Harper Adams
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ANIMAL SCIENCE RESEARCH CENTRE

Oats for intensively finished bulls

TRIAL REPORT B46 (P065104)

FOR EBLEX

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25 July 2012

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Executive Summary

Forty-eight dairy-bred bulls (42 Holstein and 6 British Blue cross Holstein) weighing 280kg were reared through to slaughter and fed *ad libitum* cereal based rations based on rolled barley, 50:50 rolled barley/oats or oats. The rations were formulated to contain 140g crude protein/kg DM (12% CP as fed) with the inclusion of soyabean meal, rapeseed meal, molasses and minerals.

Overall bull performance was satisfactory with the Holsteins recording slaughter weights of 565kg at 14.3 months old. The British Blue cross Holstein bulls were slaughtered at 633kg at 14.2 months old.

The Barley fed bulls recorded significantly higher ($P<0.05$) slaughter weights (593kg v 556kg) compared to the Oats fed bulls. The Barley and Barley/Oats fed bulls recorded higher ($P = 0.093$) daily live weight gains compared to the Oats fed bulls (1.29kg v 1.28kg v 1.19kg respectively).

The Barley and Barley/Oats fed bulls recorded higher ($P = 0.096$) carcase weights compared to the Oats fed bulls (302kg v 294kg v 283kg).

There were no significant differences in carcase characteristics or liver scores. Liver abscesses are associated with mild acidosis from feeding high starch based diets. It could have been expected for the Barley fed bulls to have recorded higher liver damage scores but this was not recorded in this experiment.

Cereal feed intakes were highest for the Oats fed bulls (2,101kg, 2,157kg and 2,196kg for Barley, Barley/Oats and Oats respectively) which subsequently recorded the poorest FCR (6.76, 7.24 and 7.36 respectively). The Barley fed bulls recorded the highest daily straw intakes (0.90kg, 0.67kg, 0.57kg respectively).

The FCR of 6.76:1 (fresh weight) 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 280kg. During this rearing phase dairy-bred bulls at Harper Adams typically record DLWGs of 1.52kg with an intake of 570kg of feed with an FCR of 3.4:1. Overall feed intakes estimated from 3 months old to slaughter appear relatively high at 2.6-2.8t per bull however it must be noted that the bulls were finished older at heavier weights of 565kg and 633kg for the Holstein and British Blue cross Holsteins compared to the EBLEX targets of 540kg and 570kg respectively.

It is suggested that the reduced performance with the Oats fed bulls is due to the lower starch and energy density of the diets.

The highest margin over feed was recorded with the Barley fed bulls which was £61 and £126 more than the Barley/Oats and Oats fed bulls respectively. If the bulls were fed on a Barley based mix from 3 months of age and assuming that they performed at the same level as recorded in this study then they would return a significantly higher margin.

The replacement of Barley with Oats increased feed costs per kg gain by 13.7% (16p) and 30.2% (35p) per kg for the Barley/Oats and Oats fed bulls respectively. Feed costs per kg carcase gain were increased by 13.1% (28p) and 26.6% (57p) per kg respectively.

Oats would have to cost £49/t less than Barley to justify their inclusion in an intensive cereal based ration. This would be £51/t less where Oats totally replaced Barley.

Farmer Recommendations

- Total replacement of rolled barley with oats to 6-7 month old intensively fed dairy-bred bulls will result in significantly lower DLWGs, slaughter weights and carcase weights. Feed intakes will increase and in combination with a lower DLWG result in a worse FCR.
- The replacement of 50% of rolled barley with oats will result in a modest reduction in animal performance. Oats would have to cost £34/t less than barley to justify their inclusion at 50% of the cereals in an intensive beef ration.

1.0 Introduction:

Intensively fed cattle are traditionally fed diets based on rolled barley. There is growing interest in replacing some or all of the barley with oats and requests for information on this topic were recently received from beef producers at recent EBLEX/Harper Adams intensive beef finishing meetings.

