End of Project Report

OPTIMISATION OF CATTLE HOUSING SYSTEMS FOR BEEF FARMERS

Grange Research Centre

Project No. 4425

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Introduction

The provision of animal accommodation and feed storage is essential for the efficient management of a beef herd. Housing should provide living conditions that are conducive to good animal health and efficient production while optimising labour efficiency and minimising the potential for negative impacts to the environment. The type of facilities provided on individual farms is influenced by many factors which may be herd related, such as herd size, productivity targets, animal health & welfare or business related, such as access to (& cost) of capital, taxation situation, capital grant availability, financial incentives (REPS), labour availability (& cost) or environmental, such as nutrient management, codes of practice, statutory requirements, location, soil type.

For large areas of the country where beef systems pre-dominate, the necessity to provide suitable housing is a reality. Soil type and annual rainfall quantities are crucial factors in dictating the length of the housing season. In the case of farmers participating in the Teagasc Cash-in on Grass programme the target length of the grazing season is 220 days. In fact, the figures actually achieved are slightly less than this as indicated in Table 1.

Table 1. Length of housing season for Cash-in on Grass programme

	1997	1998	1999
Days at grass	213	218	208
Days in house	152	147	157

Source: Teagasc, 2000

Of course, the accommodation systems chosen must be economic and care must be taken before making the investment decision which because of its nature is a long-term commitment. Attention to detail at the planning stage will ensure maximum flexibility can be achieved from the facility layout to ensure best use of capital invested. Overall there has been investment in excess of £1 billion in farm buildings over the last 10 years. While the level of investment varies between years it represents an accumulating asset on farms in addition to facilitating efficient production while ensuring protection of the environment.

Housing types

Slatted floor and loose bedded systems are two main house types are used for accommodating beef animals. Design specifications are available from the Farm Development Service of the Department of Agriculture, Food and Rural Development for the construction of the house types outlined. In many instances, hybrid house types have developed which are constructed using combinations of the above types particularly in the situation where facilities have evolved over time e.g. the addition of slatted feed passage to a straw bedded loose house. In recent times the predominant house type which has been constructed utilises liquid manure storage systems as the availability and cost of straw is a limiting factor in comparison with our European neighbours, as shown in Table 2. The move away from the traditional design layouts of open yards with self-feed silage has also been driven by the management problems associated with the high volumes of dirty water produced with these designs due to the high levels of annual rainfall.

Table 2. Straw production in selected European countries

	Straw per animal	*Bedding days for bovines*	
	(t)	3 kg /day	6kg /day
Germany	3.3	1100	550
Sweden	3.3	1100	550
Denmark	3.1	1033	517
UK	1.3	433	217
France	1.2	400	200
The Netherlands	0.2	66	33
Ireland	0.2	66	33

Source: Wilkinson, 1998

Slatted floor developments

Slatted floor systems have been built since the late 1960's and there are an estimated 63,000 units constructed throughout the country on all cattle farm types. While the systems have provided a practical solution to the accommodation requirements and manure storage demands on many farms there are, however, some concerns regarding the animal/floor interface. The figures for ground contact pressures presented in Table 3 indicate the relative loadings on bovine hoofs compared to human feet and also tractor tyres.

Table 3. Ground contact pressures

	Weight (kg)	Contact area[1] (cm^2)	Pressure (bar)
Steer	500	314	1.60
Tractor 100 kW	2500[2]	3125	0.80
Human	80	500	0.16

[1]Measured for steer and human, calculated for tractor
[2]rear axle of 4WD tractor

On a solid floor, the floor interface pressure for a steer, is ten times greater than a human and in the case of a slatted floor the effect is increased as the contact area is further reduced because of the perforations in the floor. The floor interface pressure for a steer is twice that of the tractor. However, as overall loadings from the tractor are higher, only specially designed slats should be used in areas of vehicle traffic.

