



**MAXIMISING BEEF OUTPUT FROM THE SUCKLER  
HERD THROUGH THE PRODUCTION OF HEAVY BULLS.**





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 funded by the AgriSearch Beef Advisory Committee.



Agri-Food and Biosciences Institute,  
Hillsborough, Co Down, BT26 6DR

**RESEARCH TEAM**

T.W.J. Keady,  
D.J. Kilpatrick,  
B.W. Moss,  
L.E.R Dawson and  
F.O. Lively.

Report prepared by  
F.O. Lively and L.E.R. Dawson

**CO-FUNDERS**

Department of Agriculture and Rural Development for Northern Ireland

## MAXIMISING BEEF OUTPUT FROM THE SUCKLER HERD THROUGH THE PRODUCTION OF HEAVY BULLS

### OVERALL SUMMARY OF PROJECT

This project, was established to examine the effects of increasing weight at slaughter and diet type on production characteristics and meat quality attributes of continental bred bulls. The study was carried out with 251 continental bull weanlings with a mean age and weight at the start of the study of 257 days and 351 kg respectively. The bulls were allocated to two dietary treatments consisting of either *ad libitum* concentrates supplemented with 5 kg grass silage fresh weight or a totally mixed ration containing grass silage and concentrates at a 50:50 ratio, on a dry matter (DM) basis. Bulls were slaughtered at live weights ranging from 500 to 800 kg. Data on food intake, animal performance, carcass attributes and assessment of meat quality were recorded. Margin over feed costs was also calculated.

The results showed that bulls slaughtered at 500 kg live weight produced a 292 kg carcass, while bulls slaughtered at 800 kg live weight produced a 462 kg carcass. Bulls slaughtered at 800 kg consumed 1.45 kg more food per day (DM) than bulls slaughtered at 500 kg. However, rates of live weight and carcass gains were similar across the slaughter weight range, averaging 1.4 and 0.9 kg/day respectively, while carcass grading characteristics (conformation and fat classification) increased with increasing slaughter weight. Increasing slaughter weight had a negative effect on food conversion ratio (FCR), with bulls slaughtered at 500 kg requiring 8.9 kg feed DM per kg carcass weight compared to bulls slaughtered at 800 kg requiring 9.6 kg feed DM per kg carcass weight. This food conversion ratio, even at the heavier slaughter weight, is excellent for beef cattle, and clearly illustrates that suckler bulls can be taken to heavy final live weights efficiently. Carcass dissection data indicated that increasing slaughter weight decreased carcass bone and lean content and increased carcass fat content. Increasing slaughter weight had no effect on meat quality or meat colour parameters.

Replacing 50 % of the *ad libitum* concentrate diet with excellent quality grass silage (D-value 780 g/kg) had no effect on live weight or carcass gain, however replacing 50 % of the *ad libitum* concentrate diet with good quality grass silage (D-value 700g/kg) resulted in a 0.05 kg/day lower live weight gain and 0.06 kg/day lower carcass gain. Dietary treatment had no effect on carcass classification, however *ad libitum* concentrate feeding increased dressing proportion by 10 g/kg and carcass weight by 6.5 kg. Forage to concentrate ratio had no effect on carcass composition. *Ad libitum* concentrate finishing decreased meat cooking loss after 7 days aging by 10g/kg but had no other effect on meat quality or meat colour parameters.

An economic evaluation indicated that at a purchase cost of £600 (350 kg liveweight), silage cost of £120 / tonne DM, concentrate cost of £180 / tonne (fresh weight) and at a beef price of £2.60 kg, maximum margin over costs would be achieved by slaughtering suckler bred bulls at 800 kg live weight provided there were no penalties for heavy carcasses. Finishing bulls on a diet containing 50 % high quality grass silage and 50 % concentrate on a dry matter basis returns greater margins than *ad libitum* concentrate finishing. At current production costs and beef price the 50 % high quality grass silage and 50 % concentrate system has potential to return a positive margin over feed cost, whilst the *ad libitum* concentrate feeding system would barely cover margin over feed cost.

