HARPER ADAMS
University College

ANIMAL SCIENCE RESEARCH CENTRE

Crimped maize grain for finishing beef cattle

TRIAL REPORT B40/72204

FOR EBLEX

Simon P. Marsh
Senior Lecturer
Harper Adams University College
Newport
Shropshire
TF10 8NB

16 September 2010

1.0 Executive Summary

Thirty-six Holstein and Beef cross Holstein bulls weighing 360kg were reared through to slaughter at EU fat classification 3 and fed either *ad libitum* rolled barley or crimped maize grain. Both rations were formulated to contain 140g crude protein/kg DM with the inclusion of soyabean meal, rapeseed meal and minerals. Overall bull performance was very good with the Holsteins recording slaughter weights of 565kg at 13.6 months old compared to the EBLEX (2005) target for intensive beef production of 540kg at 13 months old.

The maize grain (var: *Benicia*) was grown under plastic mulch, harvested on the 19th of October 2009 with a dry matter content of 620g/kg and crimped and ensiled with 4l/t inoculant (Pioneer 11A44).

Feeding crimped maize grain resulted in significantly higher ($P<0.01$) daily live weight gains (1.51 v 1.34kg) with bulls being slaughtered 12.9 days earlier. The crimped maize grain fed bulls recorded a higher carcase weight (294.6 v 286.9kg), killing out percentage (51.6 v 50.8%) but these were not significantly different. With a reduced number of days to slaughter and higher carcase weight this resulted in a significantly higher ($P<0.01$) carcase daily gain (0.909 v 0.782kg) for the crimped maize fed bulls.

Liver quality was assessed at the abattoir and it was recorded that there was a trend for the crimped maize grain fed bulls to record lower ($P=0.060$) liver damage scores. Liver abscesses are associated with mild acidosis from feeding high starch based diets.

Total concentrate intakes on a fresh weight basis were relatively similar however due to the lower dry matter content of the crimped maize mix (66.0% v 84.1%), daily and total dry matter intakes were markedly lower for the crimped maize fed bulls. The crimped maize fed bulls recorded an improved feed conversion ratio (8.20 v 11.29 kg DM/kg carcase gain).

It is suggested that the improved performance with the crimped maize grain fed bulls could be due to improved efficiency of energy utilisation together with a reduced incidence of rumen acidosis.

Margin over feed and feed costs per kg gain were calculated based on the prices prevailing at the time of the study (2009) and the growing costs for barley and maize grain. Rolled barley was valued at £102.6/t (£119.3/t DM) from a crop yielding 6.6t/ha (2.67t/acre). Crimped maize was valued at £98.9/t (£141.3/t DM) from a crop yielding 9.8t/ha (4.0t/acre) grown under plastic. The crimped maize fed bulls recorded a higher margin over feed of some £32 per bull. The margin over feed per bull would be significantly higher if the bulls had been fed on crimped maize from 3 months old and the crimped maize grown without plastic mulch. Feed costs per kg gain were reduced by 10.4% (10p) and by 13.4% (22p) per kg carcase gain with crimped maize.

A financial sensitivity was carried out:

Rolled barley would have to be below £79.40/t to produce a higher margin over feed with crimped maize @ £98.90/t.

Crimped maize would have to be over £121.50/t to produce a lower margin over feed with rolled barley @ £102.60/t.

