Harper Adams University Beef Unit – Management Summary 2017/18

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Introduction

The Harper Adams University beef unit has historically been based on finishing dairy-bred bull calves from the university's 400 head dairy herd. The cattle were finished intensively on a cereal beef system with concentrates fed *ad libitum* with straw to slaughter at 13-14 months old. The land around the campus is grade 2 quality and used for arable, vegetable and dairy production. Unfortunately beef production cannot usually generate the same level of income as these enterprises which restrict beef production to intensive systems with low land use or managed as a secondary enterprise. However we have been able to obtain grazing at our farm near Telford to enable us to change to a semi-intensive 18 month beef production system, and also land locally to evaluate a low cost outdoor high forage beef production system. Full details of this latter new system are given on page 11. Weaned suckled calves are also occasionally purchased for 'yard finishing'. The beef unit provides opportunities for trial work to be carried out, including projects for commercial organisations, education and demonstration purposes.

Reasons for Intensive Beef Production

There is good integration between arable, dairy and intensive beef production with the beef unit rearing calves from the dairy herd and using home grown cereals for feed, straw for bedding with the beef cattle supplying manure for the arable ground.

Most beef systems usually require a significant amount of working capital and therefore attention to all management aspects are a prerequisite for generation of profits. Profitability is very sensitive to the relationships between the purchase price of calves, feed costs and the sale value of the finished animal. Profitable beef production requires:

- A high standard of management
- Utilisation of home grown feed and efficient feed conversion
- Appropriate breed selection and use of easy calving high index sires
- A low fixed cost structure
- Focus on marketing.

Historically land at Harper could not be justified for a grazing based beef system so therefore an indoor finishing system offered the only opportunity for a beef enterprise at the University campus. This is now changing.

The Harper Adams Beef Unit

Cattle fed either via hoppers or troughs

Performance Summary

The performance results from some recently finished beef cattle at Harper Adams are summarized in table 1. Full gross margin details are shown in Appendix 1.

Table 1 – Recent cereal bull beef performance results Harper Adams

Breeds	British Blue x Holstein bulls	Holstein bulls	Angus x Holstein bulls
Slaughter wt (kg)	584	572	554
Age at slaughter (months)	13.3	13.3	12.8
DLWG from birth (kg)	1.33	1.31	1.32
DLWG from 12 weeks old (kg)	1.46	1.43	1.45
Carcase wt (kg)	330	288	289
Kill out (%)	56.5	50.5	52.2
Daily carcase gain from birth (kg)	0.75	0.65	0.69
Carcase classification	R-2+	O-2+	O+4=
Finishing concentrates	2,327	2,737	2,210
FCR (from 12 wks)	4.96	5.92	5.03

12 month old Holstein bulls

7/8th Bred Limousin suckled bulls

Beef Unit Management Summary

Calf Rearing

Batches of 40-50 calves are reared in October and January and form the basis of 4 BSc IV Honours Research Projects. See pages 13-14 for a full list of calf rearing research reports.

Achieving early and adequate intake of high quality colostrum is the single most important management factor in determining calf health and survival. Colostrum is rich in nutrients but most importantly immunoglobulins (Ig) or antibodies, which provide the calf with passive immunity.

The priority with new born calves is ensuring at least 2 litres of colostrum is fed within six hours of birth with 10% of body weight fed in the first 24 hours. Colostrum is then fed for the next 3 days and at 4 days old the calf is then fed either whole milk or milk replacer twice per day (approx. 2-2.5 litres per feed) to weaning at 6-8 weeks. Fresh water, clean bright straw and palatable good quality 18% crude protein (CP) early weaning concentrates are offered *ad lib* from 7 days old. Weaning is dictated by concentrate intake with 1kg/calf/day being the target.

The calves are involved in commercially sponsored feeding trials and are individually penned and bedded on straw and moved into groups of 8 - 12 calves post weaning. Calves are sometimes reared in groups on computerized machine feeding regimes which restrict the quantity of milk fed to levels similar to bucket feeding. Some batches of calves have been reared on *ad lib* milk from automatic feeders. This latter system produces very high growth rates to weaning, however milk intake can average 8-12 litres per day. Calf live weights at 12 weeks old tend to be approximately 10-15kg heavier compared to restricted milk feeding systems.

Harper Adams Calf Unit

Computerized machine group reared calves

Cereal Beef Production

The system is relatively simple to operate and involves feeding a concentrate diet *ad lib* to housed cattle to achieve high growth rates through to slaughter at 13-14 months of age.