## INTRODUCTION

Low returns from suckler cow production and the decoupling of subsidies from agricultural production, has resulted in a decline in the UK's suckler herd and as a result will lead to a reduction in the numbers of prime cattle for slaughter in the future. It is well established that bulls grow faster, utilise food more efficiently and produce leaner carcasses than steers when given both high concentrate and high forage diets. A major cost in suckler beef production is the cost associated with keeping a cow all year to produce one calf; or for beef finishers is the purchase cost of the weanling. One possible method of increasing the output from the weanling is to finish it to a higher live weight, hence producing a heavy carcass.

The traditional system for finishing suckler bulls has involved intensive feeding, with animals offered concentrates *ad libitum* supplemented with a limited amount of forage as a source of roughage. This type of production system has become less attractive in recent years as the cost of cereals relative to that of forage has increased. Profitability is the key determinant of the viability of any production system. Consequently, there may be potential to replace part of the concentrate portion of a bull ration with grass silage, thereby achieving significant reductions in feed costs.

Meat from bulls has been rejected in some outlets due to the perception that it is of inferior quality to that from steers or heifers. The impact of changing either weight at slaughter or diet type on meat quality is an important aspect which should be considered in an evaluation of bull beef production systems.

### Objectives

A study was initiated by the Agri Food and Bioscience Institute at Hillsborough to evaluate the effects of slaughter weight and forage to concentrate ratio in the diet on

- animal performance
- carcass characteristics
- meat quality

of continental bulls sourced from the suckler herd.

## MAXIMISING BEEF OUTPUT FROM THE SUCKLER HERD THROUGH THE PRODUCTION OF HEAVY BULLS

### PROCEDURE

- The experiment was carried out over two years at AFBI Hillsborough
- 251 continental suckler bred bull calves (3/4 or greater continental breeding) were sourced at weaning
  - Year 1: 123 calves with mean live weight 359 kg and age 273 days
  - Year 2: 128 calves with mean live weight 343 kg and age 235 days
- Two dietary treatments
  - *Ad libitum* concentrates plus 5 kg grass silage (fresh weight)
  - 50:50 ratio of grass silage: concentrates on dry matter basis
- Bulls were slaughtered at live weights ranging from 500 to 800 kg



## REVIEW OF FINDINGS

## Silage quality

\* Year 1: excellent quality (22 % DM and D-value 780 g/kg)

\* Year 2: good quality (28 % DM and D-value 700 g/kg)

**Table 1 Physical and chemical characteristics of silage offered**

	Grass Silage	
	Year 1	Year 2
Dry matter (g/kg fresh)	218	276
pH	3.7	3.9
<i>Composition of dry matter (g/kg unless otherwise stated)</i>		
Crude protein	154	162
Ammonia — N (g/kg total N)	9.9	8.0
Ash	91	111
Lactate	129	104
Acetate	19.0	22.1
Butyrate	1.23	1.9
Gross energy (MJ/kg DM)	17.9	19.2
D-value (g/kg) <sup>†</sup>	780	700
Intake value <sup>†</sup> (g/kg LW <sup>0.75</sup> )	84	82
ME (MJ/kg DM) <sup>†</sup>	12.5	11.1

<sup>†</sup> Determined by Near Infra-red Reflectance Spectroscopy (NIRS) using the Hillsborough Feeding Information System

# MAXIMISING BEEF OUTPUT FROM THE SUCKLER HERD THROUGH THE PRODUCTION OF HEAVY BULLS

## SLAUGHTER WEIGHT

### Feed intake and animal performance

- Increasing slaughter weight:
  - increased feed intake by 0.5 kg DM per day per 100 kg increase in slaughter weight
  - increased finishing duration by 71 days per 100 kg increase in slaughter weight
  - increased food conversion ratio, however even the bulls at 800 kg were very efficient converters of feed to carcass
- Live weight and carcass gain averaged 1.4 and 0.9 kg/day irrespective of slaughter weight.