Farmer Recommendations

- There is growing interest in feeding grain maize to cattle due to its high energy (14.5 ME MJ/kg DM) and starch (71% in DM) content. A relatively high proportion (35%) of the starch is rumen undegradable compared to 15% for rolled barley which should help minimise problems with rumen acidosis.
- Production costs in 2009 for rolled barley were £102.6/t (£119.3/t DM) from a crop yielding 6.6t/ha (2.67t/acre). Growing costs for maize grain (crimped) were £98.9/t (£141.3/t DM) from a crop yielding 9.8t/ha (4.0t/acre) grown under plastic. The costs for grain maize are reduced to £79.50/t (£113.6/ DM) without plastic mulch.
- From the results of this experiment involving 8.5 month old dairy-bred bulls replacing rolled barley with crimped maize grain for intensively fed bulls will result in earlier slaughter and significantly higher DLWGs, carcase gains and lower liver damage scores.
- Improved performance with crimped maize fed bulls is likely to be due to improved efficiency of energy utilisation together with a reduced incidence of rumen acidosis indicated by lower liver damage scores.
- Based on the costs prevailing at the time of the study the crimped maize fed bulls recorded a higher margin over feed of some £32 per bull. The margin over feed per bull would have been significantly higher if the bulls had been fed on crimped maize from 3 months old and if crimped maize can be grown without plastic mulch. Feed costs per kg gain were reduced by 10.4% (10p) and by 13.4% (22p) per kg carcase gain with crimped maize.
- Rolled barley would have to be below £79.40/t to produce a higher margin over feed with crimped maize costing £98.90/t.
- Crimped maize would have to be over £121.50/t to produce a higher margin over feed with rolled barley costing £102.60/t.
- If the crimped maize had not been grown under plastic and therefore cost £79.5/t with a 9.89t/ha yield this would further reduce feed costs in this experiment and increase the margin over feed by some £57 per bull. Feed costs per kg gain would be reduced by 23p/kg and reduced by 42p per kg carcase gain.
- The option of growing maize without plastic mulch is possible in some southern counties of the UK and would be enhanced with the development of earlier maturing maize varieties. There is currently much debate about global warming but if it occurs this could enable maize grain to grown in increasing areas of the UK without plastic mulch.
- Changing from feeding a ration based on rolled barley via hoppers to crimped maize grain fed via troughs will necessitate a change in feeding system. It is likely to require the use of a mixer wagon and since crimped maize is a moist feed, the feeding routine must be timed so that fresh feed is not placed on top of old feed.
- Feeding crimped maize grain should enable producers achieve recognise performance targets for intensive beef production.

2.0 Introduction:

Maize silage is widely regarded as an ideal forage for finishing beef cattle. Recent work by Browne *et al.,* (2000), Keady and Kilpatrick (2004), Keady and Gordon (2006) and Keady *et al.,* (2007) found that the replacement of grass silage with maize with finishing beef cattle significantly increased performance.

There is growing interest in feeding grain maize to cattle due to its high energy (14.5 ME MJ/kg DM) and starch (71% in DM) content. A relatively high proportion (35%) of the starch is rumen undegradable compared to 15% for rolled barley which should help minimise problems with rumen acidosis. The majority of grain maize currently being grown in the UK is fed to high yielding dairy cows however there is increased interest in its use in beef cattle finishing diets. There is a paucity of information on feeding grain maize to beef cattle in the UK.

According to Ivan Grove (2009. Pers. Comm. Dr I G Grove is a Senior Crop Lecturer, Harper Adams University College) grain maize is generally grown south of a line from Bristol to East Anglia, any further north and yields and maturity may suffer. However the development of early maturing varieties and the use of plastic can lift this growing area to a line from Lancaster to Durham. The average yield is 9-11 t/ha at 30-35% moisture but this is only on good land. It is not possible to get grain moisture lower without drying. The grain would typically be crimped with an acid or inoculant additive. The crop is normally ready for harvest 3-6 weeks later than forage maize. Bill Jones (2009. Pers. Comm. Mr. B Jones is a Crops Specialist for BCW Agriculture Ltd, Market Drayton) states that there is significant interest in growing grain maize in the livestock dense areas of the Midlands and Northern England. Arable farmers in the West Midlands also consider the crop as an ideal alternative to sugar beet since the closure of the Allscott factory at Shrewsbury and are growing the crop to sell to livestock units.

