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DAIRY CALF-TO-BEEF PRODUCTION SYSTEMS

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Preface

Over the years much research effort has been devoted to the development of beef production systems at Grange Beef Research Centre. Based on earlier work by Dr. Joe Harte and his colleagues, an integrated 2-year-old dairy calf-to-beef system was established by Dr. Vincent Flynn at Ballinalack (then a field station of Grange) in the late 1970s. It comprised of Friesian steers slaughtered at about 290 kg carcass weight. Since then, other breed types have been evaluated and systems other than 2-year-old have been developed. Much of the component research data underpinning these systems has been published in the scientific literature and in various research reports from Grange but relatively little has been written about the systems themselves in their entirety. That is the purpose of this publication.

In practice, every beef farm has its own individual production system and no two are identical. Furthermore, even on the same farm, the outcome for the same system will differ from year to year. Therefore, description of a generic production system can be no more than a skeleton or framework within which a complete production cycle takes place. The targets should be seen as guidelines, recognising that the outcome will vary amongst farms and years for the same system. Similarly, the inputs should be considered as averages over the production cycle and over years. For example, the distribution of fertiliser N will vary between silage and grazing and across the grazing season in different years. Likewise, the total concentrate allowance will differ between years and its distribution between the various production phases will also differ.

This publication includes only the guidelines or targets for the different production systems. Details on all other aspects such as breeds, nutrition, health, management, carcass and meat quality can be found elsewhere in publications from this and other research centres, both within Teagasc and abroad.

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1. Introduction

The 2003 reform of the EU Common Agricultural Policy (CAP) resulted in the decoupling of premia (headage subsidies) from animals. These premia and any associated payments were converted to a single farm payment (SFP), based on historical premia receipts and the area farmed.

Following these reforms, to remain viable, beef production systems must return positive gross margins independent of the SFP. Prior to 2003, there were many constraints on beef production because of the necessity to comply with the eligibility criteria for the premia. Two-year-old steer beef systems were favoured because of the need to retain the animals for the second special beef premium (SBP). Stocking rate was constrained because there was a stocking rate ceiling for SBP compliance, and it generally made good economic sense to be eligible for the extensification premium also. Total premia payments could amount to €600 per male animal or up to €1000 per ha. Independent of the premia, the profitability of these systems was low and sometimes negative. The low profitability was to some extent due to extra compliance costs associated with premia eligibility but it was also due to excessively high calf prices because of their potential to draw down premia rather than their potential for profitable production. In the current policy environment, the beef systems of choice should be those that leave good profit margins and the purchase price of calves should reflect their value for beef production.

2. Features of Dairy Beef Production

2.1. Source of calves

The national cow herd is fairly evenly divided between dairy and beef cows. Thus, about half of the total animals for beef production come from the dairy herd, which is almost entirely Holstein-Friesian. Of the 2.13 m calves registered (in 2006), 1.08 m were from dairy cows. These comprised of 42.0 % pure Holstein-Friesians, 7.5 % other dairy breeds and crosses, 12.8 % Hereford crosses, 15.6 % Angus crosses, 3.3 % Charolais crosses, 3.3 % Simmental crosses, 9.1 % Limousin crosses, 3.5 % Belgian Blue crosses and 3.1 % other. Thus, there is a wide range of calf breed types available for beef production.

For both beef and dairy cows there is a pronounced seasonality of calf births with the majority of calves born in spring. About 84 % of all dairy calves are born in the first 5 months of the year with 66 % born in the 3 month period February to April inclusive. Beef production systems are largely defined by the season of birth and the season of finish for slaughter. For example, spring-born animals slaughtered at around two years of age are predominantly finished indoors in their second winter. Similarly, animals slaughtered at 18-21 months, or at 27-30 months, are normally finished off pasture in the second or third grazing seasons, respectively.

Despite the marked decline in the national incidence of BSE, testing of older animals is likely to continue, at least in the medium term. Ideally, prime beef cattle should be slaughtered at less than 30 months of age, so no over 30-month production systems are considered here.

2.2. Definition of Breed Types

The terms “early maturing”, "Holstein-Friesian", and "late maturing" are used here to describe the different biological types, but there are large differences between the individual breeds that comprise these types. Early maturing types consist mainly of Angus and Hereford crosses and the performance data used here represent both reasonably well. Holstein-Friesians comprise a wide range of types from extreme high dairy merit Holsteins to dual purpose type British/Irish Friesians. The main differences between these extremes are in kill-out proportion and carcass conformation. Compared with Friesians, high dairy merit Holsteins have a lower kill-out proportion and poorer carcass conformation. In addition, all measures of fatness are lower, and skeletal size is greater. Muscle size scaled for carcass weight, and hind quarter weight as a proportion of carcass weight, are similar for the two types. In terms of carcass composition, Holsteins have less fat, more bone and a similar muscle proportion to Friesians.

There are large differences between the different breed types in the late maturing category. Here it is assumed that the larger continentals such as Charolais and Belgian Blue crosses are used but other continental crosses have lower growth rates than these. Consequently, they have lighter carcasses, but conformation and leanness are generally similar to those for the larger breed types.

2.3. Breed Type and Slaughter Weight

Generally, the degree of fatness or finish is the main criterion determining fitness for slaughter. For pure bred young bulls of late maturing breed types, this is fat class 2 to 3 in continental EU countries. For cross bred steers in Ireland it is fat class 3 to 4. The ideal carcass fatness is determined by many factors. The greater the carcass fat proportion the slower the rate of cooling during chilling resulting in more tender meat. As fatness increases, both bone and muscle proportions decrease (the three components must always sum to 100 %). The decrease in bone is desirable as it has little commercial value but the decrease in muscle is not, as it is the main determinant of carcass value. However, meat as sold commercially comprises of muscle and varying proportions of fat. Thus, the decrease in muscle proportion with increasing fatness does not necessarily mean a decrease in commercial meat yield when portion of the extra fat can be included as meat. Accordingly, the optimum level of carcass fatness is that at which bone proportion is at a minimum, saleable meat (muscle plus fat) proportion is at a maximum and marbling or intramuscular fat proportion matches consumer requirements.

The two main production factors that affect carcass fatness and meat yield are breed type and slaughter weight. The only available commercial measure or indicator of fatness is carcass fat class. At any fixed carcass fat class, Holstein-Friesians are heavier than early maturing crosses, and continental crosses are heavier than Holstein-Friesians. For all breed types, carcass fat class increases with increasing weight but it does so faster for early maturing crosses than for Holstein-Friesians, and for Holstein-Friesians than for continental crosses.

2.4. Heifer Production

2.4.1. Calf availability

The national dairy herd produces about 540,000 heifer calves annually. Of these about 267,000 are from pure dairy breeds which remain in the dairy herd as replacements. The remaining 273,000 are beef crosses in an approximate ratio of 55:45 early maturing : late maturing breed types. These enter the beef industry. Some go as replacements in the suckler herd, some are exported live as calves or weanlings, and the remainder are reared for beef. As with the males, the vast majority are spring-born so the only heifer systems described here are for spring-born calves. For autumn-born calves, the early maturing steer system could be applied to continental cross heifers, and targets for early maturing heifers could be estimated pro-rata.

