Sci. Rep. Fac. Agr. OKAYAMA Univ. (54), 33−42 (1979)

Comparative Study of Dairy Cattle Housing in Japan with Special Reference to Hokkaido

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Received June 30, 1979

Summary

In Japan as in Belgium the cow house should be constructed as a single-floor-building.

As well from the point of view of labour requirement and animal health as construction costs the loose house with cubicles and concrete slatted floors between the cubicle rows, must be preferred above the stanchion barn, when the size of the herd is 25 or more cows. In Hokkaido the loose house and the stanchion barn should be insulated, the latter more than the former; in Honshu only the stanchion barn and the roof of the loose house must de insulated ($K \leq 1$). Natural ventilation can give complete satisfaction, when it is well regulated.

When constructing a stanchion barn, one should build the strawless type in order to reduce labour requirement. Full attention should be given to all construction details in order to avoid injuries with the cows and save labour.

Introduction

Milkproduction is a very important branch of agriculture in Japan, especially in Hokkaido and even the only one in the eastern part of this most northern and second biggest island of Jaban, with its severe climate. During the winter, the temperature drops there to -20°C or below, for longer periods, snowfall is abundant (1.5 à 2 m), the growing season short, nl. 5 à 6 months and even the summer is rather chilly ; in Nakashibetsu f.i. the average temperature of May-September is only 14.3 °C and the year average is the lowest of Japan, nl. 6.1 °C. It is evident that the housing conditions of cows, all belonging to the Holstein race, is of utmost importance for dairy production as the animals are kept inside during 6 à 7 months in Hokkaido and 12 months in Honshu. The cows should live in a barn with a healthy atomosphere. The cow-house must permit at the same time minimal labour requirement and construction costs, so leading to a sufficient rentability of dairy farming. A study of housing of dairy cattle in Japan, and especially in Hokkaido, comparing the actual situation with research results and experience from western Europe, seems very useful as the construction of a great number of new dairy farms is planned for the near future.

Results

For the general conception of the cow-house construction one has the choice between a single floor and a two-floor building and many realizations of both types can be seen in Hokkaido. The two-floor barn where the cows are housed on the ground floor and hay, straw, a. o. stored on the upper floor, is abandoned everywhere in Europe. It requires much higher construction cost (up to 1 million yen/cow) and labour (first bringing all materials to be stored, upwards and then bringing them down again for use in the stable) than the simple single-floor buildings for animal

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housiug and storage. So, it is indisputable that last mentioned conception is the one to be used in future.

As rafters steel beams are generally used in Japan. Their disadvantages are that they must be painted every 3 - 5 years and that condensation of water vapour on them is often unavoidable. Beams in prestressed reinforced concrete on the contrary are very long lasting, resistant against all kind of corrosion and don't need any maintenance. Some advance as their opinion that steel beams better resist earthquakes than concrete. This resistanse depends mainly on the foundation of the building, which much be stiff and solid and many important constructions in the field of civil engineering in Japan are made of reinforced concrete, so that it seems unjustified to reject this material for the simple agricultural buildings. In connection with snowload, the angle of inclination should at least be 20° and, in Hokkaido, better 25°.

Another *fundamental choice* to be made is the one *between stanchion barn and loose house*. Everywhere in Japan the stanchion barn is generally used for milk cows, in Western Europe on the contrary loose housing is more and more eapplied for new cow houses.

From our own research[1] based on many chronometrical determinations of labour requirement in cow-houses, it appears, that, a. o. in dependency of the degree of mechanization, the daily cares of cows require only 6 à 9 min/cow/day in loose houses, against 11 à 13 min/cow/day in stanchion barns. We could note in Hokkaido that, in average, one man took care of 22 cows in a littered stanchion barn, of 30 cows in a strawless stanchion barn With gratings and of 50 cows in a loose house with cubicles.

Our study of animal behaviour[1], by the analysis of pictures, automatically taken by a camera every 5 ' during 50 hours, gives the average results represented in Table 1.