John Morgan (2009. Pers. Comm. Mr. J Morgan, Creedy Associates working on behalf of the Maize Growers Association) states that grain maize needs to be combined with a special header attached to the front of a normal forager. Since grain maize is harvested later than other crops it therefore extends the working season of the machines which is appreciated by the contractors. The stalk is chopped by blades on the header of the combine. The "straw" is then incorporated. There are benefits in terms of nutrient return particularly P & K which is estimated by Bill Jones to be 30kg of P and 50kg of K. There are also benefits as to reduced soil on roads. The chopped stalks act as a carpet and keep machines cleaner than might be expected.

Grain (crimped) maize is stored in a clamp or ag bag and therefore farmers do not need purpose built, expensive, dry grain storage. In principle grain maize costs are very similar to forage maize growing costs as ‘no extras’ are needed.

Dry matter and energy cost comparisons to rolled barley and wheat for 2009 are shown in appendix 1. The cost per unit of ME for rolled wheat, rolled barley and crimped maize are calculated at 0.79, 0.90 and 0.78p/MJ respectively. Crimped maize grown under plastic has a cost of 0.97p/MJ. Rolled barley is predominantly used in intensive beef systems since wheat can cause problems with acidosis. Standard advice is that 50% of the cereal proportion of an intensive ration can be replaced by wheat. The replacement of rolled barley with crimped maize therefore has the potential to significantly reduce feed costs.

3.0 Method

3.1 Objective

The objective of this experiment was to determine the effect of feeding crimped maize grain to intensively finished Holstein and Beef cross Holstein bulls through to slaughter.

3.2 Location

Harper Adams University College, Newport, Shropshire, TF10 8NB.

3.3 Animals & Timing

The trial commenced on the 4th of November 2010 with thirty-six December 2008 to March 2009 born dairy-bred bulls weighing approximately 360kg at 8-9 months old. There were 26 Holstein, 6 Angus cross Holstein and 4 Continental cross Holstein bulls.

3.4 Treatments

Eighteen bulls were allocated according to live weight and breed into the following feeding treatments with two pens of bulls per treatment:

1. Control
A*d libitum* 140g crude protein/kg DM barley based concentrates (See appendix 2 for the formulation, analysis results and feed costs).

2. Grain Maize
A*d libitum* crimped maize supplemented with soya bean meal, rapeseed meal and minerals. Diet formulated to be iso-nitrogenous to the control treatment with 140g crude protein/kg DM (see appendix 2).

The bulls involved in the trial were sourced from the Harper Adams University College dairy herd. Prior to commencement of the trial the calves were fed *ad libitum* 'Harper Adams 14% CP' barley beef ration (see appendix 3 for formulation). The treatment rations were gradually introduced over a 10 day period.

3.5 Production, crimping and conservation of crimped maize grain

The maize was sown under plastic on the 20th of March 2009 using a seed rate of 90,000/ha. The variety used was *Benicia* and the seed was dressed with *Thiram Mesurol*. The crop received an application of the pesticides *Pendamethalin* and *Cadou Star Pre-em*. The maize was harvested at 62% dry matter using a Class Lexion 480 with a drago stripper header on the 19th of October. The grain was then crimped on site at Harper Adams using a Korte 2000s 2x2 grain crimper (see plate 1), which also added the inoculant Pioneer 11A44 and applied at 4 litres/t.

Plate 1: Crimping maize grain at Harper Adams

Once crimped the grain was then ensiled and thoroughly rolled with a tractor and sealed with double sheet plastic weighed down with gravel bags in a clamp measuring 9.8m x 4.6m (see plate 2). A total of 42.82 tonnes of crimped maize was ensiled.

Plate 2: Ensiled crimped maize

It was estimated that there was 560kg crimped maize/m^3 in the clamp.

3.6 Management

The cattle were group housed in straw-bedded yards and had free access to straw from racks. The control ration was fed via hoppers with the crimped maize fed in a trough (see plates 3 & 4).