2.4.2. Performance relative to steers

Up until the onset of puberty there is little difference in the performance of artificially reared male and female calves. Males have a greater birth weight, an advantage they retain throughout life. At the end of the first grazing season, spring-born steer calves have a small weight advantage over heifers. Because animals are not fed to grow to their potential over the first winter, the difference in growth rate between steers and heifers is small. Thus, it is not until the animals exceed one year of age that steers and heifers really diverge in growth rate. Thereafter, to slaughter at the same level as fatness, steers grow on average about 12 % faster than heifers and the difference increases with time.

2.5. Standard Inputs and Practice

2.5.1 Nitrogen and slurry

For all the systems described here, the standard milk powder input is 25 kg per head. Fertiliser N application rates for 1st cut silage, 2nd cut silage, silage aftermath, early grazing and each top dressing of the grazing area are 115, 110, 34, 57.5 and 13.5 kg/ha, respectively. Thus, total fertiliser N use depends on the system stocking rate and varies with the proportion of the total land area used for silage, the number of silage cuts and the number of top dressings of the grazing area.

For all systems it is assumed that the slurry from the animals is returned to the system area according to best practice for optimisation of the nutrients. Maintenance levels of fertiliser P and K are applied as necessary.

2.5.2 Permitted N use

Calculating the level of fertiliser N allowed under the Nitrates Directive and the Rural Environment Protection Scheme (REPS) can be complex. Under the Nitrates Directive, a stocking rate above 170 kg organic N/ha requires a derogation. At or below the 170 kg/ha organic N ceiling, the total available N allowed is 226 kg. The available organic N is calculated as the product of the total organic N, the proportion of the year for which storage is specified (varies from 16 to 22 weeks in different counties) and the specified N availability. For cattle manure, the latter varies from 35 % from January 1, 2008 and from 40 % from January 1, 2010. Where derogations are available, the total available N is 306 kg/ha for organic N levels in the range 171 to 210 kg/ha, and 279 kg/ha for organic N levels in the range 211 to 250 kg/ha.

REPS can impose a greater constraint on fertiliser N use than the Nitrates Directive. In REPS 3, organic N production is constrained to 170 kg/ha and total N usage (including organic) is limited to 260 kg/ha, provided fertiliser N does not exceed organic N. Thus, for example, where organic N is < 130 kg/ha, total N allowed is restricted to double the organic N value. Fertiliser N use is less restricted in REPS 4 than in REPS 3 and can match organic N up to 170 kg/ha. Above 170 kg/ha organic N, fertiliser N use is determined by the N fertiliser plan agreed in derogation. Thus, production systems in which fertilizer N is marginal or limiting in REPS 3 are more easily managed in REPS 4 because of the greater availability of fertiliser N.

2.5.3 Parasite control

Calves are treated for the control of gastrointestinal parasites with a systemic anthelmintic at 3, 8 and 13 weeks after turn-out and again two weeks after housing. When gastrointestinal parasites are effectively controlled in calves there is usually no need for anthelmintic treatment at the yearling stage or subsequently. Other veterinary treatments are based on farm history and veterinarian recommendations.

2.5.4 Utilised silage and herbage

The yield of consumed 1st cut silage is taken as 4.9 t DM/ha and that of 2nd cut silage is taken as 3.7 t DM/ha. The yield of grazed herbage is taken as 7.0 t DM/ha.

3. Systems of Steer Production from Spring Born Calves

3.1. Standard System of Two-Year-Old Continental Steers

3.1.1. Overview

In this system, spring-born male animals are finished for slaughter as steers at around two years of age producing carcasses of acceptable weight and finish. The system can be operated within the Nitrates Directive and REPS 3 organic and total N constraints.

3.1.2. Inputs

The main inputs for this system are summarised in Table 1. Concentrate inputs are 25 kg milk replacer, 80 kg calf concentrates in the indoor rearing period, 60 kg concentrates at pasture in the first grazing season, 110 kg concentrates in the first winter and 750 kg concentrates in the finishing winter (total concentrates 1 t). The remaining feed comes from the system land area in the form of 2.45 t dry matter (DM) of grazed grass (0.66 t DM in the first grazing season and 1.79 t DM in the second grazing season, and 1.46 t silage DM (0.50 t DM in the first winter and 0.96 t DM in the second winter). Assuming the specified yield of 4.9 t DM/ha of consumed silage, the silage area required per animal unit (finisher + weanling) is 0.30 ha cut once.

The grass intake of the yearlings and calves in the early part of the grazing season is 8.5 kg and 2.2 kg DM per day, respectively. This is provided by 0.25 ha of grazing area per animal unit (yearling and calf) up to the time silage aftermath becomes available.

After the silage area becomes available the total grazing area per animal unit is 0.55 ha. Thus, the overall stocking rate on the system is 1.8 animal units per ha.

Table 1. Summary of inputs for spring-born continental x Holstein-Friesian steers in a standard two-year system.

Concentrates (kg)[1]		
Calf indoors	80	(varies with birth and turn-out dates)
Calf at pasture	60	(1 kg/day for 2 weeks after turn-out and for final 6 weeks)
Weanling – 1st winter	110	(1.5 kg/day for 8 weeks followed by 1kg/day for 4 weeks)
Finisher – 2nd winter	750	(5 kg/day for 147 days)
Total	**1000**	
Grazed grass (kg DM)		
1st season	660	(mean of 3.5 kg/day for 189 days)
2nd season	1790	(mean of 8.5 kg/day for 210 days)
Total	**2450**	
Silage (kg DM)		
1st winter	500	(mean of 4 kg/day for 126 days)
2nd winter	960	(mean of 6.5 kg/day for 147 days)
Total	**1460**	
Land		
ha per animal unit[2]	0.55	(0.30 silage, 0.25 grazing)
Animal units/ha	**1.80**	
Nitrogen (kg/ha)		
Organic N production	146	
Permitted fertiliser N (REPS 3)	114	
Permitted fertiliser N (REPS 4)	146	(or to limit of Nitrates Directive)
Fertiliser N used (kg/ha)		
Silage	115	
Aftermath	34.4	
Early grazing	57.5	
Top dressing (grazing)	13.5	
Total	**114**	

[1]Fresh weight; [2]Yearling + calf

3.1.3 Nitrogen

To operate within the N constraints of REPS 3, total N input must not exceed 260 kg per ha of which not more than 170 kg is from organic sources. Based on the standard inputs described earlier, the fertiliser N requirement is 115 kg/ha (5 bags of urea) for silage production, 34 kg/ha (2.5 bags of calcium ammonium nitrate (CAN)) for the aftermath, 57.5 kg/ha (2.5 bags urea) for spring grazing, and 13.5 kg/ha (1 bag CAN) for any subsequent top dressing.