Slat design has improved and modern facilities are using gang rather than the single slats that were used in the original units. The resulting floors are more uniform and provide a better surface in terms of comfort for the animal. Slats should be checked annually to ensure they remain in a serviceable condition. There are variations within the range of slat types produced by different manufacturers in terms of free area and this will influence the comfort aspect of the animal floor interface as well as the cleanliness of the animal. The latter is also influenced by feed type and the ventilation characteristics of the building. The free area of different slats is presented in Table 4.

Table 4. Free area of different slat (rib and gap dimensions in mm)

Rib/gap	125/25	125/30	125/35	125/40	125/45
% free area	*17*	*19*	*22*	*24*	*27*
	135/25	135/30	135/35	135/40	135/45
	16	*18*	*21*	*23*	*25*
	145/25	145/30	145/35	145/40	145/45
	15	*17*	*19*	*22*	*24*
	150/25	150/30	150/35	150/40	150/45
	14	*17*	*19*	*21*	*23*
	170/25	170/30	170/35	170/40	170/45
	13	*15*	*17*	*19*	*21*

Comparison of buildings with different floor configurations

Two slatted houses were selected at Grange Research Centre with different floor configurations to determine the effects of house type on animal performance and welfare in terms of weight gain, hide cleanliness and lying behaviour. House 1 was a conventional slatted house with a floor fabricated with single slats. House 2 had a partially slatted floor fabricated with gang slats plus an area of solid concrete at the front and rear of the pens. Details of pen configuration are given in Table 5.

Table 5. Slatted floor configuration

	House 1	House 2
Pen area (m^2)	18.0	18.0
Slatted area (m^2)	17.4	10.5
Free area (m^2)	3.8	1.5
Percentage of pen area which is slatted	97	58
Percentage of total pen area which is perforated	21	8

Twenty-four continental cross steers were used in the experiment. The animals were approximately 20 months of age and 600 kg liveweight at the start of the study. The animals were divided into four groups of six animals. Two groups were allocated to pens in House 1 and fed either 5 kg (Pen A) or 8 kg (Pen B) of concentrate (rolled barley 915, soyabean meal 70 and minerals/vitamins 15 g/kg) daily. Two groups were similarly allocated to House 2 – Pen C (5 kg) and Pen D (8 kg). Grass silage was offered to appetite. Liveweight gain was measured over a 69 day trial period. Animals' hide cleanliness scores as devised by the West of Scotland College of Agriculture (Scott and Kelly 1989) were recorded at four week intervals. This assessment system is based on a visual scoring method where the animal side profile is divided into 35 sub-areas and allocated a score from 0 (clean) to 3 (completely dirty). The individual scores for the profile sub-areas are aggregated to give the overall score. Animal lying behaviour in terms of the number and location of lying incidences at 09.15, 12.15 and 16.15 hours was recorded on 35 days.

Details of the results are presented in Table 6. There was no significant effect of house type on liveweight gains for the animals in houses 1 and 2, respectively. There was a significant interaction between house type and preferred lying position ($P<0.001$). Where animals had a choice (House 2) they selected to lie in areas of the pens with solid concrete floors. Animals on the lower level of concentrate ration were dirtier ($P<0.01$) in House 2 (partially slatted) than House 1 on Day 28. There was a similar trend on Day 56 for all animals ($P=0.06$).

Table 6. Slatted house trial results

	House 1		House 2		S.E.
	Pen A	Pen B	Pen C	Pen D	
Average daily liveweight gain (kg)	1.27	1.36	1.28	1.26	0.1
% lying incidences					
Front	38	44	30	30	-
Middle	32	31	9	15	-
Back	30	25	61	55	-
Mean cleanliness score					
Day 0	9	9	5	10	1.4
Day 28	46	57	58	57	1.7
Day 56	53	73	62	79	2.7

Improving the animal/floor interface

To improve the animal floor interface while maintaining the proven features of slatted floors, a comfort surface product manufactured from a nitrile compound has been developed for fitting to the slat ribs and concrete floors[1]. The product is manufactured to offer a high degree of comfort and protection to the animal while allowing the natural opening and closing of the claw. The product is manufactured by an extrusion process and contains three integrally moulded attachment strips in its base for locating fixing screws to attach the product to the slat ribs. The screws are hidden inside the product with no access to any part of the animal.