Compared to barley, oats have a lower energy and starch value and a higher fibre content. Further details of the feed value of barley and oats are shown in appendix 1. This may not appear to be beneficial when it is starch that drives live weight gain with intensively fed bulls. Feeding oats however could result in reduced problems with rumen acidosis with consequential improvements in performance.

There is no published data on the feeding of oats to intensively fed beef cattle in the UK. The objective of this experiment was to determine the effect of full or partial replacement of rolled barley with rolled oats to intensively finished Holstein and Continental cross Holstein bulls through to slaughter.

2.0 Materials & Method

2.1 Location

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

2.2 Animals & Timing

The trial commenced on the 20th of April 2011 with forty-eight September to October 2010 born dairy-bred bulls weighing approximately 280kg at 6-7 months old. There were 42 Holstein and 6 British Blue cross Holstein bulls.

2.3 Treatments

The bulls were allocated in a randomized block design according to live weight and breed into the following feeding treatments with sixteen bulls per treatment. Prior to commencement of the trial the calves were fed *ad libitum* 'Harper Adams 14% CP' barley beef ration (see appendix 2 for formulation). The treatment rations were gradually introduced over a 10 day period.

1. Barley
A*d libitum* 140g crude protein/kg DM (12% as fed) concentrates (84.5% rolled barley, 4% soya-bean meal, 4% rapeseed meal, 5% molasses, 2.5% intensive beef minerals). This is the 'standard' intensive beef finishing ration at Harper Adams.

2. Barley/Oats
A*d libitum* 140g crude protein/kg DM (12% as fed) concentrates (41.75% rolled barley, 41.75% rolled oats, 4.5% soya-bean meal, 4.5% rapeseed meal, 5% molasses, 2.5% intensive beef minerals).

3. Oats

A*d libitum* 140g crude protein/kg DM (12% as fed) concentrates (82.5% rolled oats, 5% soya-bean meal, 5% rapeseed meal, 5% molasses, 2.5% intensive beef minerals).

The diets were formulated to be iso-nitrogenous. Details of the rations and declared specification and mineral specification are shown in appendix 3. The rations were analysed by Near Infrared Reflectance Spectroscopy (NIR) and the results shown in table 1.

Table 1: Feed analysis results

Feed analysis (% as fed)	Barley Mix	Barley/Oats	Oats
Dry matter (%)	84.2	84.7	85.3
Oil B (%)	1.6	2.5	3.3
Ash (%)	9.1	10.0	10.1
Crude Protein (%)	11.9	12.0	12.3
Crude Fibre (%)	4.0	6.3	10.4
Starch (%)	42.2	35.9	25.7
ME (MJ/kg DM)	12.9	12.2	11.9

As expected the rations containing oats had a higher fibre and lower starch content.

2.4 Management

The cattle were group housed in straw-bedded yards with 2 pens of bulls per treatment and had free access to straw from racks. The rations were fed via hoppers (see plate 1).

Plate 1: Barley/Oats mixes fed via hoppers

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 (Senior Lecturer – Beef Cattle Specialist). All of the cattle were slaughtered at Anglo Beef Processors Ltd (ABP) at Shrewsbury using the UK dressing specification.

3.0 Results and Discussion:

Overall bull performance was satisfactory with the Holsteins recording slaughter weights of 565kg at 14.3 months old compared to the EBLEX (2005) target of 540kg at 13 months old. The British Blue cross Holstein bulls were slaughtered at 633kg at 14.2 months old compared to the EBLEX target of 570kg at 14 months. Further details of the physical and financial performance of the Holstein and British Blue cross Holstein bulls are shown in Appendix 4. The data was analysed using ANOVA with start weight as a co-variate. Liver scores were analysed using Kruskal-Wallis analysis of variance.