Plate 3: Barley Mix fed via hoppers

Plate 4: Bulls fed crimped maize grain mixed with soya, rapeseed and minerals

The bulls were fed the crimped maize grain on a daily basis and the feeding timed once the troughs had been cleared to avoid placing fresh feed on top of feed left from the previous day. The soya, rapeseed meal and minerals were weighed and mixed with the crimped maize as shown in plate 5.

Plate 5: Bulls being fed crimped maize grain by Tom Bletcher, a final year BSc Agriculture student who used the experiment to form the basis for his Honours Research Project (thesis)

The bulls were 'double weighed' at the start of the trial and at slaughter. They

were selected for slaughter at EU fat class 3 by Simon Marsh. All of the cattle were slaughtered at Anglo Beef Processors Ltd (ABP) at Shrewsbury using the UK dressing specification.

4.0 Results and Discussion:

Overall bull performance was very good with the Holsteins recording slaughter weights of 565kg at 13.6 months old compared to the EBLEX (2005) target for intensive cereal beef production of 540kg at 13 months old. Further details of the physical and financial performance of the Holstein and Beef cross Holstein bulls are shown in Appendix 4.

Table 1: Animal performance

(kg/bull)	Barley	Maize	s.e.d	Sig
Start wt	358.6	359.4	15.88	NS
Slaughter wt	565.1	570.9	9.97	NS
Days to slaughter	154.2	141.3	11.97	NS
DLWG	1.34	1.51	0.048	**
Age at slaughter (months)	13.53	13.14	0.277	=0.019

NS = not significant, * = P<0.05, ** = P<0.01, *** = P<0.001

The bulls recorded similar slaughter weights however the crimped maize grain fed bulls reached slaughter condition 12.9 days earlier resulting in a significantly higher (P<0.01) DLWG. Plates 6 and 7 were taken of some of the barley and maize grain fed bulls approximately 2 weeks prior to slaughter.

Plate 6: Barley mix fed bulls

Plate 7: Crimped maize fed bulls

It was observed that the crimped maize fed bulls had a superior coat bloom at slaughter. This however was not assessed to quantify this statement.

Table 2: Carcase characteristics

	Barley	Maize	s.e.d	Sig
Carcase wt (kg)	286.9	294.6	6.23	NS
Kill out (g/kg)	508	516	5.5	NS
Carcase DG (kg)	0.782	0.909	0.0400	**
Conformation[1]	3.1	2.9	0.22	NS
Fat class[1]	3.3	3.4	0.16	NS
Liver score (1-5)	2.06	1.22	0.428	=0.060

[1] EUROP carcase classification: Conformation: P+=1 and E=7, Fat class: 1=1 and 5H=7.
[2] See appendix 5 for Liver Assessment Scores

Killing out percentage appears relatively low however it must be noted that the bulls were weighed 'gut full' prior to slaughter. The crimped maize fed bulls recorded a higher killing out percentage but this was not significantly different. With a reduced number of days to slaughter and higher carcase weight this resulted in a significantly higher ($P<0.01$) daily carcase gain for the crimped maize fed bulls.

The carcasses graded very well for dairy-bred bulls with the majority of the Holstein and Beef cross Holsteins grading O+ and R respectively. Of the 26 Holstein bulls, 11.5% graded R, 65.4% graded O+ with 23.1% grading –O. There were no P+ grades.

The bulls fed crimped maize recorded lower ($P=0.060$) liver damage scores. Liver abscesses are associated with mild acidosis from feeding high starch based diets. It could be assumed that the reduced incidence of liver

abscesses was due the higher proportion of by-pass starch in crimped maize. There were no other significant (P>0.05) effects on carcase characteristics.