An animal performance trial was undertaken on a prototype of the system with weanlings while animal performance and cleanliness trials were undertaken using finishing animals.

[1]patented by R.J. Mooney Ltd., Dublin (Slat mat - Airomat ®)

Two groups of eight weanlings were assigned to either a conventionally slatted pen or a pen with modified slats. The animals were assigned to pens based on initial liveweight. Animals were fed 1 kg of concentrate per day with grass silage offered to appetite. Weight gain was recorded over a housing period of 73 days. Two groups of seven finishing steers were assigned to either a conventionally slatted pen or a pen with modified slats based on initial cleanliness score and bodyweight. Animals were fed 3 kg of concentrate per day with grass silage offered to appetite over a period of 120 days.

Details of the results are presented in Tables 7 to 9. The animals housed on the modified slatted floors recorded increases in liveweight gains of 0.16 kg/day in the case of weanlings and 0.19 kg/day in the case of finishing animals (p=0.12). The finishing animals on the modified slats maintained their state of cleanliness during the first two month period of the trial while those on the conventional slats became dirtier. Towards the end of the trial period both groups of animals became cleaner and this can be attributed to the shedding of winter coats. However, at the end of the trial, the animals on the modified slats were cleaner than when the trial started, whereas the animals on the conventional slats recorded similar cleanliness scores as those at the start of the trial. The trends recorded in the trials indicate that the system may lead to improvement in animal performance and animal cleanliness and merit further investigation.

Table 7. Effect of floor type on performance of weanlings over 73 days

	Conventional slats	Modified slats	
Average daily liveweight gain (kg)	0.70	0.86	(P=0.12)
Initial liveweight (kg)	365	360	
Final liveweight (kg)	416	423	

Table 8. Effect of floor type on the performance of finishing steers over 120 days

	Conventional slats	Modified slats	
Average daily liveweight gain (kg)	0.64	0.83	(P=0.11)
Initial liveweight (kg)	604	609	
Final liveweight (kg)	681	709	
Carcass weight (kg)	385.1	396.8	

Table 9. Effect of floor type on the cleanliness score of finishing steers

	Conventional slats	Modified slats
Day 0	34	34
Day 30	36	33
Day 60	44	33
Day 120	35	26

Labour efficiency

Well designed and constructed buildings save on labour costs and provide a satisfactory working environment for the operator. Labour has become a scarce and expensive commodity. The real cost of time spent on farm operations is particularly clear to farmers who work off-farm. While there will continue to be discussion on financial returns generally, the real issue is the financial return available for a given time or labour input to the enterprise. Well designed facilities can improve labour efficiency. Table 10 presents some details of the extra labour costs incurred when efficient versus inefficient building layouts (Teagasc, 2001) are available on a cattle farm.

Table 10. Labour costs associated with efficient versus inefficient facilities

Animal age (mts)	SMD[1] required per head Efficient facilities	Inefficient facilities	Difference (SMD)	Cost (€) A[2]	B[3]	C[4]
0 to 6	1.0	1.5	0.5	28	50	75
6 to 12	0.6	1.0	0.4	22	40	60
12 to 18	0.3	0.4	0.1	6	10	15
18 to 24	0.6	1.1	0.5	28	50	75
TOTAL	***2.5***	***4.0***	***1.5***	***84***	***150***	***225***

[1] Standard man day – equivalent to 8 hours work by person over 18 years old
[2]A – SMD @ €56/day (statutory minimum agriculture wage)
[3]B – SMD @ €100/day
[4]C – SMD @ €150/day

Housing costs

Capital investment in housing is by its nature long-term and it is necessary to spend adequate time on planning (both technical and financial) prior to undertaking any financial commitment. In many cases there are existing facilities available on the farm that can be upgraded to improve their serviceability. Where new structure(s) are being considered care should be taken to integrate, where appropriate, the designs with the existing core facilities e.g. location of new house adjacent to existing fodder storage or cattle handling facilities etc.. While issues like pollution control may provide the principal impetus for the new facility, its design should ensure animals are provided with favourable living conditions e.g. adequate ventilation and shelter, labour utilisation can be optimised and that the facility blends with the surrounding existing structures in the farmyard and the surrounding countryside. Maximum use should be made of financial assistance which may be available (capital grants where applicable and possibility of participating in the Rural Environmental Protection, REPS, if appropriate for the farm business) while the issue of tax allowances should also be considered.