With year round housing it is possible to rear bulls and therefore take advantage of their superior performance (+10%) above steers. A recent study has just compared the performance of bulls versus steers (see Trial Report 2017(c) for further details). The system suits late maturing breed types although it is possible to finish Continental x heifers, albeit at relatively light (approx 260kg) carcase weights. It is the most appropriate beef production system for Holstein bulls.

The calves enter the cereal beef unit at 12 weeks and are managed in groups of 8-10 per pen. Their early weaning concentrate is gradually changed to a 14% CP ration based on rolled barley which is offered *ad lib*. At 275kg liveweight the CP level is reduced to 12% with Holstein bulls. Typical rations fed at Harper Adams are shown in Table 2.

Table 2 – Harper Adams Cereal Beef Rations

	Crude Protein (% as fed)	
Feeds (kg/t)	**12%**	**14%**
Lightly Rolled Barley	750	685
Soya/distillers (50:50)	75	140
Beet Pulp or Soya Hulls	100	100
Molasses	50	50
Intensive Beef Minerals	25	25
ME (MJ/kg DM)	12.9	12.8
Starch (% in DM)	40.2	36.9

Barley is a key nutrient for the system. It provides high levels of energy from starch which optimises both daily live weight gain (DLWG) and feed conversion ration (FCR). It is lightly rolled (not ground) which helps prevents rapid fermentation and therefore minimises problems with acidosis. Feeding whole grain cereal results in a significant proportion of the grains passing through the animal undigested.

Up to 50% of the barley can be replaced with wheat if required. Beet pulp or Soya Hulls are included at 100kg/t since trials at Harper Adams have shown that this can have a positive effect on DLWG. Molasses is included as an energy source but mainly to dampen dust to help minimise associated respiratory problems. The ration is balanced to either 12 or 14% CP using a 50:50 mix of soya (44% CP) and distillers grains (28% CP).

An AHDB funded trial at Harper Adams evaluated the effect of protein level on the performance of 280kg Holstein bulls through to slaughter. Bulls were fed 12%, 14% or 16% CP rations. There were no significant differences between the treatments. See Trial Report 2008(a) for further details. The CP level in the Harper beef ration is therefore reduced from 14% to 12% from 275kg liveweight through to slaughter by reducing the soya/distillers to an inclusion rate of 75kg/t. Depending on the price of soya and distillers this can reduce the cost of the finished ration by £5-£13/t. However genetic improvement and sire selection for higher productivity and lean tissue deposition have substantially increased the protein requirement with Continental bred cattle and a recently completed study to evaluate 12% versus 14% CP rations with 320kg Continental x Holstein bulls recorded improved DLWGs (1.42 v 1.48kg) with feeding the higher CP ration. See Trial Report 2015(a) for further details. A study has also recently been complete to evaluate feeding elevated levels of digestible undegradable protein (DUP) to young bulls. See Trial Report 2015(c) for further details.

Continental x Holstein bulls

Charolais x Lim/Fr finishing heifers

Mineralisation of a cereal beef ration is vitally important especially to provide adequate calcium for bone development with a 'calcium to phosphorus ratio' of 1.5-2:1 in the finished ration. Proprietary minerals used within barley based rations should contain a high level of calcium (24%) low phosphorus and magnesium (3% or less) and 8-10% sodium together with the usual range of trace elements. Vitamins are also required with 300,000, 60,000 and 800 iu/kg for A, D_3 and E respectively. If moist grain is fed, the mineral should contain 1,500+ iu/kg of vitamin E.

Straw must be offered *ad lib* to provide long fibre for rumen function to minimize problems with bloat. Intakes are typically 0.3-0.9kg per day.

Bulls are slaughtered at target fat class 3 with Continental x Holstein heifers taken to fat class 4L in order to maximise carcass weight.

Relationship between Slaughter Weight and Feed Conversion Ratio (FCR)

It is well established that FCR deteriorates with increasing live weight. A point is reached within any cereal beef system that cattle start to lose money when daily feed costs exceed the value of live weight gain. Factors such as market requirements for both fat classification and slaughter weight must be taken into consideration, as well as the cost of the finishing ration. Typical growth rates, feed intakes and FCR's for Holstein bulls are shown in Table 3. The deterioration in FCR with Continental cross bulls takes place at heavier weights.