Table 1 The total and average lying time of cows in various types of stables (in hours and minutes per 24 hours' day)

Stable type	Total lying time	Number of lying turns	Average time of one lying turn
Stanchion stable (stand. place 1 m wide)			
-with straw	11h 08′	7.1	1h 34' ± 1h 02′
-with gratings	11h 04′	9.6	1h 09' ± 1h
Loose house			
-with straw	12h 43′	8.1	1h 34' ± 1h 24′
-with cubicles and slatted floors in the walking passages	12h 45′	10.1	1h 16' ± 0h 57′

The cows seem to enjoy more comfort in a loose house ; the use of straw increases this comfort but is nevertheless unjustified because of its price and handling costs.

Our research[2] on the influence of the housing type on some injuries, which lasted years and included a great number of cows, lead to the results represented in Table 2.

Teat injuries, caused by stepping on her teats by the cow or her neighbour, are 2 à 5 times more frequent in stanchion barns than in loose houses. This explains partly why mastitis is more frequent[3] in stanchion barns than in loose houses. Among the stanchion stables those with gratings, present more teat stepping than the littered type. Lesions of the members are in stanchion stables double as frequent in comparison with loose houses, whereby the use or not applying of straw seems to be of no

Table 2 Traumas and claudications of dairy cattle according to the type of stable

Type of stable	Number of farms	Numder of cows	% cows with teat trauma	% cows with claudications by clawlesions	% cows with lesions of the members
Littered stanchion stable	1,149	28,048	3.40	3.03	1.09
Stanchion stable with gratings	706	20,995	5.35	1.86	1.01
Loose house with cubicles	279	13,236	1.85	5.61	0.58
Littered loose house	88	3,454	1.09	2.90	0.62
Total or average	2,222	65,733	3.59	3.17	0.94

importance. The lack of movement appears to play the important role.

Claw lesions are much more frequent in loose houses with cubicles than in all the other stable types. From further details of our observations it results that of 13,158 cows housed in a loose house with cubicles and with walking passages in slatted floors, 628 or only 4.7 % presented claw lesions, while of 15,096 cows, housed in a loose house with cubicles but with walking passages completely in full concrete, 956 or 6.3 % had such lesions. This difference can be explaind by the observations of SPINDLER[4] who proved that the claw horn is wearing off two times more rapidly on humid than on dry concrete. A walking passage in full concrete, mucked out by a tractor or a delta slide, remains continually humid, softens the claws which easily obtain small lesions that get infected. A passage with,slatted floors and especially a stanchion barn with gratings, are clearly less humid by the fact that the urine is immediately drained away, so that there claw lesitions are less to be feared.

Concrete slatted floors have a conic shape (Fig. 1) and the liquid manure (1.5m^3/cow/month) is stored under them.

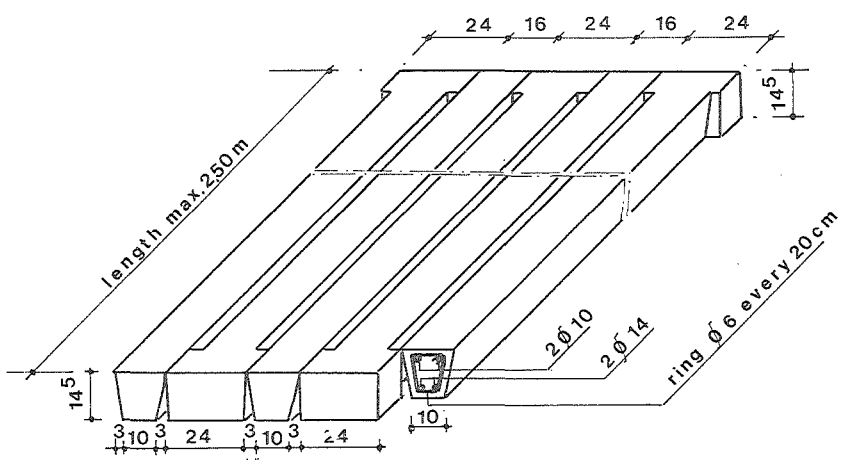

Fig. 1 Concrete slatted floor

Generally speaking, cows in a loose house have healthier way of living than in a stanchion stable.