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Bovine husbandry practices adopted by farmers, as well as operating within the constraints of policy and related legislation, must conform to rising public and consumer expectations in relation to animal welfare, food safety and environmental impacts.

In order to compare the actual costs of facilities a number of sample new units have been chosen and the details of these are presented in Table 11. The first three designs represent configurations of slatted units that have been most numerously constructed under the Farm Development Service's capital grant schemes while the fourth design represents a compact slatted house with double tank design which can be configured to provide the housing facilities for suckler cows and progeny to beef (e.g. steers to beef at 24 months and heifers to beef at 20 months. Alternatively the unit can be configured to house 100 steers at a space allowance of $2.5m^2$ per head. Cross-sectional views of the houses are presented in the appendix. For direct cost comparisons the Type 4 and 5 facilities can cater for 100 animals. The capital costs of the houses are based on contractors' estimates. Costs are presented without the addition of VAT as it is presumed that this is reclaimable.

It is assumed that adequate (and similar) facilities are available for silage and meal storage and these are not included in the comparison. Likewise, the labour costs involved in the feeding and herding of animals are assumed as being common across all systems and are not taken into account. However, the annual operational costs in terms of handling and management of bedding materials and wastes as appropriate will vary for the different systems and these costs are presented in Table 12. (Source details for Table 12 are presented in Tables A1 & A2 in the appendix).

Table 11 . Outline house specifications

Facility	**Description**	Animal area (m^2)	Animal occupancy	Cost (€)
Type 1	Single sided slatted house	$68m^2$	27 animals @ $2.5m^2$ /head	25,500
Type 2	Single sided slatted house as per house Type 1 with addition of creep area	$68m^2$ (+ up to $43m^2$ creep)	24 suckler cows @ $2.8m^2$/head + calves	35,000
Type 3	Conventional slatted house with central feed passage	$136m^2$	54 animals @ 2.5 m^2/head	47,500
Type 4	Double tank slatted house with one covered feed passage which can act as calf creep in spring depending on house configuration and use.	$250m^2$ (+ up to $87.6m^2$ creep)	Configuration 1: 30 suckler cows + progeny to slaughter steers @ 24 months, heifers @ 20 months Configuration 2: 40 suckler cows + progeny to slaughter bulls at 16 months, heifers @ 20 months Configuration 3: 100 steers @ $2.5m^2$/head	69,800
Type 5	Loose bedded house with slatted feed passage	$525m^2$	100 animals @ 4 m^2/head solid area & 1.25 m^2/head slatted area	59,700

Table 12. Estimated annual operational costs (€) for bedding material management and manure application for 100 steers in a range of accommodation types

	House type	
	Slatted house	*Loose-house*
Bedding	zero	€2,500
Placement of bedding	zero	€600
Removal of bedding	zero	zero[2]
Manure application	€900[1]	€900
Repairs & maintenance	€300	€300
Annual cost(Cost/head)	*€1,200*	*€4,300*
	(€12)	*(€43)*

[1]including agitation and application
[2]dung allowed to build up in the building during the winter

In order to assess the relative costs of the developments to cater for 100 animals Table 13 presents the capital costs for the units and the costs per animal for the facilities for different grant allowances where appropriate. Table 14 summarises the annual costs for the facilities written-off over 7,12 and 15 year periods. The following assumptions are made:

- Total costs are borrowed @ 9% per annum
- Three situations are taken regarding grant situation – No grant available or grant available at 20% and 40% in accordance with DAFRD Scheme of Investment Aid for Farm Waste Management
- Maximum amount of investment eligible for grant is €50790
- Capital allowances are written-off over the costing period @ 20% (it may be advantageous to avail of accelerated capital allowances depending on the farms taxation situation)
- Tax relief on interest payments is taken @ 20%
- Repairs and maintenance costs are taken at relatively low value as for the structures the write-off periods are relatively short.
- It is assumed that the facilities must be fully paid for within the write-off period and that they have no residual value to the farm business.

