12

August
2006

D-06-98

HOLSTEIN BULL BEEF PRODUCTION

AgriSearch NI
Farmer Funded Research

AgriSearch NI
Farmer Funded Research

AgriSearch was formed in 1997 to provide a mechanism through which dairy, beef and sheep farmers could have a direct involvement in near market research. Funds contributed to AgriSearch are used to commission research into the improvement and development of sheep, beef and dairy farming and to disseminate and publish the results. This project has been jointly funded by AgriSearch beef and dairy committees.

The Agricultural Research Institute of Northern Ireland,
Hillsborough, Co. Down, BT26 6DR

RESEARCH TEAM
R.M. Kirkland,
T.W.J. Keady,
D.C. Patterson,
R.W.J. Steen,
B.W. Moss and
D. Anderson.

Report prepared by
R.M. Kirkland and T.W.J. Keady

C0-FUNDERS
Department of Agriculture and Rural Development for Northern Ireland

OVERALL SUMMARY OF PROJECT

This project, was established to examine the effects of slaughter weight on production characteristics and meat quality attributes of Holstein-Friesian bulls. The study was carried out with 180 Holstein-Friesian calves with a mean age and weight at the start of the study of 16 weeks and 134 kg respectively. Bulls were slaughtered at one of six slaughter live weights : 300; 350; 400; 450; 500 or 550 kg, while a further group of cattle were slaughtered as steers at 450 kg live weight. All animals were offered concentrates ad libitum and a restricted quantity of straw. Data on food intake, animal performance, boning out yields, market suitability of joints, and assessments of meat quality were recorded. An economic evaluation was also undertaken, including an assessment of fixed and variable costs and margins achievable.

The results showed that bulls slaughtered at 300 kg live weight were off-farm at 8.1 months of age with carcass weights of 155 kg, while bulls slaughtered at 550 kg were 14.3 months of age at slaughter and had carcass weights of 294 kg. Bulls slaughtered at 550 kg live weight consumed over 1500 kg additional concentrate dry matter compared to bulls slaughtered at 300 kg. However, rates of liveweight and carcass gains were similar across all slaughter weight groups, averaging 1.31 and 0.70 kg/d respectively, while killing out and carcass grading characteristics improved with increasing slaughter weight. Slaughter weight had a major effect on food conversion ratio (FCR), with bulls slaughtered at 550 kg requiring an additional 2.8 kg concentrate dry matter to produce a kg of carcass compared to bulls slaughtered at 300 kg.

Boning out data indicated that the proportion of the carcass as red meat was similar regardless of slaughter weight, while delaying slaughter from 500 to 550 kg live weight resulted in a major increase in the proportion of red meat achieving the highest value, supermarket grade specification, resulting in higher returns to the processor. At present, these higher returns are not being reflected in prices paid to the producer. In the assessment of meat quality, redness of meat increased with increasing slaughter weight, while evaluation of sirloins from each animal indicated that meat was acceptably tender. Furthermore, when evaluated by taste panels, sirloins of bulls were regarded as above average in quality and were given high ‘satisfaction’ scores.

HOLSTEIN BULL BEEF PRODUCTION

An economic evaluation indicated that at present feed costs and prices maximum margin over variable costs (£44 per animal) would be achieved by slaughtering bulls at 500 kg live weight, while all bulls, regardless of slaughter weight, lost money when fixed costs were also taken into account. The data also indicated that beef prices need to increase to 245 p/kg for U3 grades, to return margins over total costs (excluding labour) approximating to £100 per head for heavier bulls.

In the comparison of steers with that of bulls slaughtered at 450 kg live weight, the results indicated that steers required more feed and had poorer food conversion than bulls slaughtered at the same live weight. Steers also had lower rates of liveweight and carcass gains, but killing out proportion, carcass grading characteristics and boning out data were similar. When slaughtered at the same weight, steers and bulls produced beef with similar eating quality characteristics, an important finding for the marketability of beef from Holstein bulls. However, finishing Holstein male cattle as steers on intensive diets results in considerably higher financial losses compared to bulls slaughtered at the same live weight.

INTRODUCTION

With the continuing trend for increased use of Holstein genetics in the dairy herd, the number of Holstein-Friesian bull calves produced as a by-product within the dairy industry has increased. These calves have been bred for dairy traits which are negatively correlated to many important beef traits e.g. carcass conformation and food conversion efficiency. The value of Holstein bull calves has been low in recent years and consequently, a large number of calves with a low financial value have become available as a potential resource for the beef industry.

