætninger med fast gulv ved foderbordet og 2.7 $m^2$ opstrøet liggeareal per kvie. I hver besætning var der tre forsøgsbokse med henholdsvis 5, 5 og 10 forsøgskvier. I alt indgik 24 forsøgsbokse og 160 forsøgskvier i forsøget. I hver besætning blev der dannet tre forsøgshold:

- Homogen gruppe med 5-6 lette kvier (130-250 kg)
- Homogen gruppe med 5-6 tunge kvier (250-380 kg)
- Stor blandet gruppe med 10-12 tunge og små kvier (130-380 kg)

Boksudformning og floksammensætning er vist i figur 6.6.

I 4 besætninger blev der fodret med fuldfoder eller ensilage efter ædelyst og i de øvrige 4 besætninger med tilskudsfoder restriktivt samt amoniakbehandlet halm efter ædelyst. I 6 besætninger (3 af hver rationstype) blev der gennemført adfærdsstudier.




**Figur 6.6 Design til undersøgelse af floksammensætningens betydning for produktion, sundhed og adfærd**

*Resultater*
Der var vekselvirkning mellem ration og virkning af homogen versus heterogene grupper. Ved rationen med kraftfoder og ammoniakbehandlet halm var der en tendens til at lette kvier i den homogene gruppe havde en højere tilvækst end lette kvier i den heterogene gruppe. Omvendt klarede tunge kvier sig bedre i den heterogene gruppe end i den homogene gruppe. Dette antages at skyldes at de tunge kvier åd mere kraftfoder end de lette kvier i den heterogene gruppe. Ved rationen med fuldfoder/ensilage efter ædelyst var der ingen virkning på tilvæksten af floksammensætning. Der var en betydelig forskel i tilvækst mellem rationstype. Kvier der fik ensilage som eneste foder åd mindre end forventet ud fra de beregnede fyldeværdier. Det må endvidere forventes at der var en lavere foderudnyttelse som følge af et stort proteinoverskud i græsensilagen i forhold til behovet.

Lette kvier i den heterogene flok havde i gennemsnit 11 % kortere ædetid til kraftfoder end lette kvier i den homogene gruppe. Liggetiden for de lette kvier var upåvirket af floksammensætningen. De lette kvier havde flere liggeperioder ved den homogene flok end i den heterogene flok. Dette gjaldt ved begge rationer.

Der var ingen forskelle i forekomsten af balleforrådnelse såleknusning/rød sål, lange klove eller trykninger/sår mellem de to forsøgsbehandlinger. Der var heller ingen vekselvirkninger mellem kviernes størrelse og behandling.

## 6.6 Floksammensætning

*Formål*
Forsøget i 1995/96 blev gennemført på en måde så det ikke umiddelbart lod sig besvare hvorvidt behandlingsvirkningen skyldes floksammensætning eller flokstørrelse. Formålet med forsøget i 1996/97 var derfor at studere virkning af floksammensætning ved samme flokstørrelse. Resultaterne for de to år skulle således ses i sammenhæng.

*Materiale og metode*
Forsøget blev gennemført i 1996/97 i 6 besætninger med fast gulv ved foderbordet og 2.7 $m^2$ opstrøet liggeareal per kvie. I hver besætning var der to forsøgsbokse med hver 10 forsøgskvier. I alt 12 forsøgsbokse og 120 forsøgskvier.

- Homogen gruppe med 10 kvier i vægtintervallet 200-300 kg
- Heterogen gruppe med 5 lette kvier (140-200 kg) og 5-6 tunge kvier (300-400 kg)

*Resultater*
Der var en forskel i tilvækst mellem de lette og de tunge kvier i den heterogene gruppe på 139 g per dag. Mellem den heterogene og den homogene gruppe var der ingen signifikant forskel på tilvæksten.

Der var en tendens til kortere liggetid i den heterogene gruppe sammenlignet med den homogene gruppe som følge af flere opjagninger. Ellers ingen væsentlige forskelle.

Der var ingen forskelle mellem lette og tunge kvier eller mellem heterogen og homogen gruppe med hensyn trykninger og hudlæsoioner ved forsøgets slutning. Ved forsøgets start blev to lette kvier i en heterogen gruppe i en besætning alvorligt skadet og måtte nødslagtes/aflives.

## 6.7 Konklusion

Med baggrund i forsøgsseriens resultater kan følgende hovedkonklusioner uddrages:

- En høj belægningsgrad for kvier i fuldspaltebokse giver lav tilvækst og reducerer velfærden
- Kviernes velfærd kan forbedres ved at give dem adgang til et opstrøet liggeunderlag
- Kviernes tilvækst og velfærd kan forbedres ved at øge det strøede liggeunderlag fra 1.8 til 2.7 $m^2$
- En mere uens floksammensætning samtidig med restriktiv fodring med kraftfoder vil øge tilvæksten hos de store kvier på bekostning af de små. Dog ikke på dramatisk måde.
- Med store størrelsesforskelle på kvierne (fra 130-400 kg) i en flok er der i den første tid efter sammenblanding risiko for at de små kvier lider alvorlig overlast.