Table 13. Capital costs (€) of facilities

	House type	
	Slatted house	Loose house
Total cost	69,800	59,700
Cost/head	698	597
Grant @ 20%	596	495
Grant @ 40%	494	394

Table 14. Annual repayments (€) on facilities

	House type	
	Slatted house	Loose house
7 year write-off		
No grant	109	93
Grant @ 20%	93	77
Grant @ 40%	77	62
12 year write-off		
No grant	78	67
Grant @ 20%	67	55
Grant @ 40%	55	43
15 year write-off		
No grant	70	60
Grant @ 20%	60	50
Grant @ 40%	50	39

The overall cost of the facility must take into consideration the annual operational costs including waste management as outlined in Table 12. These figures for the facilities written-off over 12 years are presented in Table 15.

Table 15. Estimated total annual costs (€) for facilities written-off over 12 years

	House type	
	Slatted house	Loose house
No grant	90	110
Grant @ 20%	79	98
Grant @ 40%	67	86

Conclusions

Taking the comparison it is clear that the provision of accommodation represents a large financial commitment for farmers. A number of points should be noted:

- The maximum amount of investment eligible under the Scheme of Investment Aid for Farm Waste Management is €50,790 per farm. Where the sample structures cost more than this amount the effect of grant assistance is diluted.
- The value of the nutrients in animal slurry is approximately €20 per animal. As the agitation and application costs are allowed for in the above comparisons this figure can be deducted from the slatted house cost. In the case of solid manure systems it may be more difficult to recycle the nutrients effectively.
- With the above designs labour efficiency should be optimised. This can potentially lead to a saving of €28 per head taking labour costs at the statutory minimum agricultural wage. This saving would be substantially greater if higher wage costs are involved.
- The specification of the slatted and loose houses represent durable designs. These units are written-off to a zero value for the selected 7, 12 and 15 year terms. The facilities would in fact have substantially longer serviceable life-spans and this residual value is not reflected in the figures.

The provision of accommodation for beef cattle is essential for efficient management and typically represents a substantial capital investment by farmers. While the type of accommodation provided depends on a range of issues, attention to detail at the design stage will ensure the satisfactory durability and operational efficiency of the facilities constructed.

Appendix.

Table A1. Estimated annual operational costs (€) for slatted house (100 steer places)

1.	Agitation and application of slurry	€900
2.	Facility repair and maintenance	€300
	Total	€1,200

Table A2. Estimated annual operational costs (€) for loose house (100 steer places)

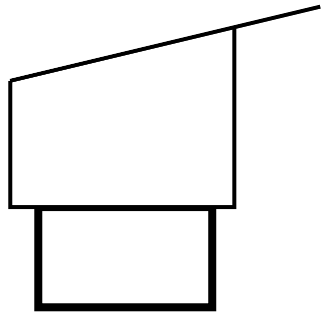
1.	Bedding material[1,2]	€2,500
2.	Placement of bedding material	€600
2.	Agitation and application of slurry	€450
3.	Application of solid material[3]	€450
4.	Facility repair and maintenance	€300
	Total	€4,300

[1]3kg/head/day allowance as some faeces and urine collected as slurry
[2]No allowance for storage facility for straw
[3]Dung is spread directly from building

Figure A1. Slatted house cross-sections

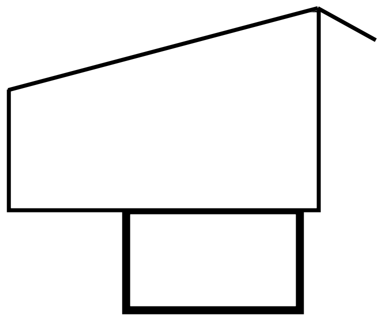
Type 1: Single-sided house (three 4.8m bays)