3.1 Liveweight and days to slaughter

As shown in table 2 the Barley fed bulls recorded significantly higher (P<0.05) slaughter weights compared to the Oats fed bulls. DLWG was calculated by the difference from slaughter weight to start weight. The Barley and Barley/Oats fed bulls recorded higher (P = 0.093) daily live weight gains (DLWG) compared to the Oats fed bulls.

Table 2: Animal performance (kg/bull)

	Barley	Barley/Oats	Oats	s.e.d	Sig
Start wt (kg)	283	283	282	2.3	NS
Slaughter wt (kg)	593^{a}	579^{ab}	556^{bc}	14.0	*
Days to slaughter	242	231	236	6.4	NS
DLWG (kg)	1.29	1.28	1.17	0.058	=0.093

Within row, means with the same superscript are not significantly different (P>0.05)
NS = not significant, * = P<0.05, ** = P<0.01, *** = P<0.001

It was observed that there was no difference in coat bloom at slaughter. This however was not assessed to quantify this statement.

3.2 Carcase characteristics

Carcase characteristics are illustrated in table 3. Killing out percentage appears relatively low however it must be noted that the majority of the bulls were Holsteins, they were weighed 'gut full' prior to slaughter and the carcasses were trimmed to UK specification. The Barley fed bulls recorded a higher (P = 0.096) carcase weight compared to the Oats fed bulls.

Table 3: Carcase characteristics

	Barley	Barley/Oats	Oats	s.e.d	Sig
Carcase wt (kg)	302	294	283	8.6	=0.096
Kill out (%)	50.8	50.8	50.7	0.60	NS
Carcase DG (kg)	0.70	0.70	0.65	0.036	NS
Conformation[1] (1-7)	2.4	2.4	2.2	0.23	NS
Fat class[1] (1-7)	2.7	2.6	2.5	0.18	NS
Liver score[2] (1-5)	1.33	1.00	1.33	0.223	NS

[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

The Barley fed bull's recorded higher conformation and fat classification scores but this was not significantly different.

The carcasses graded very well for dairy-bred bulls with the majority of the Holstein and British Blue cross Holsteins grading -O and R respectively. Of the 42 Holstein bulls, 23.3% graded O+, 63.4% graded -O with 13.3% recording P+ grades.

There were no significant differences in liver scores. It could have been expected for the Barley fed bulls to have recorded higher liver damage scores since liver abscesses are associated with mild acidosis from feeding high starch based diets (Plaizier, 2009). This was not recorded in this experiment.

3.3 Feed intakes

It can be seen from table 4 that the replacement of Barley with Oats increased total and daily concentrate feed intake and with no improvement in DLWG resulted in a deterioration of the FCR.

Table 4: Feed intakes and Feed Conversion Ratio (FCR)

	Barley	Barley/Oats	Oats
Total concentrate intake	2,101	2,157	2,196
Daily concentrate intake	8.68	9.34	9.31
FCR (kg feed: kg gain)[1]	6.78	7.29	7.39
FCR (kg feed: kg carcase gain)[1]	12.40	13.34	14.32
FCR (kg feed DM: kg gain)	5.71	6.17	6.22
FCR (kg feed DM: kg carcase gain)	10.44	11.30	12.21

[1] FCR calculated on a feed fresh weight basis.

The FCR of 6.78:1 (fresh weight) 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 280kg. During this rearing phase dairy-bred bulls at Harper Adams typically record DLWGs of 1.52kg with an intake of 570kg of feed with an FCR of 3.4:1. Overall feed intakes appear relatively high at 2.6-2.8t per bull however it must be noted that the bulls were finished older at heavier weights of 565kg and 633kg for the Holstein and Continental

cross Holsteins compared to the EBLEX targets of 540kg and 570kg respectively.

Wheat straw was offered ad libitum from racks to the bulls throughout the experiment and intakes were recorded for a 48 day period during October and November 2011 with the bulls initially weighing 370kg. Intakes are shown in table 5.