**Table 2** Effect of weight at slaughter on feed intake and animal performance

	Slaughter weight (kg)			
	500	600	700	800
<i>Feed intake (kg dry matter/day)</i>				
Concentrate	5.5	5.7	6.0	6.2
Silage	2.4	2.6	2.9	3.1
Total	7.9	8.3	8.9	9.3
<i>Animal performance</i>				
Length of finishing period <sup>1</sup>	107	178	249	320
Carcass weight (kg)	292	349	405	462
Food conversion ratio (FCR) <sup>2</sup>	8.9	9.1	9.3	9.6
Kill out (%)	58.3	58.1	57.9	57.7

<sup>1</sup> Study duration assuming initial live weight 350 kg; <sup>2</sup>FCR = kg of food dry matter required to produce a kg of carcass weight

### Carcass classification

- 29 % of bulls slaughtered at 500 kg live weight achieved the top E and U grades from the EUROP classification scheme compared to 88% of the bulls slaughtered at 800 kg live weight
- 43 % of bulls slaughtered at 500 kg live weight achieved the optimal fat classification 3 score compared to 85% of the bulls slaughtered at 800 kg liveweight

**Table 3** Effect of weight at slaughter on carcass classification

	Slaughter weight (kg)			
	500	600	700	800
<i>Confirmation classification</i>				
% E grade	0	8	7	20
% U grade	29	58	65	68
% R grade	57	32	27	12
% O+ grade	14	2	1	0
<i>Fat classification</i>				
%2	43	20	7	0
%3	43	68	73	85
%4 L & H	14	12	20	15

### Carcass composition and meat quality

- Increasing slaughter weight from 500 to 800 kg lead to an increase in fat deposition within the carcass
- Increasing slaughter weight had no detrimental effect on instrumental meat quality as assessed by ultimate pH, sarcomere length, cooking loss, tenderness or colour

**Table 4.** Effects of slaughter weight on carcass dissection and meat quality

	Slaughter weight (kg)			
	500	600	700	800
<i>Carcass dissection</i>				
Lean (g/kg)	675	664	652	640
Fat (g/kg)	151	167	184	201
Bone (g/kg)	161	153	145	137
<i>Meat quality</i>				
Ultimate pH	5.63	5.63	5.63	5.63
Sarcomere length (µm)	2.68	2.71	2.73	2.76
<i>Cooking loss (g/kg)</i>				
7 day ageing	301	296	291	285
21 day ageing	307	301	296	291
<i>Tenderness (kg/cm<sup>2</sup>)</i>				
7 day ageing	3.47	3.48	3.50	3.51
21 day ageing	3.14	3.13	3.12	3.11
<i>Meat colour</i>				
Lightness	40.9	40.5	40.1	39.7
Redness	17.1	17.2	17.4	17.5
Yellowness	13.8	13.9	14.0	14.1

### Economics of production

- Increasing slaughter weight from 500 to 800 kg increased:
  - total concentrate and silage requirement by 1395 and 735 kg DM respectively, accounting for a £384 increase in feed cost
  - carcass weight by 170 kg and improved carcass conformation, resulting in a £452 higher carcass value
  - margin over feed costs by £68
- The evidence from this report suggest that taking bulls to live weights of up to 800 kg is a viable method of maximising margin over feed costs per head, however it is necessary to have a guaranteed market for heavy carcasses prior to undertaking such a finishing system.

## MAXIMISING BEEF OUTPUT FROM THE SUCKLER HERD THROUGH THE PRODUCTION OF HEAVY BULLS

**Table 5.** The effect of weight at slaughter on economics of production

	Slaughter weight (kg)			
	500	600	700	800
Length of finishing period (days)	107	178	249	320
Total concentrate intake (kg/DM)	589	1015	1494	1984
Total silage intake (kg/DM)	257	463	722	992
Feed costs (£/head) <sup>1</sup>	156	271	404	540
Purchase price (350kg@1.71p/kg)	600	600	600	600
Price awarded (£/kg) <sup>2</sup>	2.55	2.58	2.58	2.59
Carcass weight (kg)	292	349	405	462
Carcass value (£)	745	900	1045	1197
Margin / feed cost (£/head) <sup>3</sup>	-11	30	42	57

<sup>1</sup>Feed costs - assuming feeding from initial live weight 350kg with silage cost £120/tonne DM and concentrate cost £180/tonne fresh weight

<sup>2</sup>Price awarded - calculated according to conformation and fat classification scores as presented in Table 2