The traditional system for finishing Holstein male cattle in many parts of the UK has involved intensive feeding, with animals offered concentrates *ad libitum* supplemented with a limited amount of straw as a source of roughage. This type of production system has become more attractive in recent years as the cost of cereals relative to that of forage has decreased. Furthermore, with the current lack of manufacturing beef within the processing sector, many abattoirs have been keen to promote the fattening of young bulls to help meet market requirements. Profitability is the key determinant of the viability of any production system. Previous studies have reported a decline in feed conversion efficiency with increasing slaughter weight, such that slaughtering at light weights is one method which might be employed in an attempt to achieve greater efficiency of conversion of feed to product.

A major study was initiated by the Agricultural Research Institute of Northern Ireland to evaluate the effects of slaughter weight on production characteristics, meat eating quality, suitability of meat for the market place and economics of beef production from Holstein male cattle. This booklet summarizes the findings from this study and considers practical implications for the beef industry.

MATERIALS AND METHODS

Animals and treatments
A total of 180 Holstein-Friesian bull calves were used in the study. At an average age of 16 weeks and live weight 134 kg, calves were allocated at random to one of seven treatments. The seven treatments in the study comprised six different slaughter live weights with bulls, namely 300, 350, 400, 450, 500 and 550 kg, and a further treatment with steers slaughtered at 450 kg. Calves allocated to the steer group were castrated by a veterinary surgeon at six months of age. Animals were housed in solid floor pens until six months of age and finished in slatted-floored pens.

Diet
The diet consisted of concentrates offered *ad libitum* and a restricted quantity of barley straw (nominally 5% of total dry matter intake). The composition of the concentrate portion of the diet varied according to age and/or live weight of the animals and is presented in Table 1.

Table 1 Ingredient composition (kg/t) of concentrate offered in the study

	Period	
Ingredient	**16 weeks to 350kg**	**350kg to slaughter**
Rolled Barley	500	535
Soya bean meal	175	140
Molassed sugar beet pulp	200	200
Maize meal	100	100
Vitamins/minerals	25	25

Measurements
A full range of production characteristics was examined for all animals, including food intake, growth rate, carcass characteristics and data and evaluation of meat eating quality. The digestibility of the total ration offered post 350 kg live weight was also determined. Carcass value was calculated for all carcasses using a price-grade structure applicable to Northern Ireland in January 2005.

A total of 82 animals were boned out into individual joints to facilitate a full commercial evaluation of carcasses across the range of weight treatments. Hind quarters were cut into 10 primal joints, while fore quarters were boned out into 9 primal joints. The amount of trim from each carcass was also recorded. The sum of the hind quarter and fore quarter joints and trim was taken as the red meat yield from each carcass.

Each individual joint from the hind and fore quarters of each boned out carcass, along with the trim components, were weighed and subjectively assessed for suitability for particular market specifications by abattoir staff i.e. supermarket grade (highest quality), commercial grade, or manufacturing grade (lowest quality). An estimate of the retail value of each carcass component was provided by the abattoir and used in the evaluation of commercial value of carcasses across the slaughter weight groups in the study.

Assessments of meat quality were undertaken on joints from all animals at Food Science Division, DARD, Newforge Lane, Belfast.

A full evaluation of the financial implications of producing bulls (and steers) across the range of slaughter live weights assessed presently, including detailed analyses of variable and fixed costs in each production system, was undertaken by staff of the Agricultural Research Institute of Northern Ireland, Hillsborough, in conjunction with the Department of Agricultural and Food Economics at Queen's University Belfast.

REVIEW OF FINDINGS

(1) Diet offered

The mean chemical composition of the concentrate offered (pre and post 350 kg live weight) is presented in Table 2. Concentration of crude protein was reduced by 3.7 % when the animals reached 350 kg live weight.

Table 2 Chemical composition of concentrates offered in the study

	Concentrate	
Parameter	**Pre 350kg**	**Post 350kg**
Dry Matter (%)	84.6	85.1
Composition of dry matter (%)		
Crude protein	19.1	15.4
Acid detergent fibre	8.1	7.9
Neutral detergent fibre	19.4	18.3
Ash	7.4	6.7

The dry matter digestibility of the total diet offered post 350 kg was 78.2%, while concentration of metabolisable energy (ME) was 12.2 MJ/kg dry matter.

(2) Animal production

(a) Feed intake, feed conversion efficiency and animal performance data

Feed intake

Data on feed intakes are presented in Table 3. The average intake of straw was 0.21 kg dry matter/day when bulls were slaughtered at 300 kg live weight and 0.36 kg dry matter/day when slaughtered at 550 kg live weight. Similarly, the average concentrate intake increased from 4.4 to 6.6 kg dry matter/day when slaughter weight was increased from 300 to 550 kg live weight. This resulted in major differences in total concentrate intake, with bulls slaughtered at 300 and 550 kg consuming 624 and 2131 kg concentrate dry matter respectively from initiation of the trial (at 16 weeks) until slaughter (resulting in estimated concentrate dry matter intakes of 807 and 2314 kg respectively from birth to slaughter).