## 6.8 Praktiske anbefalinger

Forsøgsseriens resultater viser at kviernes velfærd kan tilgodeses i de eksisterende fuldspaltebokse til kvier. Det kræver imidlertid, at mindst 1,8 $m^2$ , men gerne 2,7 $m^2$ , pr.

kvie opstrøes og at der derudover er et foderbordsareal hvor hver kvie har 0,5 m foderbord.

Ved staldrenovering eller nybygning peger forsøgsresultaterne på dybstrøelsesstalden som et hensigtsmæssigt system, når der er mindst 2,7 $m^2$ opstrøet liggeareal og adgang til foder døgnet rundt ved et foderbord med minimum 0,5 m pr. kvie.

Med hensyn til flokstørrelse og floksammensætning, synes der ikke at være problemer med en flokstørrelse på 10-12 kvier. Ved anvendelse af heterogene grupper bør der de første dage efter sammenblanding sættes ekstra tid af til opsyn, især hvis vægtforskellen mellem lette og tunge kvier er over 200 kg, idet der er risiko for fysisk belastning af de mindste kvier ved opspring.

# 7. Publikationer fra projektet

### 7.1 Artikler i internationale videnskabelige tidsskrifter med reviewprocedure

Hindhede, J., Sørensen, J.T., Jensen, M.B. & Krohn, C.C. 1996. Effect of space allowance, access to bedding, and flock size in slatted floor systems on production and health for dairy heifers.
Acta Agriculturae Scandinavica Section A, Animal Science 46, 46-53.

Hindhede, J. Mogensen, L. & Sørensen, J.T. 1999. Effect of flock composition and feeding system on behaviour, production and health of dairy heifers in deep bedding systems.
Acta Agriculturae Scandinavica, Section A, Animal Science (accepteret)

Mogensen, L., Nielsen, L.H., Hindhede, J. Sørensen, J.T. & Krohn, C.C. 1997. Effect of space allowance in deep bedding systems on resting behaviour, production and health of dairy heifers.
Acta Agriculturae Scandinavica, Section A, Animal Science 47, 178-186.

Mogensen, L., Krohn, C.C., Sørensen, J.T. & Hindhede J. & Nielsen, L.H. 1997.
Connection between resting behaviour and live weight gain in dairy heifers housed in pens with different space allowance and floor type.
Applied Animal Behaviour Science 55, 11-19.

Mogensen, L., Sørensen, J.T. , Hindhede J, Nielsen, L.H., & Kristensen, A.R. 1999.
Effect of space allowance and access to bedding in slatted floor systems during second year on subsequent milk production of primiparious dairy cows
Acta Agriculturae Scandinavica, Section A, Animal Science (under trykning)

Nielsen, L.H, Mogensen, L., Krohn, C.C. , Hindhede, J. Sørensen, J.T. 1997.
Resting and social behaviour of dairy heifers in pens with different bedded lying area in the slatted flour systems.
Applied Animal Behaviour Science 54, 307-316.

### 7.2 Trykte indlæg fra internationale videnskabelige kongresser

Jensen, M.B., Krohn, C.C., Hindhede, J. & Sørensen, J.T. 1995. Resting behaviour of heifers housed in pens, the effect of space allowance and access to a bedded lying area.
Proceedings of the 29th International Congress of the International Society of Applied Ethology. 35 Aug 1995 Exeter UK 183-184.

Mogensen, L., Krohn, C.C., Hindhede, J. & Sørensen, J.T. 1997 Resting, social and eating behaviour in heifers kept in small homogenous or large heterogenous groups in a deep bedding systems. 31'th International Congress of the International Society for Applied Ethology Prague 13-16 August 1997 2 pp

Sørensen, J.T., Hindhede, J., Mogensen, L. Jensen, M.B. & Krohn, C.C. 1997. Effect of housing on animal behaviour, health and production of heifers in commercial dairy herds. Proceedings 9th International Congress in Animal Hygiene 17-21 August 1997. Helsinki, Finland 28-31.

### 7.3 Danske publikationer

Hindhede, J. & Jensen M.B. 1995 Kvier kvitterer for bedre plads i boksen Bovilogisk 5, 24-25.

Hindhede, J., Sørensen, J.T., Jensen, M.B. & Krohn, C.C. 1995. Kvier i fuldspaltebokse. Virkning af belægningsgrad, strøet liggeareal og flokstørrelse på produktion, sundhed og adfærd. HusdyrForskning Nr. 2. 1995, 16-18.

Hindhede, J., Sørensen, J.T., Krohn, C.C. & Mogensen, L. 1996. Opstaldningens indflydelse på kviers velfærd og produktion. HusdyrForskning Nr. 3. 1996, 4-7.

Hindhede, J., Mogensen, L. Sørensen, J.T. Krohn, C.C. 1997.Opstaldning af kvier i fællesboks med dybstrøelse/spalter I: Opstaldning af kalve og ungdyr - Indflydelse på velfærd, sundhed og produktion. Intern Rapport 83 fra Statens Husdyrbrugsforsøg 45- 51.

Jensen, M.B. 1992. Opstaldning af kvier og ungtyre. Adfærd, sundhed stressfysiologiske reaktioner, reproduktion og produktion. Et litteraturreview. Landskontoret for Kvæg 82 pp

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ISSN 1397-9892