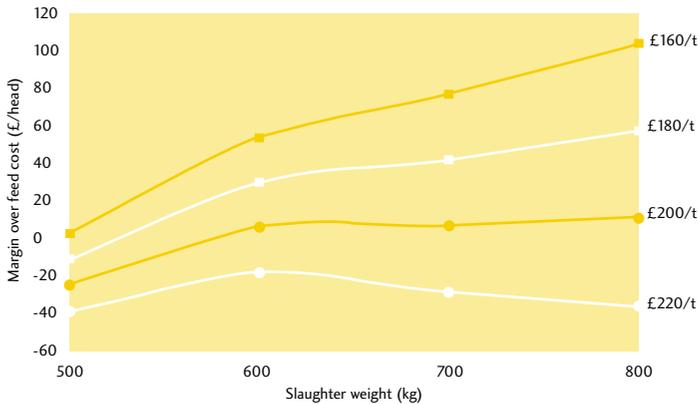
<sup>3</sup>Margin/feed cost = Carcass value (assuming base price of £2.60/kg carcass weight) minus feed costs minus purchase price (350kg @ £600)

### Sensitivity analysis

#### Concentrate price

- At concentrate prices greater than £200 / tonne finishing bulls is not economically viable
- Provided concentrate price is lower than £200 / tonne increasing the slaughter weight increased margin over feed cost

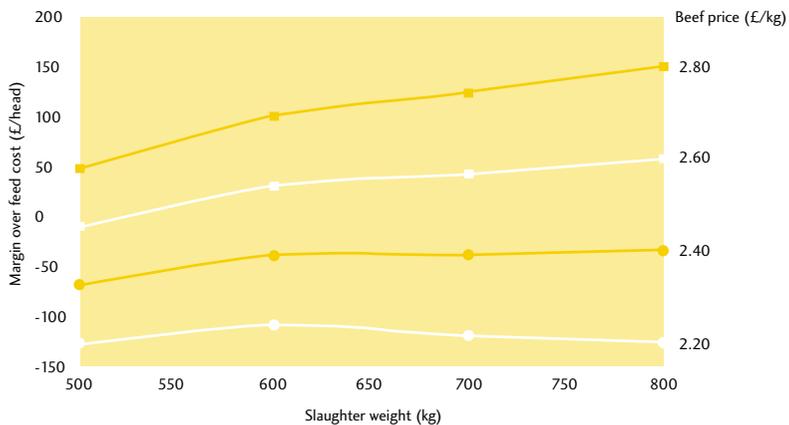
**Figure 1.** The impact of concentrate price and slaughter weight on margin over feed costs.



### Beef price

- At beef prices less than £2.60 / kg carcass weight finishing bulls is not economically viable
- If beef price is greater than £2.60 / kg carcass weight increasing the slaughter weight will increase margin over feed cost however it is essential to have a market outlet for heavy carcasses as no account has been taken for penalties for heavy carcasses in these calculations.

**Figure 2.** The impact of beef price and slaughter weight on margin over feed costs.



## MAXIMISING BEEF OUTPUT FROM THE SUCKLER HERD THROUGH THE PRODUCTION OF HEAVY BULLS

### FINISHING SYSTEM

#### Feed intake and animal performance

- Excellent quality grass silage (D-value 780 g/kg) can replace 50% of the concentrates in an *ad libitum* system without altering live weight gain
- Replacing 50% of an *ad libitum* concentrate diet with good quality grass silage (D-value 700 g/kg) reduced live weight gain by 3.5%
- Replacing 50% of an *ad libitum* concentrate diet with grass silage resulted in a 1% decrease in kill out percentage and 7 kg lighter carcass
- Dietary treatment had no effect on food conversion efficiency

**Table 6.** The effect of diet type on feed intake and animal performance.

	Year 1 Silage D-value 780g/kg		Year 2 Silage D-value 700g/kg	
<b>Forage: concentrate ratio</b>	<b>50:50</b>	<b>15:85</b>	<b>50:50</b>	<b>15:85</b>
<i>Feed intake (kg dry matter/day)</i>				
Concentrate	4.4	7.6	4.3	7.3
Silage	4.4	1.4	4.3	1.3
Total	8.7	9.0	8.6	8.6
<i>Animal Performance</i>				
Length of finishing period (days)	219	219	219	218
Live weight gain (kg/gain)	1.47	1.48	1.40	1.45
Carcass weight (kg)	392	398	377	384
Carcass gain (kg/day)	0.94	0.97	0.90	0.96
Food conversion ratio (FCR) <sup>1</sup>	9.2	9.3	9.4	9.0
Kill out (%)	57.4	58.3	57.5	58.5