Table 5: Straw intakes (kg[fresh wt]/bull/day)

	Barley	Barley/Oats	Oats
Straw intakes	0.90	0.67	0.57

The Barley fed bulls recorded higher straw intakes which are presumably due to the lower fibre and higher starch content of barley compared to oats. This would also partly explain the higher cereal feed intakes with the Barley/Oats and Oats treatments. Mean daily feed intakes for cereals and straw are shown in table 6.

Table 6: Daily Concentrate and Straw intakes (kg[fresh wt]//bull/day)

	Barley	Barley/Oats	Oats
Daily Feed Intake (Cereals + Straw)	9.58	10.01	9.88

3.4 Financial appraisal

The cost of the rations were calculated based on the feed costs prevailing at the time of the study and are shown in table 7.

Table 7: Ration formulation and costs

Feeds (kg/t)	Barley	Barley/Oats	Oats
Barley @ £152/t	845	417.5	
Oats @ £170/t		417.5	825
Rapeseed meal ext @ £190/t	40	45	50
Soyabean meal @ £288/t	40	45	50
Molasses @ £130/t	50	50	50
Minerals @ £350/t	25	25	25
£/t	162.81	171.20	179.40
Plus £10/t mill & mix costs	172.81	181.20	189.40

Margin over feed and feed costs per kg gain were calculated. Details of the carcase prices on a £/kg basis were standardised for the various carcase grades and are shown in appendix 6.

From the results shown in table 8 the highest margin over feed was recorded with the Barley fed bulls which was £61 and £126 more than the Barley/Oats

and Oats fed bulls respectively. If the bulls were fed on a Barley based mix from 3 months of age and assuming that they performed at the same level as recorded in this study then they would return a significantly higher margin.

The replacement of Barley with Oats increased feed costs per kg gain by 13.7% (16p) and 30.2% (35p) per kg for the Barley/Oats and Oats fed bulls respectively. Feed costs per kg carcase gain were increased by 13.1% (28p) and 26.6% (57p) per kg respectively.

Table 8: Financial performance

	Barley	Barley/Oats	Oats	s.e.d	Sig
Carcase price (£/kg)	3.09	3.06	3.04	0.044	NS
Carcase value (£)	933.18	899.64	860.32	38.1	NS
Feed cost (£/t)	172.81	181.20	189.40		
Feed cost (£/bull)	363	391	416		
Margin over Feed (£/bull)	570	509	444		
Feed cost/kg live wt gain (£/kg)	1.16	1.32	1.51		
Feed cost/kg carcase gain (£/kg)	2.14	2.42	2.71		

A financial sensitivity was carried:

i) Barley v Barley/Oats

Oats would have to cost £103/t (i.e. £49/t less) to produce a similar margin over feed with Barley costing £152/t.

ii) Barley v Oats

Oats would have to cost £101/t (i.e. £51/t less) to produce a similar margin over feed with Barley costing £152/t.

4.0 Conclusions:

- Overall performance of the bulls was satisfactory achieving similar results to the EBLEX (2005) targets for intensive cereal beef production.
- The Barley fed bulls recorded significantly higher (P<0.05) slaughter weights compared to the Oats fed bulls.
- The Barley and Barley/Oats fed bulls recorded a higher (P = 0.093) DLWG compared to the Oats fed bulls.
- The Barley fed bulls recorded higher (P = 0.096) carcase weights compared to the Oats fed bulls.
- There were no significant differences in carcase characteristics or liver damage scores.
- Cereal feed intakes were highest for the Barley/Oats and Oats fed bulls which subsequently recorded the poorest FCR.
- The Barley fed bulls recorded the highest straw intakes.
- It is suggested that the reduced performance with the Oats fed bulls is

due to the lower starch and energy density of the diets.