Table 3 – Typical monthly growth rates, feed intakes and FCRs for Holstein Bulls

Age (months)	Weight (kg)	DLWG (kg)	Daily feed intake (kg)	DMI % of body weight	Feed per month (kg)	FCR
3	**110**	1.25	3.8	2.55	116	3.05
4	**148**	1.38	4.5	2.25	137	3.27
5	**190**	1.64	5.5	2.14	168	3.36
6	**240**	1.80	6.5	2.00	198	3.60
7	**295**	1.64	7.0	1.75	214	4.27
8	**345**	1.48	7.5	1.61	229	5.08
9	**390**	1.36	8.3	1.56	252	6.29
10	**430**	1.31	9.0	1.55	275	6.86
11	**470**	1.20	9.8	1.53	297	8.50
12	**505**	1.15	10.5	1.54	320	9.15
13	**540**	0.98	11.4	1.56	348	11.59
14	**570**			**Total**	**2,553**	

The above feed intakes relate to cereals. They do not include straw which is approximately 0.3kg per head per day at 3 months old and 0.9kg at 13 months old. Calculation of the optimum slaughter weight must also include items such as interest charges and sundry costs such as bedding etc. However the most appropriate option is usually to sell Holstein bulls a soon as they fall into the minimum acceptable fat class.

Performance Targets

Targets for cereal fed dairy-bred beef cattle are shown in Table 4

Table 4 - Cereal Beef System Targets for dairy-bred Calves

	Holstein bulls	Continental x Holstein bulls	Continental x Holstein heifers
Slaughter age (months)	14	14	13.5
Slaughter wt (kg)	570	600	480
DLWG from birth (kg)	1.24	1.31	1.07
DLWG from 12 wks old (kg)	1.35	1.40	1.15
Carcase wt (kg)	285	335	260
Daily carcase gain from birth (kg)	0.67	0.78	0.63
Killing out %	51	56	54
Carcase classification	-O3	O+/R3	O+4L
Finishing concs (t)	2.55	2.42	2.00
FCR (3 months-slaughter)	5.5	5.0	5.4

Notes: Killing out % based on 'gut full' weight and UK carcase dressing specification.

The majority of the meat trade which supply supermarkets will penalise lightweight (below 260kg) carcasses produced by intensively fed heifers. The main market outlet for this type of carcase should be the small 'local' butcher. Early maturing beef bred heifers should not be reared on an intensive beef system.

Early maturing beef bred bulls such as Hereford and Aberdeen Angus crosses will typically finish at carcase weights under 260kg at fat class 4L. However, the recent introduction of Canadian genetics into some of the Aberdeen Angus and Hereford bloodlines can enable these breed types to achieve higher carcase weights and a recent batch of Hereford x Holstein bulls recorded an average carcase weight of 313kg.

Crimped grain maize

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. In 2009/10 a batch of bulls were finished on grain maize and recorded significantly higher DLWGs than bulls fed on rolled barley. Full details are available in Trial Report 2010(c).

Co-product feeds

Other alternative feeds to rolled barley are co-product feeds such as Brewers Grains and Traffordgold. In 2009 a batch of bulls were finished on a blend of Traffordgold, processed bread and beet pulp. Full details are available in Trial Report 2009(a).

Purchased suckled calves

When pens are available weaned suckled bull or steer calves at 7-10 months old are purchased for intensive yard finishing. The preference is to buy ¾ Continental cross suckled calves and to buy them direct from the breeder thus minimising stress and disease risk. The stipulation when buying weaned calves is that they must have been fed *ad lib* creep feed for at least one month prior to purchase and vaccinated against the main respiratory viruses i.e. BVD, RSV, IBR and Pi3 plus the clostridial diseases. On arrival at Harper Adams the cattle are not put under any stress and are housed in well-ventilated straw-bedded yards with access to good quality forage with concentrates gradually built up to *ad lib*. After about 14 days when they are first weighed they are treated with an anthelmintic to protect against external and internal parasites including liver fluke.

Targets for intensively finished suckled calves are shown in table 5.