The average daily intake of steers (6.2 kg dry matter/day) was relatively similar to that of bulls slaughtered at the same live weight (450 kg), but steers required considerably more concentrate to achieve the same slaughter weight as that of bulls (241 kg of additional concentrate dry matter).

Animal performance
The effects of slaughter weight and sexual status (whether the animals were slaughtered as bulls or steers) on animal performance are presented in Table 3.

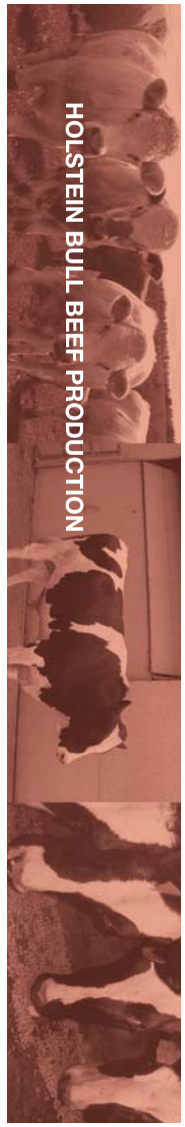
Live weight of bulls at slaughter has major implications for the time bulls spend on farm and the potential rate of throughput and turnover from the production system. In this respect, bulls slaughtered at 300 kg averaged just over 8 months of age at slaughter, while those slaughtered at 550 kg remained on farm until 14.3 months. Rates of liveweight and carcass gains were similar across all slaughter weight groups, averaging 1.31 and 0.70 kg/day respectively, resulting in carcass weights of 155 kg and 294 kg for bulls slaughtered at 300 and 550 kg live weight respectively. However, under present commercial conditions, carcasses between 240 and 260 kg are subject to a minimum penalty of £12/carcass, whilst those under 240 kg are liable for a minimum £24/carcass deduction. Such deductions have a major impact on the profitability of the enterprise and are an important consideration in the determination of optimum slaughter weight (Section 3: Economic evaluation).

The efficiency with which feed is converted into carcass weight is a vital factor when determining the profitability of any beef finishing enterprise. The results of this study demonstrated that increasing slaughter weight from 300 to 550 kg live weight increased the concentrate requirement per kg of carcass gain from 6.4 to 9.2 kg, reflecting the higher maintenance costs and increased fat deposition as slaughter weight increases. The relationship between live weight at slaughter and food conversion ratio (FCR) (kg concentrate dry matter per kg carcass gain) is presented in Figure 1.

Table 3 Effect of weight at slaughter on feed intake, food conversion ratio and animal performance

	Bulls						Steers
Slaughter weight (kg)	**300**	**350**	**400**	**450**	**500**	**550**	**450**
Feed intake (kg dry matter/day)							
Straw	0.21	0.26	0.27	0.31	0.33	0.36	0.34
Concentrate	4.36	4.79	5.66	5.96	6.20	6.57	6.24
Total	4.57	5.05	5.93	6.27	6.53	6.93	6.58
Total concentrate intake (kg dry matter)[1]	624	876	1111	1429	1779	2131	1670
Animal performance							
Slaughter age (months)	8.1	9.5	10.2	11.5	13.0	14.3	12.4
Liverweight gain (kg/day)	1.32	1.27	1.39	1.36	1.31	1.33	1.19
Carcass weight (kg)	155	179	211	237	265	294	233
Carcass gain(kg/day)	0.70	0.65	0.75	0.73	0.71	0.72	0.62
FCR[2]	6.4	7.5	7.6	8.3	8.9	9.2	10.2
Kill out (%)	50.9	50.6	52.2	52.1	52.6	53.0	51.4
Conformation grade[3]	1.2	1.3	1.7	1.5	1.6	1.8	1.5
First class[4]	1.9	2.3	2.4	2.9	2.8	2.9	3.1

[1] 16 weeks to slaughter
[2] Food conversion ratio (kg concentrate dry matter/kg carcass gain)
[3] E, U, R, O+, O, O-, P = 5, 4, 3, 2.5, 2, 1.5, 1 respectively
[4] 5 point scale : 1 = leanest, 5 = fattest