Total organic N production at a stocking rate of 1.8 animal units per ha is 146 kg/ha, leaving an allowed fertiliser N input of 114 kg/ha. Of this, the silage and aftermath (55 % of total area) requires 82 kg/ha and early season grazing requires 26 kg/ha, leaving only 6 kg/ha available for top dressing of the grazing area. Clearly, while there is adequate fertiliser N available for silage, aftermath and early season grazing, the amount available for later season top dressing is limited. Nevertheless, the fertiliser N input outlined together with optimum slurry management should result in the production of sufficient herbage to meet the requirements of the animals. Under REPS 4, a higher level of fertiliser N is allowed at this stocking rate so N for top dressing is not limiting. Outside of REPS, where the permitted levels of fertiliser N use under the Nitrates Directive are higher, the availability of fertiliser N is more than adequate in all situations.

3.1.4 Animal performance

Target weights and weight gains for continental cross steers commencing the system at 50 kg live weight in mid March and slaughtered at two years of age are shown in Table 2. The values are applicable to the faster growing continentals such as Charolais and Belgian Blue crosses. Slower growing continentals have growth rates and live weights for age about 5 % lower than these.

Target live weight gain during the rearing period is 0.7 kg/day. Provided the calves remain healthy this level of performance is not difficult to achieve and results in a live weight of 90 kg at turn-out in mid May. The target live weight gain for the first grazing season is 0.8 kg/day. With a 1 kg/day concentrate allowance for the 2 weeks after turn-out and again for the final 6 weeks of the grazing season, this target should be achieved provided grassland management is good. The most difficult period in meeting the target gain is the final two months of the grazing season particularly if use of fertiliser N is restricted under REPS 3. Daily gain may fall below target late in the grazing season but, as it should have exceeded the target earlier, the overall target should be met giving a live weight at first housing of 240 kg. The target live weight gain during the first winter is 0.65 kg/day, resulting in a yearling turn-out weight of 320 kg.

Table 2. Target live weight gains and live weights for spring-born continental x Holstein-Friesian steers in a standard two-year system.

Date	No. days	Gain kg/day	Gain Total (kg)[1]	Live weight (kg)	Age (wks)	Event
March 15	-	-	-	50	-	Start calves
May 12	58	0.70	40	90	8	Turn-out 1st summer
Nov. 17	189	0.80	150	240	35	House for 1st winter
March 23	126	0.65	80	320	53	Turn-out 2nd summer
Oct. 19	210	0.90	190	510	83	House for 2nd winter
March 15	147	0.95	140	650	104	Slaughter
Total/Mean	**730**	**0.82**	**600**	**650**	**104**	
Carcass weight (kg)				**350 (kill-out 538g/kg)**		

[1]For period

For the second grazing season, the target live weight gain is 0.90 kg/day giving a second housing weight of 510 kg. In the weeks immediately after turn-out live weight gain may seem low because of the loss of gut contents, but thereafter it should exceed 1 kg/day for 3-4 months. Live weight gain declines towards the end of the grazing season but, because of the higher values earlier, the overall grazing season target should be achieved.

During finishing, the target live weight gain is 0.95 kg/day. In the early weeks of finishing when gut contents are increasing and before the animals enter the fattening phase, daily gain exceeds the target. Then, as feed intake reaches a plateau and fat deposition accelerates, the rate of gain declines. This is accentuated with increasing length of the finishing period.

Overall life time daily gain at 0.82 kg is well below the maximum growth potential of the animals but is sufficient to yield the target slaughter weight of 650 kg at two years of age.

3.1.5 Output

Output is summarised in Table 3. The slaughter weight of 650 kg yields a carcass of 350 kg. About 70 % of carcasses are in conformation class 'R' with 30 % in class 'O'. About 60 % are in fat class 3 with 40 % in class 4. Output per ha is 1170 kg live weight and 630 kg carcass weight.

Table 3. Summary of output for spring-born continental x Holstein-Friesian steers in a standard two-year system.

	Per animal	Per ha
Live weight (kg)	650	1170
Carcass (kg)	350	630
Conformation % R % O	70 30	
Fat class %3 %4	60 40	

3.1.6 Operation

This system is applicable to dairy farmers rearing their own calves or to beef farmers purchasing dairy calves. For the latter, the purchased calf is generally in excess of 50 kg live weight so a shorter rearing period with a lower milk replacer input will suffice. Assuming the system is operated on 100 ha farm unit, 180 calves (plus some extra to allow for mortality) are purchased and 180 finished cattle are sold annually (1.8 animal units per ha). Thus, at any one time there are 360 animals in the system (180 animals under 1 year of age and 180 animals 1 to 2 years of age).

The yearlings are turned out to pasture in late March. For two weeks after turn-out, they graze the area designated for silage (55 ha) and then move to the grazing area (45 ha). The grazing area is fenced into about 6 paddocks and the animals graze these in rotation to a post grazing stubble height of about 6 cm initially rising to 7 cm later in the season. Each rotation should be within the range of 24-30 days in duration. The shorter rotation applies to Spring/early summer and the longer to late Summer/Autumn. If grass growth is better than expected early in the year, one or more paddocks in the rotation should be skipped and later cut for silage. Conversely, if grass growth is slow early in the year, a portion of the silage area can be fenced off and used for grazing. Generally, when there is poor growth early in the season this is compensated for by increased growth later. Then, some additional area can be conserved for silage to compensate for the silage area grazed earlier. The main silage crop is harvested in late May and thereafter the entire area is available for grazing. Later in the season, any excess herbage can be conserved as silage bales. After the main silage cut is harvested, any slurry that has accumulated since spring application is spread and fertiliser N is applied. The area is fenced into a convenient number of paddocks, and incorporated into the grazing rotation. Thereafter, grazing cycle length is extended and a "wedge" of herbage is gradually built up ahead of the animals for use towards the end of the season as herbage production declines.

The calves are turned out to pasture in mid May and placed half a rotation ahead of the yearlings. This provides them with very high quality herbage and allows up to two weeks for the pasture to clean and regrow before it is grazed by the yearlings. The calves and yearlings move together in the rotation.

In early September, as the calves approach 6 months of age they are castrated, and from late September concentrates are fed at 1 kg per head daily until housing. The adults are housed in mid to late October and thereafter the calves have the entire area for grazing.

After housing, the adults are offered silage ad libitum plus 5 kg concentrates per head daily until slaughter. Because the silage is of high digestibility (harvested in late May), this level of concentrates is sufficient to achieve the target finishing gain. Alternative finishing strategies such as stepped concentrate feeding or ad libitum concentrate feeding towards the end of the finishing period can also be used.

The calves are housed in November and offered silage ad libitum plus 1.5 kg concentrates per head daily for 8 weeks followed by 1 kg/day for 4 weeks. Concentrates are withdrawn entirely for the final 6 weeks before turn-out in spring. Because silage quality is good the target rate of gain should be achieved.