Table 5 - Cereal Beef System Targets for Late Maturing Breed weaned Suckled Calves

	Bulls	Steers	Heifers
Weaned calf @ 8 months old (kg)	360	340	310
Slaughter age (months)	14	13.5	13.5
Slaughter wt (kg)	650	590	540
DLWG wean to slaughter (kg)	1.60	1.49	1.37
Carcase wt (kg)	385	330	290
Daily carcase gain from birth (kg)	0.90	0.79	0.76
Killing out %	59	57	55
Carcase classification	-U/U+3	R/-U3	R4L
Concentrates (kg)	1,800	1,525	1,400
FCR (kg feed: kg gain)	6.00	6.22	6.36

With dairy-bred bulls slaughter should be dictated by FCR and fat cover, with most bulls slaughtered below 600kg. However with ¾ Continental bred suckler bulls work by Keady and Kilpatrick (2006) has shown that these bulls can be taken up to weights of 800kg (460kg carcase) without a significant deterioration in FCR with growth rates at a constant 1.4-1.5kg/day from weaning on an intensive cereal finishing system. Slaughter can therefore be dictated by the carcase weight required by the market.

A key factor influencing profitability with any beef production system is to rear cattle bred from good quality easy calving high index (EBV) bulls.

Silage Beef Production

This system is based on feeding *ad lib* forage plus a restricted quantity of concentrates to achieve moderate-high growth rates through to slaughter at 14-16 months of age. The success of the system is based on feeding very good quality (11.0+ ME MJ/kg DM) forage. Like the cereal beef system with year round housing it is possible to rear bulls. The system suits late maturing breed types. Compared to the cereal beef system, lower growth rates are achieved, however cattle tend to be slaughtered older at slightly heavier weights. Some markets penalize bulls over 16 months old which needs to be taken into consideration. Target performance is shown in table 6. The silage can be either grass, maize or whole crop. The choice of which forage to grow will depend primarily on yield and feed value for the locality, but it MUST be good quality silage.

Table 6 - Target Performance for Continental x Holstein bulls calves reared on Intensive Beef Systems

	Cereals	Grass Silage	Maize Silage
Start wt @ 12 wks old (kg)	120	120	120
Slaughter age (mo)	14	15.5	15.5
Slaughter wt (kg)	600	630	630
DLWG from 12 wks old (kg)	1.40	1.35	1.35
Carcase wt (kg)	335	345	345
Killing out %	56	55	55
Forage (kg)	300 (straw)	6,000 @ 25% DM	5,000 @ 30% DM
Rolled barley (kg)	1,985	1,170	825
35% CP Concs (kg)	365	130	275

Silage Quality

Silage must be well made with good intake characteristics and fed *ad lib*. The key factor dictating cattle growth rates is the energy (ME) content of the silage as shown in table 7.

Table 7 – Effect of silage energy content on level of concentrate supplement required for a 400kg bull gaining 1.2kg/day

ME content (MJ/kg DM)	11.2	10.9	10.6	10.2	9.9	9.6	9.3
Concs (kg/head/day)	1.9	2.3	3.1	3.9	4.5	5.0	5.5

The crude protein content of the concentrates is dependent on the forage. With grass silage, concentrates can simply be mineralised rolled barley. With maize silage and fermented whole crop the concentrates should contain 16-18% crude protein.

Maize Silage for Beef Cattle

In 2008/09 a batch of bulls were finished on some good quality maize silage fed either 50:50 or 75:25 on a dry matter basis with concentrates. The rations were balanced to contain an overall CP content of 14% (in the DM). There was no benefit from feeding a higher level of concentrates. The proviso on this comment is that the maize was very good quality @ 33.9% DM, 11.3ME and 30.5% starch. The bulls recorded carcase weights of 295kg and were 15.2 months old at slaughter compared to 13-14 months for our cereal fed bulls. See Trial Report 2009(b) for full details.

In 2016/7 a batch of British Blue x Holstein heifers were finished on *ad lib* maize silage plus 3.2kg/h/d of concentrates in a total mixed ration (TMR) on a study to evaluate feeding elevated levels of protein. The heifers finished at 15.3 months old at carcase weights of 272kg grading R-3+. See Trial Report 2017(g) for full details.

Whole crop for beef cattle

Bulls can be successfully finished on whole crop. Winter wheat is the preferred cereal for whole crop. Fermented whole crop should be made with the crop ‘green going yellow’ and the grain texture of soft cheddar. At Harper Adams, fermented whole crop is typically made with winter wheat in mid-late July. Cracked urea treated whole crop (Alkalage) is made at 75-85% DM with a very hard grain texture and made in mid-August about 7 days prior to conventional harvest with a forager with a grain processing mill in order to crack the grains. Increasing the cutting height increases the energy and starch content of Alkalage and minimizes the use of concentrates. In 2003 and 2005 experiments were carried out to compare the performance of Continental x beef cattle finishing on various types of whole crop. The results are detailed in trial reports 2003(b) and 2005(a).