Table 3: Feed intakes and feed conversion ratio (FCR)

Feed intakes (kg/bull)	Barley	Crimped Maize
Total concentrate intake	1,619	1,596
Daily concentrate intake	10.50	11.30
Concentrate DM (%)	84.1	66.0
Total dry matter intake	1,362	1,053
Daily dry matter intake	8.83	7.45
FCR (kg feed/kg gain)	7.84	7.55
FCR (kg feed DM/kg gain)	6.59	4.98
FCR (kg feed DM/kg carcase gain)	11.29	8.20

Total concentrate intake on a fresh weight basis were relatively similar however due to the lower dry matter content of the crimped maize mix, total and daily dry matter intakes were markedly lower for the crimped maize fed bulls.

The crimped maize fed bulls recorded an improved FCR. The FCR of 7.84kg fresh weight feed per kg live weight gain for the barley fed bulls appears relatively high but it must be taken into consideration that the trial did not include the period of growth from 110kg to 360kg. During this rearing phase dairy-bred bulls at Harper Adams typically record an FCR of 3.5:1.

It is suggested that the improved performance with the crimped maize grain fed bulls could be due to improved efficiency of energy utilisation together with a reduced incidence of rumen acidosis.

Table 4: Financial performance

	Barley	Maize	s.e.d	Sig
Carcase price (p/kg)	259.8	258.6	1.85	NS
Carcase value (£)	745.37	761.84	18.98	NS
Feed cost (£/t)	122.04	114.65		
Feed cost (£/t DM)	145.12	173.71		
Feed cost (£/bull)	198	183		
Margin over Feed (£/bull)	547	579 (+32)		
Feed cost/kg live wt gain (£/kg)	0.96	0.86		
Feed cost/kg carcase gain (£/kg)	1.64	1.42		

The carcase value was based on the beef prices prevailing at the time of the study. Details of the prices on a p/kg basis for the various carcase grades are shown in appendix 6.

The feed costs for the barley and maize are based on growing costs shown in appendix 1. Rolled barley is valued at £102.6/t (£119.3/t DM) from a crop

yielding 6.6t/ha (2.67t/acre). Crimped maize is valued at £98.9/t (£141.3/t DM) from a crop yielding 9.8t/ha (4.0t/acre) grown under plastic. Feed costs for the soya, rapeseed meal, molasses and minerals were £273/t, £134/t, £155/t and £256/t respectively.

The crimped maize fed bulls recorded a higher margin over feed of some £32 per bull. Feed costs per kg gain were reduced by 10.4% (10p) and reduced by 13.4% (22p) per kg carcase gain. The margin over feed would be significantly higher if the bulls were fed on crimped maize from 3 months old.

A financial sensitivity was carried out:

Rolled barley would have to be below £79.40/t to produce a higher margin over feed with crimped maize costing £98.90/t.

Crimped maize would have to be over £121.50/t to produce a lower margin over feed with rolled barley costing £102.60/t.

If good (9.8 t/ha) crops of crimped maize grain can be grown without the use of plastic mulch this would reduce the growing costs of crimped maize from £98.9/t to £79.5/t i.e. by £19.40/t. With this reduced feed costs in this experiment it would increase the margin over feed by some £57 per bull. Feed costs per kg gain would be reduced by 23p/kg and 42p per kg carcase gain.

The option of growing maize without plastic mulch is possible in some southern counties of the UK and would be enhanced with the development of earlier maturing maize varieties. There is currently much debate about global warming but if it occurs this could enable maize grain to grown in increasing areas of the UK without plastic mulch.