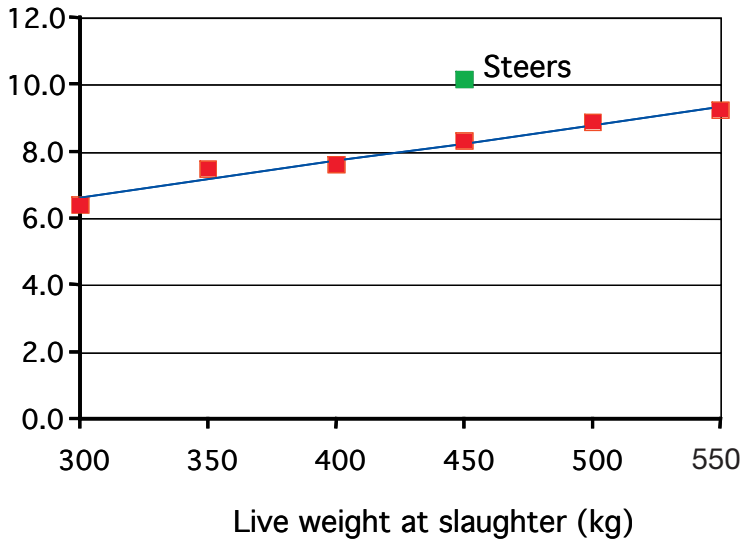


Figure 1 The relationship between live weight at slaughter and efficiency of conversion of feed to carcass gain

Delaying slaughter from 300 to 550 kg live weight improved killing out by 2 percentage units (51% vs 53%), while carcass grading characteristics were also improved. In this respect, carcass conformation increased by 0.6 conformation units and carcass fat classification by 1.0 units between the lowest and highest slaughter weights. In practical terms, bulls slaughtered at 300 kg graded approximately P2, while those slaughtered at the heavier live weights achieved more desirable O-3/O3 grades.

In the comparison of steers and bulls slaughtered at 450 kg, steers required an additional 32 days to achieve similar live weights and carcass weights to those of bulls. This observation reflects the lower rates of liveweight and carcass gains observed with steers relative to bulls (12.5 and 15.1 % lower respectively). Steers also had a poorer FCR than bulls slaughtered at the same live weight (Figure 1) (22.1% poorer than comparable bulls), reflecting the fact that steers were older and had higher internal body fat deposits than bulls slaughtered at the same weight. However, killing out proportion and carcass grading characteristics (conformation and fat classification) were similar between bulls and steers of similar live weight.

(b) Boning out data – yields of joints and market suitability

Data on a range of carcass meat components, along with the proportion of red meat achieving the particular market grade specifications are presented in Table 4.

The data presented in Table 4 are of particular value to processors as they provide an indication of the commercial value of the carcass. The proportion of the carcass as red meat was similar regardless of the weight at which the bulls were slaughtered, at an average of 70.7%. Similarly, the proportion of the carcass as high priced joints (determined as the sum of topside, silverside, knuckle, rump, sirloin, fillet and fore-rib joints) varied little with slaughter weight, averaging 27.5% of the carcass across the range of live weights evaluated. However, there was a trend for the proportion of the carcass as hind quarter to decrease, and proportion as fore quarter to increase as slaughter live weight increased from 300 to 550 kg.

As demonstrated in Table 4, bulls had to be slaughtered at 500 kg or above if any joints were to achieve the premium supermarket specification. Furthermore, delaying slaughter weight from 500 to 550 kg resulted in a major increase in the proportion of joints reaching this premium grade (34% of red meat), largely resulting from an upgrading of joints previously assessed as commercial grade specification. Joints procuring supermarket as opposed to commercial grade specifications achieve considerable increases in price per kg, such that returns to the processor are greatly improved. The proportion of red meat assessed as the lowest quality/lowest value manufacturing grade varied relatively little between the slaughter weight groups.

Carcasses of steers had similar proportions of red meat, high price joints, hind quarters and fore quarters to bulls slaughtered at the same live weight, and had similar proportions of red meat assessed as supermarket, commercial or manufacturing grade specifications.

Table 4 Effect of weight at slaughter on boning out characteristics and market grade specification

	Bulls						Steers
Slaughter weight (kg)	**300**	**350**	**400**	**450**	**500**	**550**	**450**
Percentage of the carcass as:							
Red meat	70.0	69.8	71.2	70.7	71.2	71.0	70.2
High price joints[1]	28.0	28.1	28.2	27.3	26.3	26.9	26.5
Hind quarter	52.3	52.3	51.8	50.9	50.5	50.9	51.0
Fore quarter	47.7	47.7	48.2	49.1	49.5	49.1	49.0
Percentage of red meat achieving each grade specification:							
Supermarket (highest quality)	0.0	0.0	0.0	0.0	5.7	34.0	2.8
Commercial	46.9	46.9	48.5	47.1	39.2	11.7	42.4
Manufacturing (lowest value)	52.5	52.3	52.6	53.9	55.1	54.3	54.8

[1] Determined as the sum of topside, silverside, knuckle, rump, sirloin, fillet and fore rib joints

(c) Meat quality

Assessments of meat quality were undertaken on samples of muscle from the fore-rib joint and sirloin from each carcass. Data on meat quality characteristics assessed are presented in Table 5. The a* value (indicator of redness of meat) increased with increasing slaughter weight, indicating a more favourable meat colour (redder) at the heavier slaughter weights. However, both ultimate pH (pHu) and Warner-Braztler shear force (WBSF) (measure of toughness) were similar regardless of live weight at slaughter. Ultimate pH is an important indicator of meat quality, with higher pHu generally producing darker meat colour, reduced storage life and, in the high end of the range (5.8 to 6.2), tougher meat. Furthermore, meat with pHu greater than 6.0 is unsuitable for vacuum packing due to poor keeping properties. In this respect, only 5.3% of steers and 3.3% of bulls were recorded as having pHu indicating that meat from animals in this study would not be expected to be tough or to have poor keeping qualities. Similarly, the WBSF values recorded (average 2.47 kg/cm2) were well below the limit of 3.2 kg/cm2, above which meat is considered tough.