Rosé beef production

In 2013 a batch of Holstein bulls were reared on a Rosé beef system fed *ad lib* beef nuts. The definition of Rosé beef is that age of slaughter is under 12 months old (veal is defined as up to 8 months old). Compared to traditional cereal finished Holstein bulls, the Rosé Holstein bulls recorded higher ($P<0.01$) DLWGs and were slaughtered at significantly lower ($P<0.01$) slaughter and carcase weights with a lower ($P<0.05$) fat classification. The FCR (kg feed: kg LW gain) of the Rosé bulls was improved from 5.72 to 5.14 with total concentrate feed intakes reduced by 443kg/bull. The gross margins per bull were similar however with the earlier slaughter of the Rosé bulls the margin per bull place was improved by £48. A market outlet should be secured before entering into Rosé Beef production since many abattoirs do not accept bulls under 12 months old. See trial report 2013(a) for further details.

Semi-intensive beef production

At our tenanted farm at Telford the batch of October born beef calves are summer grazed and reared on a semi intensive beef production system. The first batch of calves will be finished in spring

2018 and the target is to finish our Blue and Simmental cross Holstein/Friesian steers at 17 months old @ 625kg (345kg carcase).

Attention is focused on the following key areas:

- Winter forages made with sufficient feed value to minimise/eliminate concentrate feed use.
- Maximising performance at grass on clover rich pastures with target sward heights of 7-9cm throughout the grazing season
- Rearing progeny from 'High Index' Beef Bulls. A Simmental bull is used for AI on the cows. We also have a Hereford stock bull on the farm to serve PD- low yield cows and replacement heifers following AI programmes. Details of the bulls are as follows:
    - The Simmental AI bull currently used is Keeldrum Clio from Genus. Clio has an EBV for Calving Ease Direct of +12.3% putting him in the top 1% for the breed, short gestation length (-5 days) and +63kg for his 400 day wt (top 30%) with a Terminal Index of +85 (top 10% for the breed).
    - The Hereford stock bull is Normanton 1 Leopold. When we bought him he had an EBV for Calving Ease Direct of +4.4% (top 5%) and Eye Muscle Area of +3.1sq cm (top 5%) with a Terminal Index of +30 (top 10% for the breed).
- Out-wintering on forage brassicas or root crops to minimise fixed costs

Low cost outdoor forage system for dairy-bred beef

An AHDB funded study on a low cost dairy beef production system has just commenced at Harper Adams University working alongside ADAS and co-sponsored by Dunbia and The Hereford Cattle Society. The objective of the study is to undertake a detailed investigation into the feasibility of rearing and finishing Hereford x Holstein-Friesian and Holstein-Friesian autumn born steers using predominantly grass and fodder beet, with minimal reliance on cereals or other bought in concentrates apart from the initial rearing of the calf.

The project aims to create low cost intensive grass and forage based system which will maximise stocking rates through the use of intensive rotational grazing and out-wintering on fodder beet. This latter crop will also allow for a higher than expected animal winter growth rate, therefore allowing stock to be finished off grass comfortably at 20-21 months of age. By maintaining a rotational grazing system grass quality will be maintained throughout the season allowing for consistent above average growth rates. The project will look closely at the transition of the autumn born calves firstly to grass with an early turnout in the spring and then the transition of the cattle to the fodder beet. Furthermore the project will aim to finish cattle before they are required to go through a second winter after the first year on fodderbeet. The study involves 35 Hereford x Holstein-Friesian and 35 Holstein-Friesian October born steer calves. Full details will be available in due course and visitors are welcome to see the cattle.

Calves on the low cost outdoor system

Paddock grazing clover rich swards

Current Trial work

Shown below are the trials planned for 2017/18 at Harper Adams:

- Evaluation of the replacement of concentrates with maize silage with 400kg continental dairy-bred finishing steers.
- Evaluation of the replacement of concentrates with maize silage with weaned suckler-bred steers.
- Evaluation of the performance of late maturing suckler bred steers sired by bulls with either high or low terminal indexes (EBVs).
- 'Calf to carcase on a low cost outdoor forage system' for October born Hereford x Friesian and Holstein-Friesian steers finishing at 21 months old (funded by AHDB, Hereford Cattle Society and Dunbia).
- Evaluation of suckler bred progeny from Hereford bulls with either high or low Terminal Indexes (EBVs).
- Evaluation of a transitional milk replacer on the performance of artificially reared dairy-bred beef calves to 12 weeks (funded by Bonanza Calf Nutrition).
- Effect of feeding either hay or straw on the performance of artificially reared dairy-bred beef calves to 12 weeks (funded by Bonanza Calf Nutrition).