3.1.7 Variation

While a mean date of mid March is taken for the start of the system, it is recognised that some calves are born earlier and some are born later. In theory, the starting date should not matter and the weight-for-age targets should hold irrespective of starting date. In practice this is only partly true. Calves that are born earlier, and are heavier at first turn-out, have higher live weight gains during the first grazing season and this advantage is retained thereafter. Calf performance is highly dependent on grass quality. With plenty of good quality herbage, live weight gain can reach 1 kg/day, whereas with inadequate or poor quality herbage, live weight gain can fall below 0.5 kg/day.

Performance during the first winter is the least critical of the targets, as compensatory growth will be exhibited subsequently at pasture if winter gain is below target. For every 100 g live weight gain/day below target in winter, performance during the following grazing season will be about 40 g/day above target. However, complete compensation is rarely achieved so there will be some reduction in slaughter weight for failure to achieve the first winter gain target.

Gains in excess of 1 kg/day are readily achieved in the first half of the second grazing season. The difficulty is in achieving reasonable gains in the second half of the season, when the animal requirements are higher and grass quantity and quality are lower. Some reduction in performance is unavoidable but live weight gain should not fall below about 0.7 kg/day at any stage in the grazing season. If grass is in short supply late in the season, the adult animals that are destined for finishing should be housed earlier, thus leaving more herbage available for the calves.

During finishing, rate of gain slows considerably after about 12 weeks but as kill-out increases, the reduction in carcass gain is proportionately less than that in live weight gain. Nevertheless, rate of carcass gain does decline and as this is the most expensive stage of the animal's life, it is important to ensure that the costs of carcass gain do not exceed its value. Therefore, in certain circumstances, it may be economically prudent to shorten the finishing period and slaughter at a lighter weight than indicated.

3.2 System of Two-Year-Old Friesian and Early Maturing Steers

3.2.1 Overview

This can be considered as one system using a 50:50 mix of Holstein-Friesians and early maturing beef x Friesians or as two systems, one for each breed type. The background information and general comments for the *Standard Continental Steer System* apply to this system also.

In this system, Holstein-Friesian steers are finished for slaughter at two years of age and/or early maturing cross steers are finished for slaughter at 22 months of age. Compared with continental crosses, Holstein-Friesians have about 5 % higher feed intake so, in theory, the land area for this system should be increased, or the stocking rate should be reduced by 5 %. This has not been done because in practice there is an adequate safety margin within the *Standard Continental Steer System* to accommodate the higher intake of the Holstein-Friesians. Furthermore, the Holstein-Friesians are lighter on average and this partially offsets their greater intake capacity.

3.2.2 Inputs

The main inputs are summarised in Table 4. For Holstein-Friesians, the inputs are the same as for the *Standard Continental Steer System*, namely 25 kg milk replacer, 1 t concentrates, 0.3 ha per animal unit for silage, 0.25 ha per animal unit for grazing and an overall stocking rate of 1.8 animal units per ha. Because of earlier finishing, the silage requirement of the early maturing crosses is 0.4 t DM less than for Holstein-Friesians. Thus, a silage area of 0.22 ha per animal unit is sufficient allowing stocking rate to be increased to 2.1 animal units per ha. The concentrate input for early maturing crosses is 670 kg (330 kg less than for Holstein-Friesians).

3.2.3 Nitrogen

Organic N production and fertiliser N availability for the Holstein-Friesian system are the same as for the *Standard Continental Steer System*. For the early maturing crosses, organic N output per animal unit is 10 kg lower at 71 kg. Assuming a stocking rate of 2.1 animal units per ha, organic N production is 149 kg/ha leaving a possible 111 kg/ha for fertiliser N under REPS 3 (higher under REPS 4). The area required by the early maturing and Holstein-Friesian steers for grazing (0.25 ha per animal unit) is the same as for the *Standard Continental Steer System*. The fertiliser N requirement for silage plus aftermath is 69 kg/ha, while that for early grazing is 30 kg/ha, leaving 12 kg/ha available (REPS 3) for later top dressing of the grazing area (Under REPS 4, more N is available if required).

Table 4. Summary of inputs for spring-born Holstein-Friesian (FR) and early maturing x Holstein-Friesian (EM) steers in a two-year system.

	FR	EM
Concentrates (kg)		
Calf indoors	80	80
Calf at pasture	60	60
Weanling – 1st winter	110	110
Finisher – 2nd winter	750	420 (5 kg/day for 84 days)
Total	**1000**	**670**
Grazed grass (kg DM)		
1st season	660	660
2nd season	1790	1790
Total	**2450**	**2450**
Silage (kg DM)		
1st winter	500	500
2nd winter	960	550 (6.5 kg/day for 84 days)
Total	**1460**	**1050**
Land		
ha per animal unit	0.55	0.47 (0.30 (0.22 for EM) silage, 0.25 ha grazing)
Animal units/ha	**1.80**	**2.10**
Nitrogen (kg/ha)		
Organic N production	146	149
Permitted fertiliser N (REPS 3)	114	111
Permitted fertiliser N (REPS 4)	146[1]	149[1]
Fertiliser N used (kg/ha)		
Silage	115	115
Aftermath	34	34
Early grazing	57.5	57.5
Top dressing (grazing)	13.5	13.5
Total	**114**	**105**

[1]Limit of Nitrates Directive; Data as per Table 1 unless otherwise indicated.

3.2.4 Animal performance

Target live weight gains and live weights for Holstein-Friesians and early maturing crosses are shown in Table 5. The targets are the same for both types except that the early maturing crosses are slaughtered 9 weeks earlier. The dates of various events are the same as for the *Standard Continental Steer System*, but the growth targets are lower with a mean life time live weight gain of 0.79 kg/day. Slaughter weight is 30 kg (Holstein-Friesians) and 80 kg (early maturing crosses) lower than for the *Standard Continental Steer System*. Assumed kill-out proportions (~515g/kg) are the same for Holstein-Friesians and early maturing crosses. Normally, early maturing crosses have a higher kill-out than Holstein-Friesians, but kill-out is a function of live weight and as the early maturing crosses are 50 kg lighter the same kill-out is assumed for the two breed types.

3.2.5 Output

The output for both breed types is shown in Table 6. Slaughter weight and carcass weight of Holstein-Friesians is 620 kg and 320 kg, respectively. If they are of extreme dairy type, a proportion of the carcasses will fall into conformation class 'P'. Less extreme dairy animals will predominantly fall into class 'O'. About 50 % of carcasses fall into fat class 3 and 50 % into fat class 4. Output per ha is 1116 kg live weight and 576 kg carcass.

The output for early maturing crosses is 570 kg slaughter weight and 295 kg carcass weight per animal. Carcass conformation class distribution is about 70 % 'O' and 30 % 'R' and carcass fat class distribution is about 40 % 3 and 60 % 4. Output per ha is 1197 kg live weight and 620 kg carcass.

3.2.6 Operation

The operation of the Holstein-Friesian system is exactly as described for the *Standard Continental Steer System*. The system with the early maturing crosses is similar, except that the proportion of the land area required for silage is less (47 % v. 55 %), and that available for grazing is greater (53 % v. 45 %). This is due to a reduced silage requirement. Slaughter date for the early maturing animals is early January before the commencement of calf purchase for the next cycle of the system. Thus, there is no overlap of calves and finishing animals as can happen in the other systems.