Table 5 Effect of weight at slaughter on measures of meat quality

	Bulls						Steers
Slaughter weight (kg)	**300**	**350**	**400**	**450**	**500**	**550**	**450**
a*[1]	16.2	16.4	15.9	17.4	17.9	18.0	19.6
pH_U[2]	5.62	5.57	5.65	5.67	5.69	5.57	5.56
WBSF (kg/cm^2)[3]	2.45	2.48	2.71	2.56	2.47	2.31	2.32

[1] indicator of redness
[2] Ultimate pH (at 7 days); indicator of colour, toughness and storage life
[3] Warner-Bratzler shear force (indicator of toughness)

Assessments of meat quality also involved detailed evaluation of samples of sirloin by taste panels. Amongst other parameters, panellists were asked to rate their 'satisfaction' of the meat from animals at each slaughter weight into one of four categories. The results from this analysis showed that across all slaughter weights, panellists considered only 8% of sirloins from the bulls as unsatisfactory, 50% were considered everyday quality, 30% better than everyday quality and 12% were assessed as premium quality. These data indicate that sirloin from bulls slaughtered between 300 and 550 kg live weight is likely to be rated satisfactory or better.

An important finding from this study was that meat quality was relatively similar between steers and bulls slaughtered at the same live weight, with redness, pHu and WBSF measures of meat being similar between both. When subjected to taste panel analysis, panellists rated 5% of sirloins from steers to be unsatisfactory compared to 13% of sirloins from bulls slaughtered at the same weight. However, a similar percentage of the sirloins from bulls and steers were considered to be of satisfactory quality (47% for both bulls and steers), though a higher percentage of sirloins from steers were rated as being better than everyday quality (34%) compared to that of bulls (25%). Panellists rated a similar proportion of sirloins from bulls and steers to be of premium quality.

(3) Economic evaluation

(a) Carcass and red meat value

The major factor of interest to the farmer is that of carcass value. In this respect, the value of carcasses from animals slaughtered at each weight category was determined using the price-grade structure prevailing in Northern Ireland in January 2005 (base price of U3 grade bulls 202 p/kg) (Table 6). Carcass value increased from a low of £228 for bulls slaughtered at 300 kg live weight, to £523 for bulls slaughtered at the highest live weight (after deductions for low carcass weights implemented in most abattoirs at present). This increase in value reflected not only the increase in carcass weight, but also the improvement in price received per kg of carcass with increasing slaughter weight due primarily to improved grading characteristics, with a differential between lowest and highest slaughter weight groups of close to 15 p/kg.

The value of the red meat of the carcass provides a useful indicator of the value of the carcass to the processor. The red meat component comprises the sum of the individual primal joints from the hind- and fore-quarters, plus carcass trim. However, this does not facilitate a direct comparison between prices paid to producers and returns received by the processor, as other costs and incomes associated with the carcass have been excluded e.g. the value of the '5th quarter', slaughter and boning out costs. Using the figures provided by the abattoir, the value of the red meat component of the carcass increased consistently with successively higher slaughter weights. However, while the incremental increase in value between slaughter weight groups up to 500 kg live weight was relatively constant, the incremental increase in red meat value was much more dramatic when slaughter was delayed from 500 to 550 kg live weight. This indicates that the value of the red meat component of the carcass to the processor is greatly increased by slaughtering animals at higher live weights (550 kg), and reflects the greater proportion of joints achieving supermarket rather than commercial grade specifications (and therefore highest prices) at this weight (Section 2b: boning out data – yields of joints and market suitability). In contrast, the value of the carcass paid to the producer did not reflect this major increase in value when slaughter was delayed from 500 to 550 kg.