Previous Years Trials

A number of trials have been carried out over recent years and include the following:

Breeding & Beef Systems

2017(a) Evaluation of progeny from Simmental bulls with either top 1% or top 10% terminal indexes.
2017(c) Comparison of the performance and meat quality of bulls versus steers.
2016(e) Evaluation of progeny from terminal and maternal Simmental bulls.
2013(a) Evaluation of Rosé and Cereal Beef Production for Holstein bulls and Cereal Beef Production for Angus x Holstein bulls.
2012(d) Evaluation of progeny from Angus bulls with Top 10% and Top 70% Terminal Indexes.
2007(c) Evaluation of progeny from Limousin bulls with Top 1% and Bottom 1% Beef Values.
2006(c) Evaluation of progeny from Limousin bulls with Top 1% and Top 10% Beef Values.
2000 (a) Evaluation of progeny from Top 10% and Bottom 25% Beef Value Limousin bulls.
1997(a) Comparison of the performance of bulls, steers and heifers.
1996 Preliminary evaluation of the Parthenais beef breed.

Nutrition

2017(b) Evaluation of the total replacement of barley with wheat with diets containing nutritionally improved straw on the performance of intensively finished bulls.
2017(g) Evaluation of 125 and 160g crude protein/kg DM rations for 8 month old 300kg Continental heifers finished on maize silage.
2016(d) Evaluation of the partial replacement of barley with maize meal on the performance of intensively finished bulls.
2016(a) Partial replacement of barley with wheat and soya hulls with nutritionally improved straw (NIS) with 240kg dairy bred bulls.
2015(c) Evaluation of increasing the digestible undegradable protein (DUP) supply to 135kg cereal fed dairy bred bulls.
2015(a) Evaluation of 12% and 14% crude protein rations for 300kg intensively finished Continental dairy-bred bulls.
2014(c) Evaluation of the partial replacement of wheat and rapeseed meal with distillers grains

and increasing the digestible undegraded protein content of beef rations with AminoMax-R for intensively finished dairy-bred bulls.

2014(b) Evaluation of 13% versus 16% crude protein creep rations for Autumn born suckled calves.

2013(b) Effect of reducing the starch content of cereal based rations by the partial replacement of barley with soya hulls for intensively finished bulls.

2012(a) Oats for intensively finished bulls.

2012(b) Effect of feeding a Yeast Culture (Diamond V XPLS) on the performance of intensively finished bulls.

2011(b) Alkagrain for finishing beef cattle.

2010(c) Crimped grain maize for finishing beef cattle.

2009(a) Evaluation of Traffordgold, Bread and Sugar Beet Feed mix on the performance of intensively fed bulls.

2009(b) Effect of concentrate feed level on the performance of maize silage fed bulls.

2008(a) Effect of dietary crude protein level on the performance of cereal fed Holstein bulls.

2008(b) Evaluation of rapeseed meal and a urea based concentrate (Promol 80) for cereal fed beef cattle.

2008(e) Evaluation of out-wintering systems based on stubble turnips for replacement heifers.

2006(b) Effect of feeding a compound feed with high or low starch content on the performance of intensively Holstein bulls.

2005(a) Evaluation of head-cut whole crop wheat and barley for finishing beef cattle.

2004(a) Evaluation of Acid Buf on the performance of cereal fed beef cattle.

2004(b) Evaluation of Yea-Sacc[1026] on the performance of cereal fed beef cattle.

2004(c) Evaluation of CRINA® on the performance of cereal fed beef cattle.

2003(b) Whole crop wheat for intensively finished beef cattle.

2001(b) Processed urea-treated whole crop wheat (Alkalage) for beef cattle.

2000(b) Fermented whole crop wheat for beef cattle.

1999(a) Evaluation of a moist co-product mix (Praize) for intensively finished suckled bulls.

1999(b) Protein levels for intensively fed beef cattle.

1998 Evaluation of Co-product rations to finish heifers at high slaughter weights.

1997(b) Pressed sugar beet pulp ensiled with barley distillers grains for intensively finished beef cattle.

1995 Co-product feeds for intensively finished beef cattle.

1994 Evaluation of barley distillers dark grains and Molassed Sugar Beet Feed for intensively finished beef cattle.

1993 Evaluation of moist crimped barley for intensively fed beef cattle.

1992 Evaluation of Molassed Sugar Beet Feed for intensively finished beef cattle.

Calf Rearing

2017(d) Evaluation of feeding elevated levels of milk replacer (600 v 900g) on the performance and health of artificially reared beef calves to 12 weeks.