Table 5. Target live weight gains and live weights for spring-born Holstein-Friesian (FR) and early maturing x Holstein-Friesian (EM) steers in a two-year system.

		Holstein-Friesian			Beef x Holstein-Friesian				
		Gain			Gain				
Date	**No. days**	**kg/day**	**Total (kg)[1]**	**Live weight (kg)**	**kg/day**	**Total (kg)[1]**	**Live weight (kg)**	**Age (wks)**	**Event**
March 15	-	-	-	45	-	-	45		Start calves
May 12	58	0.60	35	80	0.60	35	80	8	Turn-out 1st summer
Nov. 17	189	0.80	150	230	0.80	150	230	35	House for 1st winter
March 23	126	0.55	70	300	0.55	70	300	53	Turn-out 2nd summer
Oct. 19	210	0.90	190	490	0.90	190	490	83	House for 2nd winter
Jan. 112	84	-	-	-	0.90	80	570	95	Slaughter EM
March 15	147	0.90	130	620	-	-	-	104	Slaughter FR
Total/Mean	**730 (667)[2]**	**0.79**	**575**	**620**	**0.79**	**525**	**570**	**104 (95)[2]**	
Carcass weight (kg)				**320 (kill-out 516g/kg)**			**295 (kill-out 518/kg)**		

[1]For period; [2]Early maturing x

3.2.7 Variation

As dairy farmers normally use a Holstein-Friesian bull early in the breeding season and a beef bull later, Holstein-Friesian calves are earlier born than beef crosses. Accordingly, they can start the system earlier and so are heavier at first turn-out. This is an advantage and makes it easier to achieve all live weight gain targets. The finishing winter is also shorter which helps to reduce costs. Within the Holstein-Friesian population there is a wide range in type from extreme dairy Holstein to more dual purpose Irish/British Friesians. This is reflected in differences in carcass conformation but otherwise, differences in productivity and carcass traits are small.

Table 6. Summary of output for spring-born Holstein-Friesian (FR) and early maturing x Holstein-Friesian (EM) steers in a two-year system.

		Per animal		Per ha	
		FR	EM	FR	EM
Live weight (kg)		620	570	1116	1197
Carcass (kg)		320	295	576	620
Conformation	%R	-	30		
	%O	80	70		
	%P	20	-		
Fat class	%3	50	40		
	%4	50	60		

3.3 Intensive System of Two-Year-Old Continental Steers

3.3.1 Overview

This system aims to maximise output per ha of land area with minimal constraints on fertiliser N and concentrate inputs. It can only be operated with a Nitrates Directive derogation and it is applicable only in circumstances where beef prices are high and concentrates (or alternatives) are relatively cheap. The objective is to produce 1000 kg carcass per ha from continental cross steers slaughtered at two years of age.

3.3.2 Inputs

The main inputs for the system are summarised in Table 7. Milk replacer and concentrate inputs up to the finishing winter are the same as for the *Standard Continental Steer System.* During finishing, concentrate input is 150 kg higher (at 950 kg) bringing total lifetime concentrate input to 1.15 t. (Concentrates are fed ad libitum for the final 84 days at 11 kg/day following a 3-week adjustment period). The silage requirement is 500 kg DM for the first winter and 600 kg DM for the finishing winter making a total requirement of 1.1 t DM. The first winter silage requirement is the same as for the *Standard Continental Steer System*. The lower finishing winter silage requirement is based on feeding silage only for 63 days (8.2 kg DM/day) and 1 kg/day silage DM for 84 days with concentrates ad libitum. Based on the silage yields assumed earlier (4.9 t/ha DM consumed for first cut and 3.7 t/ha DM consumed for second cut), the silage requirement per animal unit can be provided by a first cut of 0.15 ha and a second cut of 0.10 ha. The grazing area required per animal unit is 0.2 ha up to the first silage cut, 0.25 ha from the first to the second silage cut, and 0.35 ha afterwards. Thus, the carrying capacity is 2.86 animal units per ha. The grazing areas for this system compare with those for the *Standard Continental Steer System* of 0.25 ha up to the first silage cut and 0.55 ha thereafter. The smaller grazing area provided in this system is possible because:

- there is no limitation on organic N production or fertiliser N use other than as specified under the Nitrates Directive derogation.
- silage quality is less important (because animals are fed concentrates ad libitum over the final 84 days) so a higher yield of lower quality silage is acceptable (although the same yield and quality are assumed here).
- performance targets and slaughter weight are somewhat lower.
- high genetic merit beef sires and high standards of animal husbandry and grassland management are assumed.

Table 7. Summary of inputs for spring-born continental x Holstein-Friesian steers in an intensive two-year system.

Concentrates (kg)	
Calf indoors	80
Calf at pasture	60
Weanling – 1st winter	110
Finisher – 2nd winter	900 (silage only for 9 weeks, adjusted to ad libitum concentrates for 12 weeks)
Total	**1150**
Grazed grass (kg DM)	
1st season	660
2nd season	1790
Total	**2450**
Silage (kg DM)	
1st winter	500
2nd winter	600 (8.2 kg/day for 63 days, 1 kg/day for 84 days)
Total	**1100**
Land	
ha per animal unit	0.35 (0.15 ha 1st cut, 0.10 ha 2nd cut, 0.20 ha grazing)
Animal units/ha	**2.86**
Nitrogen (kg/ha)	
Organic N production	232
Permitted fertiliser N	(as per the Nitrates Directive derogation)
Fertiliser N used (kg/ha)	
First cut silage	115
Second cut silage	110
Aftermath (both cuts)	34.4
Early grazing	57.5
Top dressing	13.5 (3 on silage area, 4 x 2 on grazing area)
Top dressing	13.5
Total	**217**

Data as per Table 1 unless otherwise indicated

3.3.3 Nitrogen

Organic N production is 232 kg/ha. The main difference in fertiliser N use between this and the *Standard Continental Steer System* is the amount used on the grazing area. Fertiliser N usage is 115 kg/ha for first cut silage, 110 kg/ha for second cut, 57.5 kg/ha for spring grazing, 34.4 kg/ha for aftermath and 13.5 kg/ha for each top dressing. The silage area receives three double top dressings in addition to the aftermath application. The grazing area receives four double top dressings. Total fertiliser N requirement is 217 kg/ha which is 113 kg/ha more than for the *Standard Continental Steer System*. Assuming a response of 23 kg herbage DM per kg N, the total extra herbage production for this system is 2.6 t DM/ha. The extra grazing herbage requirement is 0.70 t in the first grazing season and 1.9 t in the second grazing season making a total of 2.6 t. Thus, the extra herbage production matches the extra requirement.