Table 6 Effect of weight at slaughter on the carcus value

	Bulls						Steers
Slaughter weight (kg)	**300**	**350**	**400**	**450**	**500**	**550**	**500**
Value of the carcus to the roducer							
£[1]	228	285	340	394	471	523	386
p/kg received	163.8	170.1	173.9	176.1	177.5	178.3	176.1

[1]Value of carcass (price paid to the producer) after deductions applied for low carcass weights (£24 per carcass <240 kg; £12 per carcass 240 to 260 kg)
[2]Price paid to the producer based on price-grade structure in Northern Ireland (January 2005)

Similarly, when assessed on a p/kg basis, delaying slaughter weight from 500 to 550 kg increased the price paid to the producer by less than 1 p/kg, while value of red meat to the processor increased by considerably more over the same weight range (potentially up to 22 p/kg). This suggests that there is scope for processors to encourage production of heavier bulls, by paying higher beef prices to the producer, to enable more of the carcass to reach higher priced markets.

Steers had similar carcass and red meat values to those of bulls slaughtered at the same live weight, reflecting the similar carcass weights and grading characteristics of both.

(b) Margins over costs

The financial implications of slaughtering Holstein bulls (and steers) at the range of live weights in the study were determined. Data from this analysis, incorporating an assessment of both variable and fixed costs, and on margins achievable, for animals slaughtered at each live weight are presented in Table 7.

Table 7 Production costs, carcass value and financial margins (per head) for animals slaughtered at each slaughter weight

Costs/ Returns (£)	Bulls						Steers
	300	350	400	450	500	550	450
Variable costs							
Calf	30	30	30	30	30	30	30
Rearing (to 112 days)[1]	67.6	67.6	67.6	67.6	67.6	67.6	67.6
Concentrate[2]	84	118	157	201	249	302	239
Straw Bedding (3-6 months)	8.40	8.40	8.40	8.40	8.40	8.40	8.40
Straw Eaten[3]	2.2	3.2	4.3	5.6	7.1	8.7	6.7
Vet and sundry[4]	15.5	19.2	22.9	26.6	30.4	34.1	29.3
Transport[5]	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Abbattoir deductions[6]	15.1	15.1	15.1	15.1	15.1	15.1	15.1
Total variable costs	**236**	**275**	**319**	**367**	**421**	**479**	**409**
Carcass value[7]	252	309	364	418	471	523	252
(p/kg)	(163.8)	(170.1)	(173.9)	(176.1)	(177.5)	(178.3)	(176.1)
Abattoir penalty[8]	24	24	24	24	0	0	24
Mortailty[9]	4.0	4.6	5.2	6.0	6.8	7.6	6.6
Fixed costs[10]							
Interest	6.2	8.2	10.7	13.6	17.0	21.0	16.1
Slurry/manure	8.1	8.7	9.2	9.8	10.4	11.0	10.2
Housing Rearing	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Housing Finishing	7.5	10.8	14.0	17.3	20.6	23.9	19.6
Total fixed costs	**30.6**	**36.4**	**42.7**	**49.4**	**56.7**	**64.6**	**54.7**
Margin over variable costs (3 per head)	**-12**	**5**	**16**	**21**	**44**	**37**	**-30**
Margin over total costs (£ per head) (excluding labour)	**-43**	**-31**	**-26**	**-28**	**-13**	**-28**	**-84**

[1]DARD (2005) calculations to 3 months, plus allowance for costs to 112 days (mean age of calves at start of study)
[2]assumes costs of £120 per ton
[3]assumes costs of £60 per ton
[4]vet and miscellaneous, proportional costs according to age at slaughter assuming £30 costs for animals slaughtered at 13 months (DARD, 2005)
[5]estimated costs covering buying and delivering calf to the farm, and cost of transporting finished animal to the abattoir
[6]includes standard abattoir charges and deductions by other bodies (per animal) : LMC levy £1.00 (+17.5% VAT); SRM removal £4.95; Antemortem £4.30; Grading £1.25 (+17.5% VAT); ARL levy (£0.20); Insurance £3.00
[7]determined using prices typical of Northern Ireland in January 2005 (base price of U3 grade bulls = 202 p/kg)
[8]carcasses below 240 kg acquire a £24 penalty; 240 to 260 kg acquire a £12 penalty
[9]determined as 3 % of half total variable costs
[10]Fixed costs include interest charges at 7% of working capital, contractor costs of spreading slurry and farmyard manure (DARD, 2005), and depreciation of housing costs (DARD, 2005). Machinery costs were excluded from the calculations on the basis that the production system requires no machinery (e.g. a tractor) for the day to day running of the enterprise. The costings also omit the costs of labour for the enterprise due to the variation in this parameter when considered on an individual farm basis.

These data demonstrate the lack of profitability of Holstein bull beef production in a subsidy-free, market-driven economy, under the economic climate typical of January 2005 (concentrate cost of £120/ton; base price of U3 grade bulls of 202 p/kg). The maximum return over variable costs of £44 per animal was achieved with bulls slaughtered at 500 kg live weight. Slaughtering bulls at 550 kg resulted in a margin of £37 per animal, while slaughtering bulls at 300, 350, 400 or 450 kg resulted in much lower margins over variable costs, ranging from £21 per animal at 450 kg live weight to a loss of £12 per animal for bulls slaughtered at 300 kg live weight.