2017(e) Effect of feeding elevated levels of milk replacer (750 v 900g) on lifetime performance of intensively finished bulls.

2017(f) Evaluation of diurnal feeding patterns of milk on the performance and health of artificially reared beef calves to 12 weeks.

2016(c) Evaluation of feeding elevated levels of milk replacer (750 v 900g) on the performance of artificially reared beef calves to 12 weeks.

2016(b) Evaluation of nutritionally improved straw (NIS) in calf concentrates on the performance of beef calves to 12 weeks.

2015(b) Evaluation of Sodium Butyrate on the performance and health of artificially reared beef calves to 12 weeks.

2014(d) Evaluation of calf coats (Holm & Laue) on the performance and health of artificially reared beef calves to 12 weeks.

2014(a) Evaluation of early weaning concentrate quality on the performance and health of artificially reared beef calves to 12 weeks.

2103(c) Evaluation of feeding high (750g) or standard (500g) levels of milk replacer on the performance of artificially reared beef calves to 12 weeks.

2013(d) Teat versus bucket feeding systems for calves.

2012(c) Effect of rearing purchased calves on either milk replacer containing 20% CP fed once per day or milk replacer containing 26% CP twice per day.

2012(e) Effect of milk replacer oil content on the performance and health of dairy-bred beef calves to 12 weeks.

2011(a) Effect of feeding a Yeast Culture (Diamond V XPLS) on the performance of artificially reared dairy-bred bull calves.

2011(c) Effect of once or twice per day milk replacer feeding systems on performance of purchased 3 week old dairy-bred beef calves to 12 weeks.

2010(a) Evaluation of skim and whey based milk replacers.

2010(b) Effect of early weaning concentrate pellet size on the performance of artificially reared dairy-bred bull calves.

2008(c) Effect of feeding either a coarse mix or pelleted early weaning concentrates to bucket reared calves.

2008(d) Effect of weaning dairy-bred calves either gradually or abruptly.

2007(a) Effect of rearing calves either individually in pens and bucket fed milk twice per day or group housed and fed a computerized machine.

2007(b) Comparison of once versus twice per day milk replacer feeding systems with 5 day old bucket reared calves.

2006(a) Effect of weaning calves at low (0.75kg) or high (1.25kg) levels of concentrate intake on performance to 12 weeks of age.

2003(a) Feeding either high (750g) or low (450g) levels of milk replacer to dairy-bred beef calves to weaning at 6 weeks old.

2002 Feeding either whole milk or milk replacer and weaning dairy-bred beef calves at either 6 or 8 weeks old.

2001(a) Yeast cultures (Diamond V XPLS Yeast) for artificially reared beef calves.

1999(c) Comparison of weaning dairy bred calves at either 5 or 7 weeks old & Comparison of whole milk versus calf milk replacer for dairy bred calves weaned at 5 weeks old.

Copies of most of the above trial reports can be found on the National Beef Association (NBA) website (go to Resources>Technical Information section) and are available from Simon Marsh (Tel: 01952 815213, E-mail: smarsh@harper-adams.ac.uk).

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Appendix 1.

Harper Adams Beef Unit - Gross Margins - 2016/17

Stock: Sept-Oct 2015 born British Blue x Holstein bulls slaughtered Oct-Dec 2016

Financial performance (£/bull)	Blue x Hol
Output	
Sales	1,115
Less calf purchase	245
Total Output	**870**
Variable Costs	
Calf rearing costs to 3 months	103
Finishing concentrates	451
Vet & medicines	7
Bedding & other costs	22
Total Variable Costs	**583**
Gross Margin/Head	**287**
Physical Performance	
Age at slaughter (months)	13.3
Birth wt (kg)	46
Slaughter wt (kg)	584
DLWG (kg from birth)	1.33
DLWG (kg from 12 weeks old)	1.46
Carcase wt (kg)	330
Daily carcase gain (kg from birth)	0.75
Daily carcase gain (kg from 12 weeks)	0.86
Killing out %[1]	56.5
Carcase classification	R-2+
Feeds (kg)	
Milk replacer @ £1,500/t	29
Calf concs @ £280/t	145
Finishing concentrates	2327
FCR (kg feed/kg gain)	4.65
FCR (12 weeks - slaughter)	4.96
Prices	
Sale price (£/kg live weight)	1.91
Sale price (£/kg carcase weight)	3.38
Finishing concs (£/t)	194

Supplementary Information:
Bulls from 7 months old finished on a trial to evaluate NIS in wheat based diets. See Trial Report 2017(b) for further details.