JÖRGENSEN[5] observed that farmers housing their dairy cattle in a loose house must call a veterinary 131 times/100 cows/year, compared with the owner of cows in a stanchion stable with gratings 188 times and the owner of cows in a littered stanchion

stable 175 times : 42.2 % of the total calls concerned mastitis, which in loose houses is less frequent.

A comparative calculation of construction costs of different cow house types for different numbers of animals, based on average prices asked by contractors in the area of Gent (Belgium) , results in Fig. 2. The yearly costs of buildings, equipment (resp. 10 % and 20 % of the investment) , wages (180 BF or 1250 yen/hour) and straw (3 BF or 20 yen/kg) are represeted in Fig. 3.

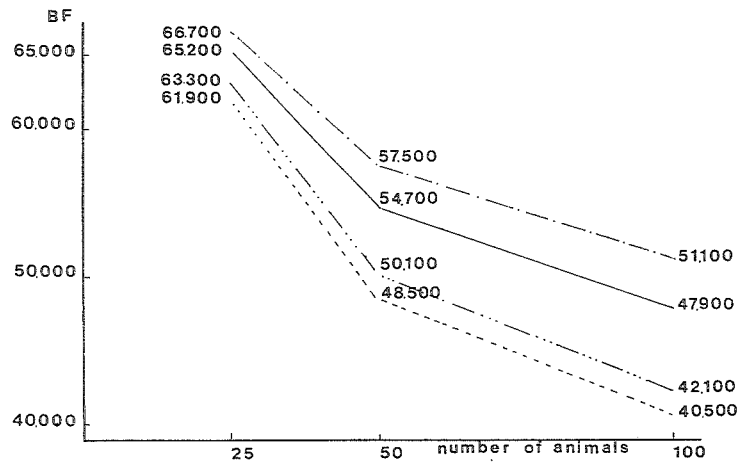

Fig. 2 Investment for a cow house and its equipment (in BF/cow-100 yen=14.5 BF) .

——— stanchion barn with straw
·—·—· strawless stanchion barn with grids
- - - - - - loose house with cubicles and passages in full concrete
--- ——— loose house with cubicles and passages in slatted floors

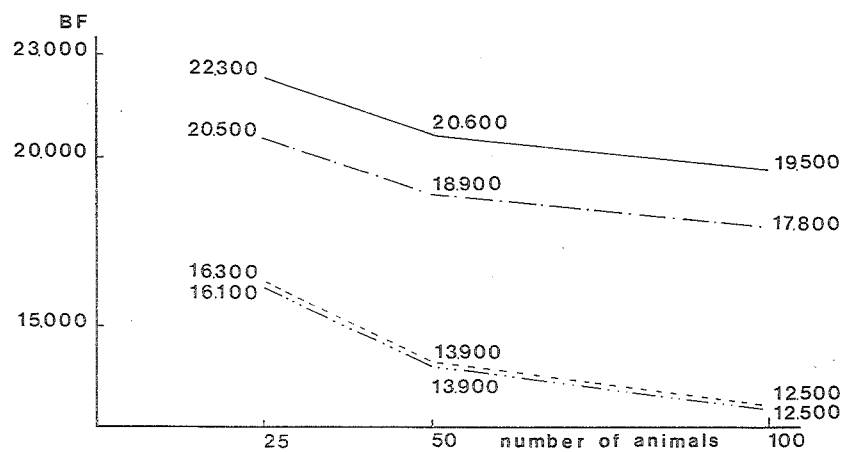

Fig. 3 Yearly costs for a cow house : buildings equipment, labour, straw (in BF/cow-100 yen=14.5 BF) .

It appears that a loose house is economically fully justified when the herd has min. 25 heads and for grater herds (50, 100 cows) it is far less expensive than the stanchion barn. The loose house reduces the labour requirement, has a good influence on animal health and comfort and is less expensive than stanchion barns.