However, it is important to consider not only the variable costs incurred with the system, but also the associated fixed costs. As shown in Table 7, when fixed costs were included in the calculations, all bulls, regardless of slaughter weight, lost money. Slaughtering bulls at 500 kg live weight minimised losses to the producer (£13 per bull), while slaughtering bulls at 300 kg live weight resulted in losses of up to £43 per animal. Furthermore, while slaughtering at lower live weights increases the potential throughput of bulls through the available housing each year, the economic evaluation indicated that losses incurred by the producer would be further increased by adopting this approach.

It should also be noted that financial penalties imposed by abattoirs for production of carcasses below specified weight limits have been included at the minimum rates operated by the majority of abattoirs at the present time. However, producers should also be aware that current and future trends are likely to result in greater deductions imposed for ‘underweight’ animals, further reducing the potential margins achievable with this production system.

The data also indicate that rearing Holstein male cattle as steers on high concentrate diets and slaughtering at 450 kg live weight is not a financially viable option without a major increase in beef prices. Furthermore, slaughtering animals as steers would result in losses of up to £64 above that of bulls slaughtered at the same live weight, reflecting the higher feed intakes and lower rates of gain (and hence poorer feed efficiency) recorded with steers compared to that of bulls slaughtered at the same live weight.

A sensitivity analysis indicating the effect of changes in the major factors considered to influence profitability in intensive beef finishing systems, namely beef price, concentrate cost and animal growth rate, on net margin is presented in Table 8.

Table 8 Sensitivity analysis - change in net margin rsulting from changes in concentrated cost, beef price and rate of lightweight gain[1]

	Bulls						Steers
Slaughter weight (kg)	**300**	**350**	**400**	**450**	**500**	**550**	**450**
±£10/ ton conc. Cost	7	10	13	17	21	26	20
±10 p/kg beef price	15	18	21	24	27	29	23
±0.1 kg/d liveweight gain	7	10	13	17	21	25	22

[1]Base price of concentrates £120 per ton; base price of U3 grade bulls = 202 p/kg; liveweight gain = 1.31 kg/d; other costs and assumptions as listed in footnotes of Table 7

A decrease in concentrate costs of £10 per ton, with beef prices remaining at the prices quoted, would improve margins over total costs by a maximum of £26 per animal (for bulls slaughtered at 550 kg). Such an improvement in margin would not be sufficient to offset the losses incurred at most slaughter weights, with only bulls slaughtered at 500 kg breaking even, and a much more substantial decrease in concentrate costs would be required to make such systems financially viable for the producer.

An increase in beef price of 10 p/kg above the base figures quoted would result in small improvements in returns, though maximum margins over total costs of only £14 per animal would be expected. Such a small improvement in beef price would not make the system attractive to the producer, and an increase of upwards of 43 p/kg would be required to return margins over total costs (excluding labour) approximating to £100 per head for heavier bulls. Such an increase would equate to a base price for U3 grade bulls of approximately 245 p/kg. Furthermore, an increase in beef prices of this magnitude would result in similar margins being returned from bulls slaughtered at either 500 or 550 kg.

The data presented in Table 8 also indicate the effects of a change in growth rate of the animals on financial margins. Even a modest reduction in rate of liveweight gain of 0.1 kg/day would reduce margins over fixed costs by up to £25 per animal, due primarily to the increased concentrate intake throughout the animals' lifetime. An improvement in animal performance of a similar magnitude would therefore have financial benefits for the producer.

(c) Marginal differences between slaughter weight groups

The costs associated with each incremental increase in slaughter weight are an important factor to determine when considering the most appropriate weight for slaughtering bulls under intensive feeding regimes. The data presented in Table 9 show the effects of delaying slaughter to successively higher weights on the marginal FCR (concentrate basis) and feed cost per unit marginal gain.

Table 9 Marginal food conversion ratio and cost of marginal gain determined between slaughter weight groups

	Slaughter weight group				
	300 to 350	350 to 400	400 to 450	450 to 500	500 to 550
Marginal FCR[1]	8.65	9.84	11.02	12.20	13.39
Feed cost of marginal carcass weight gain (£/kg)[2]	1.22	1.39	1.56	1.73	1.89

[1]kg concentrate dry matter per kg carcass gain
[2]concentrate cost at £120 per tonne

Successive increases in slaughter live weight resulted in a major deterioration in FCR, with close to 5 kg additional concentrate dry matter required to produce a kg of carcass gain when slaughter weight was increased from 500 to 550 kg compared to that required when the incremental increase was from 300 to 350 kg live weight. As a result of this decline in FCR, the cost of concentrate required to produce each additional kg of carcass increased between successive slaughter weight groups such that the marginal value of gain fell below the cost of production within the 500 to 550 kg live weight range. Further analysis of the data indicates that the break-even carcass FCR would be reached with animals slaughtered at 515 kg.