3.3.4 Animal performance

Target live weight gains and live weights are shown in Table 8. They are the same as for the *Standard Continental Steer System* up to the end of the first winter. For the second grazing season, the target growth rate is lower than for the *Standard Continental Steer System* (0.85 v. 0.90 kg/day). This is because at the higher stocking rate there is more inedible herbage (more dung areas, more sward damage) even though herbage availability per animal is the same for both. It is also more difficult to match herbage supply and demand at the higher stocking rate. At the end of the second grazing season, the animals in this system are 10 kg lighter than those in the *Standard Continental Steer System* (500 v. 510 kg). For the first 9 weeks of the finishing period the animals are offered silage ad libitum only. They gain 0.45 kg/day or 30 kg live weight in 9 weeks. Over the following 3 weeks they are adjusted to an ad libitum concentrate diet which continues to slaughter after 84 days. Because the animals express some compensatory growth (because of the lower live weight gains during the grazing season and during the first 9 weeks of the finishing period), and the ad libitum concentrate finishing period is short (84 days), daily live weight gain is high (1.35 kg/day). Mean daily life time gain at 0.81 kg/day is slightly lower than for the *Standard Continental Steer System* (0.82 kg/day).

Table 8. Target live weight gains and live weights for spring-born continental x Holstein-Friesian steers in an intensive two-year system.

		Gain				
Date	**No. days**	**kg/day**	**Total (kg)[1]**	**Live weight (kg)**	**Age (wks)**	**Event**
March 15	-	-	-	50	-	Start calves
May 12	58	0.70	40	90	8	Turn-out 1st summer
Nov. 17	189	0.80	150	240	35	House for 1st winter
March 23	126	0.65	80	320	53	Turn-out 2nd summer
Oct. 19	210	0.85	180	500	83	House for second winter (silage only)
Dec. 21	63	0.45	30	530	92	Move to ad libitum concentrates
March 15	84	1.35	110	640	104	Slaughter
Total/Mean	**730**	**0.81**	**590**	**640**	**104**	
Carcass weight (kg)				**350 (kill-out 547g/kg)**		

[1]For period

3.3.5 Output

The output is summarised in Table 9 as 640 kg slaughter weight and 350 kg carcass weight per animal. Carcass grades are similar to those for the *Standard Continental Steer System*. Total output is 1830 kg live weight and 1000 kg carcass per ha.

Table 9. Summary of output for spring-born continental x Holstein-Friesian steers in an intensive two-year system.

		Per animal	Per ha
Live weight (kg)		640	1830
Carcass (kg)		350	1000
Conformation	%R	70	
	%O	30	
Fat class	%3	60	
	%4	40	

3.3.6 Operation

Other than the need for a second silage cut, the operation of the system up to the finishing winter is similar to that for the *Standard Continental Steer System*. A first silage cut is taken from 45% of the area and a second cut is taken from 30% of the area. After the second grazing cycle, and on three further occasions up to mid August, the grazing area is N top dressed using double the standard rate (i.e. 27 kg N/ha). The first cut silage area returned to grazing receives three N top dressings and the second cut silage area receives two N top dressings all at double the standard rate. A high standard of management is necessary to ensure success of the system.

3.3.7 Variation

The general remarks for the *Standard Continental Steer System* are applicable. As this is a high cost system it is vitally important to conduct an economic appraisal before commencing. Care must also be exercised in ensuring that the level of fertiliser N usage is in compliance with the Nitrates Directive following derogation.

3.4 System of 21-Month-Old Spring-Born Steers

3.4.1 Overview

This system aims to finish spring-born steers off pasture at the end of their second grazing season at about 21 months of age.

Indoor finishing is the most expensive phase of two-year-old spring systems, and without a price rise, the total finishing costs can equal or exceed the value of the carcass gain. Thus, systems that do not require an expensive winter finishing phase are of interest. Given that the majority of calves are born in spring, winter finishing can only be avoided by either slaughtering at the end of the second grazing season at 19 to 21 months of age, or storing the animals over the second winter and finishing them off pasture in the third grazing season at 24 to 29 months of age. In order to finish at the end of the second grazing season, calves must be earlier born and have good life time performance. The system described here is intended for animals with an early mean birth date (mid February rather than mid March) and which are acceptably finished at a light carcass weight. Thus, early maturing crosses are most suited to this system, but all breed types can be considered if their carcasses are commercially acceptable at the target weights indicated. Since most of the production takes place at pasture, the system can be operated and managed within the Nitrates Directive and REPS 3 N constraints. It is described in that context.

3.4.2 Inputs

The main inputs for the system are summarised in Table 10. These comprise 25 kg milk replacer, 150 kg calf concentrates in the indoor rearing period, 40 kg concentrates at pasture in the first grazing season, 130 kg concentrates in the first winter and 300 kg concentrates in the final two months at pasture before slaughter. The total concentrate input is 0.62 t per animal. The grazed grass DM required is 2.55 t/animal (0.7 t in the first grazing season and 1.85 t in the second grazing season). This is 4 % higher than for the *Standard Continental Steer System* because the animals are earlier born and have a 6 % and 3 % greater mean live weight in the first and second grazing seasons, respectively. Up to the availability of silage aftermath, the grazing area required is 0.26 ha per animal unit. As silage is required for the first winter only, the total silage requirement is 0.60 t DM. This is provided by one cut on 0.12 ha. Thus, the total area required per animal unit is 0.38 ha giving a potential stocking rate of 2.63 animal units per ha. However, the maximum stocking rate possible under REPS 3 is 2.5 animal units per ha (0.4 rather than 0.38 ha per animal unit). The excess land area (0.02 ha per animal unit) is treated as grazing area with the excess herbage harvested as baled silage. This is used as supplementary feed in autumn when herbage for grazing becomes limiting.

This silage allowance (and hence the area required) is 20 % higher than for the *Standard Continental Steer System* because the animals, being earlier born, are heavier and the weanlings are housed 3 weeks earlier in autumn to ensure maximum availability of pasture for the finishing animals.

Table 10. Summary of inputs for spring-born steers in a 21-month system.

Concentrates (kg)	
Calf indoors	150 (higher than standard system because calves earlier born)
Calf at pasture	40 (lower than standard system because weanlings housed earlier)
Weanling – 1st winter	130 (higher than standard system because longer winter period)
Finisher – 2nd winter	300 (5 kg/day for 60 days before slaughter)
Total	**620**
Grazed grass (kg DM)	
1st season	700 (higher than standard system because heavier calves)
2nd season	1850 (higher than standard system because heavier weanlings)
Total	**2550**
Silage (kg DM)	
1st winter	600 (higher than standard system because longer winter)
Total	600
Land	
ha per animal unit	0.40 (0.12 ha silage, 0.28 ha grazing)
Animal units/ha	**2.50**
Nitrogen (kg/ha)	
Organic N production	167
Permitted fertiliser N (REPS 3)	93
Permitted fertiliser N (REPS 4)	167 (or to limit of Nitrates Directive)
Fertiliser N used (kg/ha)	
Silage	115
Aftermath	34.4
Early grazing	57.5
Top dressing[1]	13.5
Total	**93**

[1]Only 11.5 kg N/ha available under REPS 3, permitted fertiliser N (REPS 4) up to limit for Nitrates Directive of 167 kg. Data as per Table 1 unless otherwise indicated.