The question arises however if it is justified in the severe wheather conditions of Hokkaido. BIANCA[6] proved that, for the European cow, the temperature zone of comfortableness is situated between 0 ° and 15°C and that milkproduction is highest in this same zone, be it optimal around 10°C. Cows are anatomically protected against low temperatures by anastomoses between veins and arteries in the peripheric zones of their body, which reduces the pheripheric blood circulation and so the body refrigeration.

We can admit that the reaction of the Japanese cow is the same as with the European cow, so that, principally the loose housing can be applied in Japan and even in its coldest part, Hokkaido. We must however raise in this connection the problem of the *insulation of the cow house*. In Belgian conditions, with winter temperatures around 0 ° C and only a few and short periods of down to - 10° C, a loose house for dairy cows is not insulated ; for a Belgian stanchion barn insulation

Table 3 Time of lying down, of six cows, in % of a 24 hrs' day

width of standing place	1974-1975	1975-1976	1976-1977
1 m	51.3	45.5	47.1
	47.3	50.2	43.8
	44.6	43.1	44.2
	43.1	43.1	46.7
	44.4		47.7
	51.8		53.3
	49.1		44.8
	51.6		46.4
	52.0		45.3
	53.9		44.3
	56.6		46.1
	57.3		45.4
$\bar{x}$	50.3	45.5	46.3
1.1 m	53.7	46.6	50.5
	55.8	45.6	51.7
	53.5	48.6	52.1
	50.8	48.2	50.0
			54.4
			43.9
			47.4
$\bar{x}$	53.5	47.3	50.0
1.2 m	53.0	53.2	47.1
	54.6	51.2	47.8
	59.9	44.0	51.2
		47.9	50.0
			50.0
$\bar{x}$	55.8	49.1	49.2
Statistical differences			
1.2 > 1	0.08	0.22	0.03
1.1 > 1	0.21	0.36	0.01
1.2=1.1			

is done, taking into account a k-value of 1. In Hokkaido however the roof and walls of a loose house should be insulated, taking into acount a k-value of 1 and the insulation of a stanchion barn should be based on $k \leq 0.4$. Light materials such as cellular concrete and polystyrene are very useful threfore.

It is significant to note that one of the rare loose houses for cows, nl. one with cubicles for 90 cows, erected in 1975 in Nakashibetsu, gives complete satisfaction with a. o. an average milkproduction of 5100 l/cow/year, which is 400 l above the average of the area.

NATURAL VENTILATION with regulable air inlet through horizontal openings provided with adjustable doorlets and air outlet through insulated chimneys in the roof of the cow houses and equipped with an adjustable doorlet in its under part, is an adequate solution. Mechanical ventilation causes high electricity costs. The

Table 4 Time, in % of a 24 hrs' day, that minimum five on six observed cows are lying down

Width of standing place	1974-1975	1975-1976	1976-1977
1	21.0	12.5	16.7
	15.7	14.6	13.2
	11.7	10.4	18.8
	13.0	9.0	21.5
	2.7		17.7
	12.2		30.9
	27.3		10.8
	24.2		12.2
	16.0		6.6
	25.0		7.6
	32.0		11.8
	34.7		1.4
$\bar{\times}$	19.6	11.6	15.2
1.1 m	32.6	11.8	33.3
	26.2	16.0	35.4
	23.5	16.0	36.5
	17.4	17.4	29.8
			26.8
			6.9
			19.9
$\bar{\times}$	24.9	15.3	26.9
1.2 m	19.9	28.5	22.6
	26.1	29.2	22.6
	42.6	11.8	21.2
		20.1	21.5
			19.1
$\bar{\times}$	29.5	22.4	21.4
statistical differences			
$1.2 > 1$	0.03	0.09	0.15
$1.1 > 1$	0.05	0.02	0.14
$1.1 = 1.2$			

window-surface should be reduced to less than 5 % of the floor surface and made of double glass, in order to avoid heat losses.