SUMMARY AND IMPLICATIONS FOR THE INDUSTRY

The study was carried out with 180 Holstein-Friesian calves with a mean age and weight at the start of the trial of 112 days and 134 kg.

Animal production

- Bulls slaughtered at 300 kg were 8.1 months old and consumed 624 kg concentrate dry matter, while bulls slaughtered at 550 kg were 14.3 months old and consumed 2131 kg concentrate dry matter, resulting in estimated total intakes of concentrate dry matter from birth to slaughter of 807 and 2314 kg respectively.
- Rates of liveweight and carcass gains were similar across all slaughter weight groups (1.31 and 0.70 kg/d respectively).
- Food conversion ratio was 45% poorer with bulls slaughtered at 550 compared to 300 kg.
- Kill out increased from 50.9 to 53.0% between lightest and heaviest weight groups.
- Bulls slaughtered at 300 kg graded approximately P2, whilst bulls slaughtered at 550 kg graded primarily O-3 and O3.
- Steers had poorer food conversion ratio and lower rates of gain, but had similar car cass grading characteristics to bulls slaughtered at the same live weight.

Carcass and red meat values

- Prices paid to the farmer improved by 14.5 p/kg and £295 per head for bulls slaughtered at 550 compared to 300 kg live weight.
- Value of red meat to the processor increased dramatically when slaughter was delayed from 500 to 550 kg live weight (potentially up to 22 p/kg).

Boning out data – meat yield and market grade specification

- Proportion of the carcass as red meat was similar at all slaughter weights.
- Delaying slaughter from 500 to 550 kg live weight resulted in a major increase in the proportion of joints achieving the premium supermarket grade specification.

Meat quality

- Redness of meat increased with increasing live weight at slaughter.
- Sirloins of all animals were above average in quality and had high satisfaction scores.
- Steers produced beef with similar meat quality to bulls slaughtered at the same live weight.

Economics

- At a base beef price (U3 = 202 p/kg, January, 2005) and concentrate cost (£120/t), margin over total costs (excluding labour) was negative for all bulls, regardless of slaughter weight.
- Beef prices need to increase to 245 p/kg for U3 grades to return margins over total costs (excluding labour), approximating to £100 per head for heavier bulls.
- Break-even FCR was achieved by slaughtering bulls at 515 kg live weight.
- Finishing Holstein male cattle as steers on intensive diets results in considerably higher losses compared to bulls slaughtered at the same live weight.

ACKNOWLEDGEMENTS

The help and co-operation of the staff of the Beef Unit at ARINI is acknowledged and gratefully appreciated. Thanks are also extended to Dr David Kilpatrick and staff of the Biometrics Division, DARD, Newforge Lane for their considerable contribution in the statistical analysis of the data and to Dr Bruce Moss and staff of the Food Science Division, Newforge Lane, Belfast, for assessments of meat quality.


HOLSTEIN BULL BEEF PRODUCTION

AGRISEARCH BOOKLETS

1 SHEEP S-01-97
The Effects of Genetics of Lowland Cross-Bred Ewes and Terminal Sires on Lamb Output and Carcass Quality

2 DAIRY D-05-98
A Comparison of Four Grassland-Based Systems of Milk Production for Winter Calving High Genetic Merit Dairy Cows

3 DAIRY D-07-98
Dairy Herd Fertility - Examination of Effects of Increasing Genetic Merit and other Herd Factors on Reproductive Performance

4 SHEEP S-02-99
Developing Low Cost 'Natural-Care' Systems of Sheep Production

5 BEEF B-01-97
An Examination of Factors affecting the Cleanliness of Housed Beef Cattle

6 BEEF B-02-97
The Effects of Housing System on Performance, Behaviour and Welfare of Beef Cattle

7 DAIRY D-03-97
Developing Improved Heifer Rearing Systems

8 BEEF B-03-98
The Influence of Suckler Cow Genetics and Terminal Sire on Performance of the Suckler Herd

9 DAIRY DB-16-03
The Influence of Suckler Cow Genetics and Terminal Sire on Performance of the Suckler Herd

10 DAIRY D-13-02
The Effect of the Type of Dietary Supplement on the Performance of the Grazing Dairy Cow

11 DAIRY D-06-98
Are International Dairy Sire Genetic Evaluations Relevant to Milk Production Systems in Northern Ireland?

For further information or to request a copy of the full scientific report detailing the experimental tests and statistical analysis contact:

AgriSearch
97 Moy Road
Dungannon
BT71 7DX
Northern Ireland

T: 028 8778 9770
F: 028 8778 8200
W: www.agrisearch.org

AgriSearch NI
Farmer Funded Research