3.4.3 Nitrogen

Assuming the animals are slaughtered at 21 months of age, organic N production is 67 kg per animal. At 2.5 animals per ha, total organic N production is 167 kg/ha. This allows use of 93 kg/ha of fertiliser N under REPS 3. The silage (including aftermath) requirement is 45 kg N/ha, leaving 48 kg N/ha available for grazing. The early grazing requirement is 40 kg N/ha leaving only 8 kg N/ha available for top dressing of the grazing area. (Under REPS 4 there is no shortage of N for top dressing).

3.4.4 Animal performance

Target weights and weight gains are shown in Table 11. It is essential that calves be 100 kg live weight at turn-out, otherwise the system targets will not be met. The starting weight is taken as 45 kg, that typical of a Holstein-Friesian or early maturing beef cross calf. Calves are reared indoors for 12 weeks and have a mean daily gain of 0.65 kg. This is slightly higher than the target for early maturing crosses described earlier, but is reasonable because the calves are one month older and so would have a higher daily gain in the period before turn-out. The duration of the first grazing season is 24 weeks, 3 weeks shorter than for the *Standard Continental Steer System*. This is because the weanlings are housed earlier to ensure maximum herbage availability for the finishing animals. Live weight gain during the first grazing season is 0.85 kg/day, slightly higher than the 0.80 kg/day target for the *Standard Continental Steer System*. Again this is reasonable because the calves are heavier at turn-out (there is a positive relationship between calf weight at turn-out and daily gain), and they are housed 3 weeks earlier in autumn when performance is generally below the season mean. The target winter performance is 0.60 kg/day. This is slightly higher than the value for the early maturing crosses (0.55 kg/day) mentioned earlier as the animals are somewhat heavier and more mature at housing.

Table 11. Target live weight gains and live weights for spring-born steers in a 21-month system.

		Gain				
Date	**No. days**	**kg/ day**	**Total (kg)[1]**	**Live weight (kg)**	**Age (wks)**	**Event**
Feb. 17	-	-	-	45	-	Start calves
May 12	84	0.65	55	100	12	Turn-out 1st summer
Oct 27	168	0.85	140	240	36	House for 1st winter
March 23	147	0.60	90	330	57	Turn-out 2nd summer
Sept. 14	175	0.90	160	490	82	Start concentrates at pasture
Nov. 16	63	0.95	60	550	91	Slaughter
Total/Mean	**637**	**0.79 (0.82)[2]**	**505 (525)[2]**	**550 (570)[2]**	**91**	
Carcass weight (kg)				**280 (FR)** (kill-out 509g/kg)		
				285 (EM) (kill-out 518g/kg)		
				300 (CT) (kill-out 526g/kg)		

[1]For Period; [2]For continental crosses; EM = early maturing x Holstein Friesian; FR = Holstein Friesian; CT = continental x Holstein Friesian

Turn-out for the second grazing season is on the same date as for the *Standard Continental Steer System*. The duration of this grazing season is 25 weeks to mid September and target live weight gain during this time is 0.90 kg/day, the same as for the early maturing animals mentioned previously. During the final 9 weeks at pasture, concentrates are fed at 5 kg/day. Supplementary silage feeding, using excess herbage conserved earlier, is used if required. With supplementary silage feeding and concentrates supplying up to 50 % of their total DM intake, and no competition for the herbage available from late October, these animals should have a reasonably high rate of gain. The target from mid September to slaughter in mid November at about 21 months of age is 0.95 kg/day. Mean life time live weight gain is 0.79 kg/day which is similar to that for the early maturing animals mentioned earlier.

3.4.5 Output

The output from the system is summarized in Table 12. Slaughter weight is 550 kg and carcass weight is 285 kg for early maturing animals. Holstein-Friesians have a similar slaughter weight to early maturing animals (550 kg) but continental crosses are about 20 kg heavier (570 kg). Corresponding carcass weights for these breed types are 280 and 300 kg, respectively, but some of these carcasses may not be adequately finished. Carcass conformation of early maturing breed types is predominantly 'O', Holstein-Friesians are about 80 % 'O' and 20 % 'P', while continental crosses are about 60 % 'O' and 40 % 'R'. Total output per ha is 1375-1425 kg live weight and 713-750 kg carcass weight depending on breed type.

Table 12. Summary of output for spring-born steers in a 21-month system.

		Per animal			Per ha		
		EM	FR	CT	EM	FR	CT
Live weight (kg)		550	550	570	1375	1375	1425
Carcass (kg)		285	280	300	713	700	750
Conformation	%R	20	-	60			
	%O	80	80	40			
	%P	-	20	-			
Fat class	%3	70	80	100			
	%4	30	20	-			

EM = early maturing x Holstein Friesian; FR = Holstein Friesian; CT = continental x Holstein Friesian

3.4.6 Operation

The operation of this system is broadly similar to that for the *Standard Continental Steer System* except that it commences one month earlier in spring and there is no second winter. In addition, the weanlings are housed earlier to leave more pasture available for the finishing animals. Thus they have a lower autumn but a higher winter concentrate input.

Nationally, over 200,000 male dairy calves are born before the end of February so there are plenty of calves available for this system. It is vital that calves are well grown at turn-out so that they perform well during the first grazing season, otherwise it will be difficult to achieve the targets. To remain within the REPS 3 organic N limit, the system cannot exceed 2.5 animal units per ha. Of the total land area in the system, 30 % is required for one silage cut taken in late May. Any surplus herbage is conserved as large bales for supplementary feeding late in the grazing season. With only 30 % of the area as aftermath and limited fertiliser N for top dressing, ensuring an adequate herbage supply becomes progressively more difficult as the season advances (under REPS 4 fertiliser N availability is not limiting). To help alleviate this, supplementary silage should be introduced earlier than might appear necessary to permit a lengthening of the grazing cycles. The earlier housing of the weanlings and the feeding of concentrates from mid September to the finishing animals help to reduce demand on the declining late season herbage supply.

3.4.7 Variation

The target sale date is mid November at 21 months of age but in practice animals would be slaughtered for some weeks before and after as they reach fitness. Whether it is practical to feed concentrates to animals outside after mid November depends on soil type, but land destined for early spring grazing should be stripped of stock by then.

Considering the need to have animals adequately finished but yet avoid housing for a second winter, the "sales window" for this system is quite narrow and is concentrated in October/November when large numbers of cattle are usually marketed off pasture with consequent reductions in price. Therefore, to improve sale price it may be necessary to modify the system to avoid selling at the lowest price period of the year. Possible modifications include: (i) starting the system earlier with a view to disposal in September/early October before prices fall too low, (ii) housing the animals and retaining them for an extra month until November/December when prices usually rise in the run up to Christmas, and (iii) selling some of the more backward animals as stores without any concentrate feeding. Housing and finishing nearer Christmas requires an increase in silage production. To facilitate this, stocking rate would have to be correspondingly reduced. Alternatively, the animals could be fed concentrates ad libitum during finishing. This would obviate the need for extra silage and because the period is short, the response to, and efficiency of utilisation of, concentrates would be high.