<sup>1</sup>FCR = kg of food dry matter required to produce a kg of carcass weight

#### Carcass classification

- Dietary treatment had no effect on carcass confirmation or fat classification

**Table 7.** The effect of diet type on carcass classification.

	Year 1 Silage D-value 780g/kg		Year 2 Silage D-value 700g/kg	
<b>Forage: concentrate ratio</b>	<b>50:50</b>	<b>15:85</b>	<b>50:50</b>	<b>15:85</b>
<i>Conformation classification</i>				
% E grade	7	10	6	14
% U grade	61	60	38	63
% R grade	33	27	31	22
% O+ grade	0	3	2	1
<i>Fat classification</i>				
% 2	3	13	21	12
% 3	80	74	64	70
% 4 L&H	16	13	15	18

### Carcass composition and meat quality

- Dietary treatment had no effect on carcass composition
- Replacing 50% of the *ad libitum* concentrate diet with grass silage resulted in a 10g/kg increase in cooking loss after 7 days ageing but had no other effect on meat quality or colour parameters.

**Table 8.** Effect of diet type on carcass composition and meat quality.

	Forage : Concentrate Ratio	
	50:50	15:85
<i>Carcass composition</i>		
Lean (g/kg)	656	657
Fat (g/kg)	174	179
Bone (g/kg)	151	147
<i>Meat quality</i>		
Ultimate pH	5.61	5.65
Sarcomere length (µm)	2.75	2.69
<i>Cooking loss (g/kg)</i>		
7 day ageing	297	287
21 day ageing	301	295
<i>Tenderness (kg/cm<sup>2</sup>)</i>		
7 day ageing	3.43	3.55
21 day ageing	3.06	3.19
<i>Meat colour</i>		
Lightness	39.7	40.7
Redness	17.1	17.5
Yellowness	14.0	13.9

## MAXIMISING BEEF OUTPUT FROM THE SUCKLER HERD THROUGH THE PRODUCTION OF HEAVY BULLS

### Economics of production

- Replacing 50% of the *ad libitum* concentrate diet with grass silage:
  - reduced total concentrate requirement by 702 kg DM, increased silage requirement by 653 kg DM, leading to a £71 reduction in feed cost
  - reduced kill out percentage by 1% resulting in a 7 kg lighter carcass weight which lead to a £16 lower carcass value
  - increased margin over feed costs by £68

**Table 9.** Feed costs, carcass value and margin over feed costs for young bulls finished on different production systems

	Forage : Concentrate Ratio	
	50 : 50	15 : 85
Length of finishing period (days)	219	219
Total concentrate (kg DM)	938	1640
Total silage (kg DM)	943	290
Feed costs (£/head) <sup>1</sup>	312	383
Purchase price (£/head)	600	600
Carcass weight (kg)	385	391
Carcass value (£)	1001	1017
Margin / feed (£/head) <sup>2</sup>	89	34

<sup>1</sup>Feed costs - assuming feeding from initial live weight of 350kg with silage cost £120/tonne DM and concentrate cost £180/tonne fresh weight.

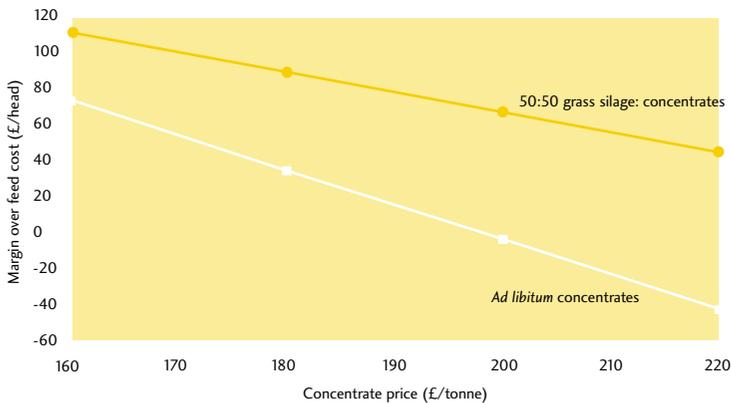
<sup>2</sup>Margin / feed cost = Carcass value (assuming base price of £2.60/kg carcass weight) minus feed costs minus purchase price.