- Based on the costs prevailing at the time of the study the highest margin over feed was recorded with the Barley fed bulls which was £61 and £126 more than the Barley/Oats and Oats fed bulls respectively. The margin over feed would be significantly higher if the bulls were fed on Barley from 3 months old, assuming that they performed at the same level as recorded in this study.
- Oats would have to cost £49/t below Barley to justify their inclusion @ 50% in an intensive cereal based ration. This would need to be £51/t less where Oats totally replaced Barley.

As concluded above the total replacement of barley with oats had a significant negative effect on cattle performance and margins. The partial replacement of 50% of barley with oats resulted in a negative effect on bull performance however this was not statistically significant.

4.1 Recommendations for future study

A relatively low inclusion rate (approximately 10-15%) of Oats should be investigated. This inclusion rate could minimise problems of acidosis with barley based rations containing very high (>36% as fed, >42% in DM) starch levels and maintain/improve animal performance.

A number of beef producers have contacted the author regarding feeding wheat to intensively finished cattle but this is not recommended due to the very high starch content of wheat and the issues of processing wheat grain since it is difficult to 'lightly roll' resulting in cattle being fed 'ground wheat' that would degrade rapidly in the rumen causing acidosis. The combination of 50% wheat and 50% oats in the authors opinion should give satisfactory performance and is worthy of investigation.

5.0 Acknowledgements:

The author would like acknowledge the support from EBLEX for funding the study. He would also like express his sincere gratitude to Steven Feehan and Chris McLachlan at ABP for their assistance with recording the liver scores at the abattoir. The contribution of Daniel Blenkiron 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.

6.0 References:

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EBLEX The Mini Feeds Directory. 2008.Huntingdon: EBLEX

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Appendix 1

Feed value of barley and oats

% in DM	Barley	Oats
ME (MJ/kg DM)	13.2	12.2
Starch	59.0	42.0
Sugar	3.0	1.0
Crude Protein	12.1	11.0
NDF	21.1	35.6
Oil	3.0	5.0

Source: EBLEX. The Mini Feeds Directory, 2008

Appendix 2

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 3

Trial diets

Feeds (kg/t)	Barley	Barley/Oats	Oats
Rolled barley	845	417.5	
Rolled oats		417.5	825
Rapeseed meal	40	45	50
Soyabean meal	40	45	50
Molasses	50	50	50
Minerals	25	25	25
Theoretical Analysis			
ME (MJ/kg DM)	12.9	12.2	11.9
Crude protein (% as fed)	12.0	12.0	12.0
Crude Protein (% in DM)	14.0	14.0	14.0
Fibre (% as fed)	5.0	5.7	6.0
Oil % as fed)	2.5	2.0	2.0
Ash (% as fed)	6.5	7.2	7.2
Starch (% as fed)	38.8	36.1	33.5
Starch (% in DM)	45.1	42.0	39.0

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

Appendix 4

Performance results for Holstein and British Blue cross Holstein bulls

Breeds	**Holstein**	**B Blue x Holstein**
Slaughter wt (kg)	565	633
Age at slaughter (mo)	14.3	14.2
DLWG from birth (kg)	1.20	1.37
DLWG from 12 weeks old (kg)	1.29	1.50
Carcase wt (kg)	282	346
Kill out (%)	50.0	54.7
Carcase DG from birth (kg)	0.59	0.74
Conformation (1-7)	2.1	3.5
Fat class (1-7)	2.6	2.7
Carcase Price (£/kg)	3.02	3.36
Carcase Value (£)	851	1163
Number of bulls	42	6

Notes
Results for the British Blue x Holstein bulls must be treated with caution due to the low number of cattle. They are however 'typical' for British Blue x Holsteins intensively finished at Harper Adams

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

Kill out appears to be low however it must be noted that the bulls were weighed gut full' prior to slaughter and the carcases trimmed using UK Specification

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 2: Liver score 1 (left) and score 5 (right)

Appendix 6:

Carcase prices (£/kg) for bulls sold from October 2011 – January 2011

Conformation class	£/kg
R	3.25
O+	3.15
-O	3.00
P+	2.85