Loose houses for raising young cattle and heifers are often used in Japan and in Belgium. They correspond to the basic requirement of young animals, nl. living in a healthy atomosphere and having much exercice. Their full indoor area should be composed of concrete slatted floors in view of reduction of labour requirement.

The examination of some important characteristics of the equipment of strawless stanchion barns with gratings for dairy cows seems useful, as most of the cowhouses, erected last years in Japan, belong to this type. The dimensions of the individual standing places are often too generous in Japan. nl. about 1.80 m×1.40 m. The combination of such standing place with a simple, ± 60 cm long horizontal chain as tying system gives a too high freedom of movement to the cows. The animals befoul their udder and standing place, which sharply increases the labour requirement.

For which concerns the width of the standing place, the results of our research[7] are showed in tables 3 and 4. It appears that the cows enjoy significantly more comfort and are singinificantly less disturbed by their neighbours when their standing place is 1.1 m or 1.2 m wide, than when it is only 1 m wide. As there are no significant differences between the results with a width of 1.1 m and 1.2 m and in order to reduce the censtruction costs, for the relatively light Belgian black-patched cows (550-600 kg) a width of 1.1 m must be preferred. Taking into account that Japanese Holstein cows are heavier (650-700 kg) and that their stabulation period is longer than in Belgium, a width of 1.2 m should be correct. A length of the standing place of 1.45 m gives complete satisfaction for black-patched Belgian cows. For the same reasons as for the width, the standing-place should have a length of 1.50 m for Japanese Holstein cows, in order to give them enough comfort, keeping at the same time cows and standing places clean. Behind the insulated concrete standing-place of 1.50 m×1.20 m covered with a 2 cm thick rubber mat and at the same level, the grating (80 cm wide), must be composed of three flat iron T bars of

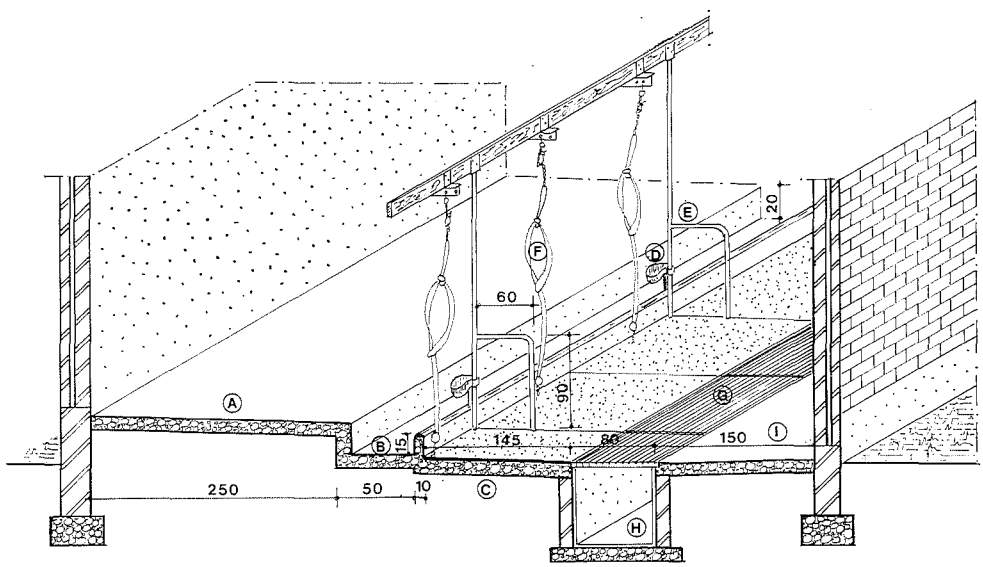

Fig. 4 stanchion barn with grid
Ⓐ feeding passage, Ⓑ crib, Ⓒ standing place (concrete-rubber mat) ,Ⓓ drinking bowl, Ⓔ separation frame, Ⓕ dutch strap, Ⓖ grid, Ⓗ liguid manure channel, and Ⓘ service passage.