5.0 Conclusions:

- Overall performance of the bulls was very good, both achieving and exceeding EBLEX (2005) targets for intensive cereal beef production.
- The bulls recorded similar slaughter weights however the crimped maize fed bulls reached slaughter condition 12.9 days earlier resulting in a significantly higher ($P<0.01$) DLWG.
- With a reduced number of days to slaughter and higher carcase weight this resulted in a significantly higher ($P<0.01$) carcase daily gain for the crimped maize fed bulls
- There was a trend for the crimped maize fed bulls to record lower ($P=0.060$) liver damage scores.
- Based on the costs prevailing at the time of the study the crimped maize fed bulls recorded a higher margin over feed of some £32 per bull. Feed costs per kg gain were reduced by 10.4% (10p) and reduced by 13.4% (22p) per kg carcase gain. The margin over feed would be significantly higher if the bulls were fed on crimped maize from 3 months old.
- If good (10t/ha @ 65% DM) crops of crimped maize can be grown

without the use of plastic mulch this would reduce the growing costs of crimped maize by approximately £19 per tonne and increase margin over feed in this experiment by some £57 per bull. Feed costs per kg gain would be reduced by 23p/kg and by 42p/kg carcase gain.

- Rolled barley would have to be below £79.40/t to produce a higher margin over feed with crimped maize costing £98.90/t.
- Crimped maize would have to be over £121.50/t to produce a higher margin over feed with rolled barley @ £102.60/t.

6.0 References:

Browne, E.M., Bryant, M.J., Beever, D.E. and Fisher, A.V. 2000 Intake, growth rate and carcass quality of beef cattle fed forage mixtures of grass silage and maize silage. *Proceedings of the British Society of Animal Science.* Paper 72.

EBLEX Beef Action for Profit 3. 2005. Better Returns from Dairy-Bred Bulls

Keady, T.W.J. and Kilpatrick, D.J. 2004 The effects of the inclusion of maize and whole crop wheat silages in grass silage-based diets on the performance of beef cattle fed two levels of concentrate. *Proceedings of the British Society of Animal Science.* Paper 65

Keady, T.W.J. and Gordon, A.G. 2006 The effects of maturity of maize and level of maize in forage based diets on the performance of beef cattle. *Proceedings of the British Society of Animal Science.* Paper 46

Keady, T.W.J., Lively, F.O., Kilpatrick, D.J. and Moss, B.W. 2007 Effects of replacing grass silage with either maize or whole-crop wheat silages on the performance and meat quality of beef cattle offered two levels of concentrates. *Animal* 1: 613-623

7.0 Acknowledgements:

The author would like acknowledge the support from EBLEX for funding the study. He would also like express his sincere gratitude to Bill Jones of BCW Agriculture Ltd for sourcing and organising the delivery of the crimped maize grain, Jonathan Bellamy of Pioneer for subsidising the purchase of the crimped maize grain, and to Steven Feehan and Chris McLachlan at ABP for their assistance with recording the liver scores at the abattoir. The contribution of Tom Bletcher who undertook this work as part of his Honours Research Project is also gratefully acknowledged, as is the support of the ruminant technicians at Harper Adams University College.

Appendix 1

Wheat, Barley & Grain Maize costings (2009)

	Winter wheat	Winter barley	Grain maize	Grain maize under plastic
Plough & power harrow (£/ha)	90	90	90	90
Contract drilling (£/ha)	42	30	42	42
Seed, fert & sprays (£/ha)	511	437	445	445
Harvest (£/ha)	80	80	93	93
Plastic (£/ha)				190
Total variable costs (£/ha)	723	637	670	860
Yield (t/ha)	8.25	6.6	9.8	9.8
Yield (t DM/ha)	7.10	5.68	6.86	6.86
Processing cost (£/ha)	50	40	109	109
ME (MJ/kg DM)	13.8	13.2	14.5	14.5
Cost (£/t)	93.7	102.6	79.5	98.9
DM Cost (£/t)	108.9	119.3	113.6	141.3
ME Cost (p/MJ)	0.79	0.90	0.78	0.97

Notes:

Processing cost based on rolling cereals @ £6/t. Grain maize crimped with an additive and stored under plastic

Wheat and barley harvested @ 14% MC. Costs of £8-15/t would be incurred for cereals harvested below 14%

Establishment costs for wheat and barley would be reduced by £20 and £45/ha if minimal tillage or direct drilling was used respectively instead of plough and harrow.