## SENSITIVITY ANALYSIS

### Concentrate price

- The concentrate price required to return a zero margin over feed cost is:
  - £198 / tonne for the *ad libitum* concentrate system
  - £261 / tonne for the 50:50 grass silage : concentrate system.

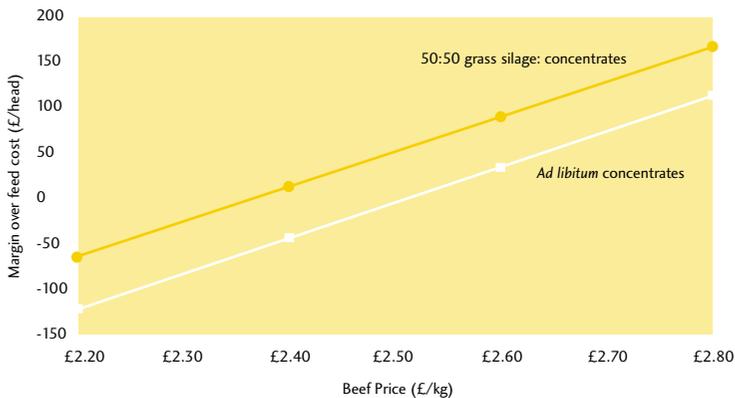
**Figure 3.** The impact of concentrate price and forage to concentrate ratio on margin over feed cost.



### Beef price

- The beef price required to return a zero margin over feed cost is:
  - £2.37 for the 50:50 grass silage: concentrate system
  - £2.51 for the *ad libitum* concentrate system

**Figure 4.** The impact of beef price and forage to concentrate ratio on margin over feed costs.



## MAXIMISING BEEF OUTPUT FROM THE SUCKLER HERD THROUGH THE PRODUCTION OF HEAVY BULLS

### SUMMARY AND IMPLICATIONS FOR THE INDUSTRY

- Bulls are very efficient converters of food to carcass gain, even at live weights up to 800 kg (9.6 kg feed DM/kg carcass gain)
- Finishing bulls to heavy slaughter weights up to 800 kg live weight has no detrimental effect on instrumental meat quality
- Increasing slaughter weight of bulls improves carcass value and margin over feed costs by £151 and £23 per 100 kg increase in slaughter weight, respectively
- Finishing bulls to heavy slaughter weights up to 800 kg live weight has the potential to improve output provided markets are available
- Finishing bulls on a diet containing 50% high quality grass silage (D-value 780 g/kg) and 50% concentrates (DM basis) can achieve a similar level of performance to an *ad libitum* concentrate diet
- Finishing bulls on a diet containing 50 % high quality grass silage and 50% concentrates (DM basis) increased cooking loss by 1 % but had no other effect on instrumental meat quality relative to finishing on an *ad libitum* concentrate diet
- Finishing bulls on a diet containing 50 % high quality grass silage and 50% concentrates (DM basis) will increase margin over feed cost by £55 relative to an *ad libitum* concentrate diet. This will assume greater importance if concentrate prices continue to increase.

## ACKNOWLEDGEMENTS

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

## DISCLAIMER

The Northern Ireland Agricultural Research and Development Council (Agri-Search) has provided funding for this project but has not conducted the research. AgriSearch shall not in any event be liable for loss, damage or injury however suffered directly or indirectly in relation to the report or the research on which it is based.



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

The Secretary  
AgriSearch  
97 Moy Road  
Dungannon  
BT71 7DX  
Northern Ireland

T: 028 8778 9770  
F: 028 8778 8200  
E: [info@agrisearch.org](mailto:info@agrisearch.org)  
W: [www.agrisearch.org](http://www.agrisearch.org)