2 cm wide (support of the hoofs) and then round iron bars of 1 cm ⌀ (easy passage of the liquid manure) ; the openings between the bars should be 3.5 à 4.0 cm (Fig. 4) .

The tying system is very important : it should allow the cow to lay down and stand up easily without giving her to much liberty of movement. The importance of the tying system appears from our research results. We have nl. compared an "american collar" (Fig. 5) composed of two vertical bars, each consisting of two

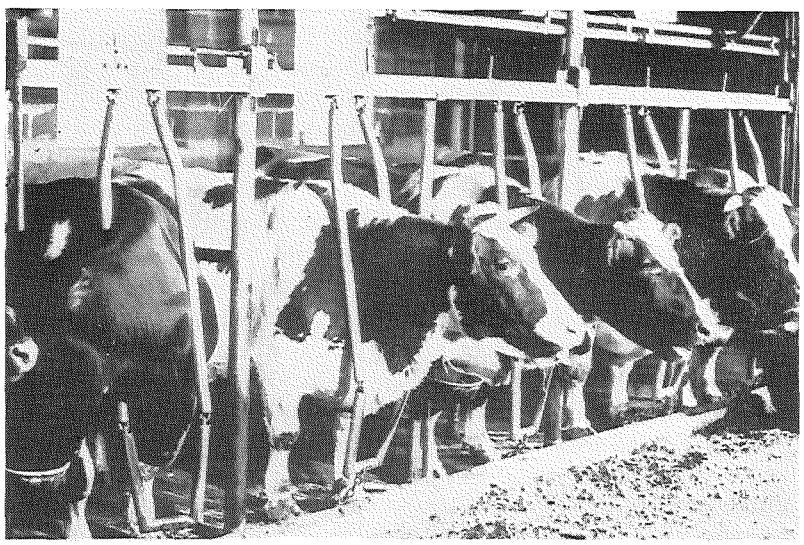

Fig. 5 Tying system : The american collar with broken bars.

pieces articulating around each other, with an "american collar", composed of two stiff, single piece bars (Table 5) .

Table 5 The prevention of teat traumas with the American tying system (2)

Tying system	American collar	
	Stiff collar	Collar with "broken" bars
Number of animals	938	873
% cows with teat traumas	5.22%	1.49%

The last mentioned type causes much more teat injuries than the american collar with "broken" bars. This tying system and the adjustable vertical strap (Fig. 4) are therefore the best tying systems. Storage of the liquid manure in steel or concrete outdoor silos is a good solution, applied already in Japan and in Belgium. The ventilation should be done as described for loose houses.

Acknowledgments

We thank the Japan Society for Promotion of Science for giving us the possibility to do this interesting and useful study and professor Dogoshi, Hokkaido University College of Agriculture for his collaboration, which, we hope may contribute to the progress of dairy husbandry in Japan and especiallly in Hokkido.

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日本とくに北海道の乳牛舎の比較研究

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乳牛舎は日本においてもベルギーと同様に平屋建にすべきである.

25頭以上の場合は建築費と共に労力および牛の衛生の点からキュービクルをもち，キュービクルの列の間をコンクリート簀の子にしたルーズハウスがスタンチョン牛舎よりも望ましい．北海道ではルーズハウスもスタンチョン牛舎も断熱構造にしなければならないが，前者よりも特に後者においてその必要性がある．本州および西南暖地においてはスタンチョン牛舎およびルーズハウスの少くとも屋根は断熱（K≦1）にすべきである．よく調節をすれば自然換気が最も理想的である.

スタンチョン牛舎を建てる場合には労力節約のために敷藁不用の牛舎にすべきである．牛の傷害事故防止および省力のために建築の細部にわたり充分な注意を払わねばならない.

謝辞：此の有益にして興味ある研究の機会を与えられた日本学術振興会ならびに本研究に協力を載いた北海道大学農学部堂越純教授に深謝の意を表すると共に，この研究が日本とくに北海道の酪農の発展に貢献することを希望する.

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