Appendix 2

Trial diet formulation

Feeds (kg/t)	Barley Mix	Crimped Maize (% as fed)	Crimped Maize (% DM)
Rolled Barley	845	0	0
Crimped Maize	0	859	815
Rapeseed meal	40	61	79
Soyabean meal	40	61	79
Molasses	50	0	0
Minerals	25	19	27

Mineral Specification

Calcium (%)	25.3
Phosphorus (%)	1
Magnesium (%)	0.1
Sodium (%)	11.8
Salt (%)	30
Copper (mg/kg)	1,200
Iodine (mg/kg)	200
Selenium (mg/kg)	16
Cobalt (mg/kg)	40
Iron (mg/kg)	2,500
Manganese (mg/kg)	2,000
Zinc (mg/kg)	3,200
Vitamin A (iu/kg)	400,000
Vitamin D3 (iu/kg)	80,000
Vitamin E (mg/kg)	800

Feed analysis results

Feed analysis (% in DM)	**Barley Mix**	**Crimped Maize**	**Crimped Maize Mix**
Dry matter (%)	84.1	62.0	66.0
Oil B (%)	2.3		
Ash (%)	6.2		
Crude Protein (%)	14.2	7.6	14.1
Crude Fibre (%)	6.3		
Starch (%)	45.3	69.2	
ME (MJ/kg DM)	12.9		

Ration costs

Feeds (kg)	**£/t**	**Barley Mix**	**Maize Mix**
Rolled Barley	102.5	845kg	
Crimped Maize	98.9		859kg
Rapeseed meal	134	40kg	61kg
Soyabean meal	273	40kg	61kg
Molasses	155	50kg	
Minerals	256	25kg	19kg
£/t		117.04	114.65
Plus £5/t mixing costs		122.04	
£/t DM		145.12	173.71

Appendix 3

Harper Adams 14% CP barley beef ration

Feeds	kg/t
Rolled Barley	675
Beet Pulp	100
Soyabean meal	75
Rapeseed meal	75
Molasses	50
Minerals	25

Appendix 4

Performance results for Holstein and Beef cross Holstein bulls

	Holstein	Continental[1]	Angus
Slaughter wt	564.7	615.5	550.5
Age at slaughter (mo)	13.57	14.13	12.58
DLWG from birth	1.256	1.324	1.317
DLWG from 12 weeks old	1.378	1.457	1.470
Carcase wt (kg)	288.0	332.7	281.5
Kill out (%)	51.0	54.1	51.1
Carcase DG from 12 wks (kg)	0.715	0.809	0.766
Conformation[2]	2.7 (-O/O+)	4.3 (R)	3.0 (O+)
Fat class[2]	3.3	3.0	3.7
Liver score (1-5)	1.73	1.00	1.67
Carcase Price (p/kg)	256.2	266.0	265.7
Carcase Value (£)	737.86	884.98	747.95

[1] Results for the Continental and Angus bulls must be treated with caution due to the low number of cattle. They are however 'typical' for Continentals and Angus's intensively finished at Harper Adams

[2] EUROP carcase classification: Conformation: P+=1 and E=7, Fat class: 1=1 and 5H=7.

Appendix 5

Liver assessment scores

Score	Description
5	Severe abscesses
4	Abscesses and/or severe discolouration
3	Slight abscesses, discolouration and/or swelling
2	Minor discolouration/swelling
1	Healthy liver

Livers scores 4-5 would be condemned and hence discarded at the abattoir. Liver score 3 could be trimmed depending on the degree of abscesses, discolouration and/or swelling.

Plate 8: Liver score 1 (left) and score 5 (right)

Appendix 6

Carcase prices (p/kg) for bulls sold from March – May 2010

Conformation class	Holstein bulls	Beef x Holstein bulls
R	262	268
O+	258	264
-O	250	256