- ◆ 3.2m to 3.8m slat
- ◆ 2.4m deep tank



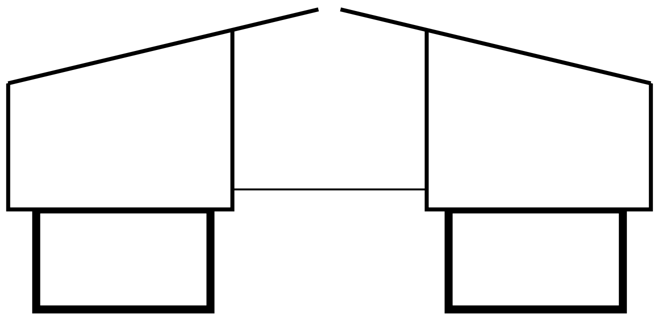
Type 2: Single-sided house with creep area (three 4.8m bays)

- ◆ 3.2m to 3.8m slat
- ◆ 2.4m deep tank



Type 3: Standard house (three 4.8m bays)

- ◆ Central covered feed passage
- ◆ 3.2m to 3.8m slat
- ◆ 2.4m deep tank



Type 4: Double tank (five 4.8m bays)

- ◆ Covered feed passage along one side which can also act calf creep area, uncovered feed passage along second side
- ◆ 4.4m slats
- ◆ 2.4m deep tank

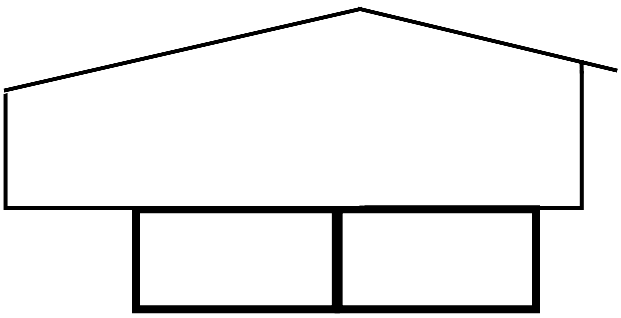
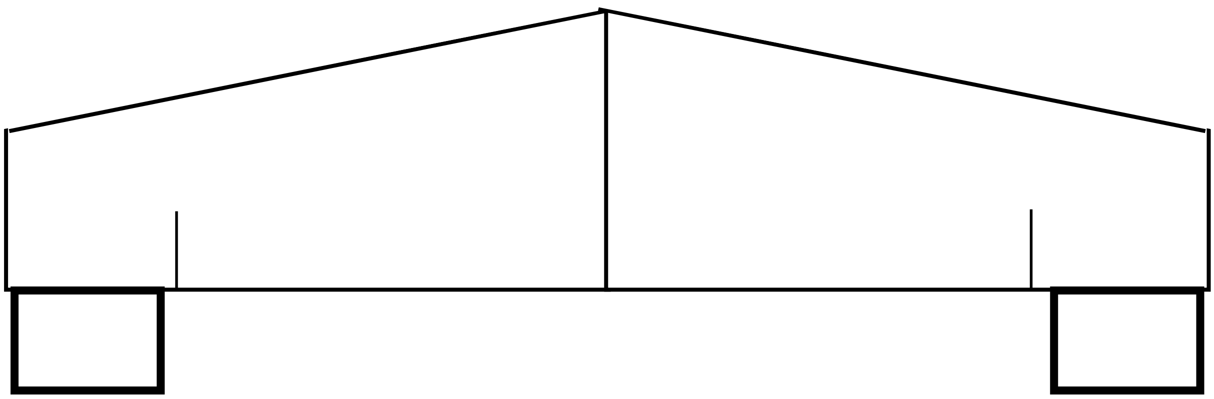


Figure A2. Cross section of Type 2 loose house



Type 5: Double tank (five 4.8m bays)

- ◆ Slatted feed passage along each side of building
- ◆ 2.5m slats
- ◆ 2.4m deep tank
- ◆ 1.25m^2 slatted area per head and 4m^2 solid bedded area per head

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