[1] Killing out percentage appears relatively low however it must be noted that the bulls were weighed 'gut full' prior to slaughter.

Stock: Jan-Feb 2016 born Holstein (n = 24), British Blue x Holstein (n = 6) and Hereford x Holstein (n = 4) bulls and steers slaughtered Feb-May 2017

Financial performance (£/bull)	Bulls	Steers
Output		
Sales	913	888
Less calf purchase	71	71
Total Output	**842**	**817**
Variable Costs		
Calf rearing costs to 3 months	103	103
Finishing concentrates	444	443
Vet & medicines	7	7
Bedding & other costs	19	19
Total Variable Costs	**573**	**572**
Gross Margin/Head	**269**	**245**
Physical Performance		
Age at slaughter (months)	14.2	14.4
Birth wt (kg)	43	43
Slaughter wt (kg)	580	565
DLWG (kg from birth)	1.24	1.19
DLWG (kg from 12 weeks old)	1.33	1.28
Carcase wt (kg)	299	286
Daily carcase gain (kg from birth)	0.63	0.61
Daily carcase gain (kg from 12 weeks)	0.71	0.66
Killing out %[1]	51.6	50.6
Carcase classification	O-/O= 2+	O-/3-
Feeds (kg)		
Milk replacer @ £1,500/t	24	24
Calf concs @ £280/t	145	145
Finishing concentrates	2538	2534
FCR (kg feed/kg gain)	5.04	5.18
FCR (12 weeks - slaughter)	5.46	5.57
FCR (kg feed: kg carcase gain)	8.49	8.86
Prices		
Sale price (£/kg live weight)	1.57	1.57
Sale price (£/kg carcase weight)	3.05	3.10
Finishing concs (£/t)[2]	175	175

Supplementary Information:
See Trial Report 2017(c) for further details.

[1] Killing out percentage appears relatively low however it must be noted that the bulls were weighed 'gut full' prior to slaughter.
[2] From 3 months to slaughter cattle fed *ad lib* 14% CP 32% starch Wynnstay Primebeef nuts.

Stock: Jan-Feb 2016 born British Blue x Holstein heifers finished on maize silage plus 3.2kg concentrates containing either 160 or 125 g CP/kg DM in the TMR. Slaughtered Feb-May 2017

Financial performance (£/head)	**160 CP**	**125 CP**
Output		
Sales	951	876
Less calf purchase	134	134
Total Output	**817**	**742**
Variable Costs		
Calf rearing costs to 3 months	103	103
Rearing concentrates	109	109
Finishing concentrates	161	136
Maize silage	94	101
Vet & medicines	7	7
Bedding & other costs	22	22
Total Variable Costs	**496**	**477**
Gross Margin/Head	**321**	**265**
Physical Performance		
Age at slaughter (months)	15.1	15.5
Birth wt (kg)	39	39
Slaughter wt (kg)	539	523
DLWG (kg from birth)	1.09	1.02
DLWG (kg from 12 weeks old)	1.13	1.05
Carcase wt (kg)	277.1	268.4
Daily carcase gain (kg from 12 weeks)	0.60	0.56
Killing out %[1]	51.4	51.3
Carcase classification	R-3+	R-3=
Feeds (kg)		
Milk replacer @ £1,500/t	24	24
Calf concs @ £280/t	135	135
Rearing concentrates	621	621
Finishing concs (£/t)[2]	689	723
Maize silage (kg DM)	893	959
FCR (kg feed DM/kg gain)	4.74	5.11
FCR (12 weeks - slaughter)	5.14	5.58
Prices		
Sale price (£/kg live weight)	1.76	1.68
Sale price (£/kg carcase weight)	3.43	3.27
Rearing concs (£/t)[2]	175	175
Finishing concs (£/t)[3]	234	188

Supplementary Information:

See Trial Report 2017(g) for further details.

[1] Killing out percentage appears relatively low however it must be noted that the heifers were weighed 'gut full' prior to slaughter.
[2] From 3 months to 8 months old heifers fed *ad lib* Wynnstay Primebeef nuts plus straw.
[3] From 8 months to slaughter heifers fed concs containing either 19 or 27% CP including Hipro soya.