While the system is described within the context of REPS 3, it would be easier to operate under REPS 4. With such a high proportion of the herbage utilised by grazing, there would be a good response to additional fertiliser N. With a Nitrates Directive organic N derogation to 210 kg/ha, this system could carry up to 3 animal units per ha and produce up to 850 kg carcass per ha mainly off grass.

3.5 System of 28-Month-Old Continental Steers

3.5.1 Overview

The aim of this system is to produce heavy carcasses from spring-born continental cross steers slaughtered off pasture at about 28 months of age.

The 21-month-old system described earlier has a narrow “sales window” at a time when finished cattle are in plentiful supply and it is based on early born calves which tend to be dearer than later born ones. An alternative system which also avoids the costs of winter finishing is to store the animals inexpensively in the second winter and finish them off pasture in their third grazing season at about 28 months of age. This is more flexible than the 21-month-old system. Later born calves will suffice, achieving the live weight targets at the various stages is not as critical, there is a wider "sales window" when prices are normally good and there is less likelihood of animals being unfinished. The system conforms to the REPS 3 and Nitrates Directive organic and total N constraints. This is the context in which it is described.

3.5.2 Inputs

The main inputs are summarized in Table 13. The non-forage inputs are 25 kg milk replacer, 80 kg calf concentrates in the indoor rearing period, 60 kg concentrates at pasture in the first grazing season, 110 kg concentrates in the first winter and 100 kg concentrates in the second winter bringing the total concentrate input to 0.35 t. The grazed grass required is 3.95 t per animal (0.61 t in the first grazing season, 1.85 t in the second grazing season and 1.49 t in the third grazing season). Based on the assumptions outlined earlier, the grazing area required by the calf plus yearling is 0.25 ha, and that required by the two-year-old is also 0.25 ha, up to the time of availability of silage aftermath. The total silage required is 1.58 t DM (0.50 t for the first winter and 1.08 t for the second winter). This can be obtained from 0.32 ha cut once. Thus, the total area required per animal unit is 0.82 ha (0.50 ha for grazing and 0.32 ha for silage) giving a potential stocking rate of 1.22 animal units per ha.

Table 13. Summary of inputs for spring-born continental x Holstein-Friesian steers in a 28-month system.

Concentrates (kg)	
Calf indoors	80
Calf at pasture	60
Weanling – 1st winter	110
Store – 2nd winter	100 (1 kg/day for the first 100 days)
Total	**350**
Grazed grass (kg DM)	
1st season	610 (mean of 3.5 kg/day for 175 days)
2nd season	1850 (mean of 8.5 kg/day for 217 days)
3rd season	1490 (mean of 12.5 kg/day for 119 days)
Total	**3950**
Silage (kg DM)	
1st winter	500
2nd winter	1080 (mean of 7.0 kg/day for 154 days)
Total	1580
Land	
ha per animal unit	0.82 (0.32 ha silage, 0.50 ha grazing)
Animal units/ha	**1.22**
Nitrogen (kg/ha)	
Organic N production	126
Permitted fertiliser N (REPS 3)	134
Permitted fertiliser N (REPS 4)	126 (or to limit of Nitrates Directive)
Fertiliser N used (kg/ha)	
Silage	115
Aftermath	34.4
Early grazing	57.5
Top dressing (twice)	13.5
Total	**110**

Data as per Table 1 unless otherwise indicated

3.5.3 Nitrogen

Assuming the animals are kept to 28 months of age, organic N production is 103 kg per animal. At 1.22 animal units per ha this gives a total organic N production of 126 kg, leaving a possible 126 kg of fertiliser N (not greater than organic N) available for use under REPS 3. The silage area plus aftermath requires 58 kg N/ha and the grazing area requires 35 kg N/ha for early season grazing. The remaining 33 kg N/ha is available for top dressing the grazing area but only 17 kg of this is required bringing the total fertiliser N requirement to 110 kg/ha. Finished cattle are slaughtered towards the end of July, so from then to the end of the grazing season the yearlings and calves have the entire area (0.82 ha per animal unit) available for grazing.

3.5.4 Animal performance

Target live weight gains and live weights are shown in Table 14. Because of the later slaughter date than for other systems it is not necessary that calves be early born. In fact, calves born up to mid summer are suitable. The target birth/starting date for the system is taken as March 31. Continental crosses are more suited to the system than Holstein-Friesians or early maturing crosses because they can be taken to a heavier slaughter weight. However, both Holstein-Friesians and early maturing animals can be used in the system but they should be slaughtered earlier and at lower carcass weights than shown here.

Table 14. Target live weight gains and live weights for spring-born continental x Holstein-Friesian steers in a 28-month system.

Date	No. days	Gain		Live weight (kg)	Age (wks)	Event
		kg/day	Total (kg)[1]			
March 31	-	-	-	50	-	Start calves
May 26	56	0.70	40	90	8	Turn-out 1st summer
Nov. 17	175	0.80	140	230	33	House for 1st winter
March 23	126	0.65	80	310	51	Turn-out 2nd summer
Oct. 26	217	0.90	200	510	82	House for 2nd winter
March 29	154	0.50	80	590	104	Turn-out 3rd summer
July 26	119	1.00	120	710	121	Slaughter
Total/Mean	**847**	**0.78**	**660**	**710**	**121**	
Carcass weight (kg)				**390 (kill-out 549g/kg)**		

[1]For period

Because the calves are later born, it is later when they are turned out to pasture resulting in a shorter first grazing season. Target daily gains during rearing, during the first grazing season and during the first winter are the same as for the *Standard Continental Steer System*, but because of the later starting date the targets will be somewhat more difficult to achieve and weanling and yearling weights are about 10 kg lower. As the animals are not destined for finishing in the second winter they can remain at pasture until later in the second grazing season. Consequently, their target daily gain for the second grazing season is somewhat lower, but the total grazing season live weight gain is the same as for the *Standard Continental Steer System*. Target live weight gain in the second winter is 0.5 kg/day giving a turn-out weight at two years of 590 kg. With the animals expressing compensatory growth following the second winter store period, they should readily achieve the target gain of 1 kg/day for the first 4 months of the third grazing season. Mean life time live weight gain is 0.78 kg/day which is the lowest for any of the systems described.

3.5.5 Output

Output per animal is 710 kg slaughter weight and 390 kg carcass weight (Table 15). Because the animals are continental crosses and are finished off pasture (which results in lower fatness than indoor finishing), carcass fat class is predominately 3. Conformation class is about 70 % 'R' and 30 % 'O'. Total live weight and carcass output per ha is 866 kg and 476 kg, respectively.

Table 15. Summary of output for spring-born continental x Holstein-Friesian steers in a 28-month system.

		Per animal	Per ha
Live weight (kg)		710	866
Carcass (kg)		390	476
Conformation	%R	70	
	%O	30	
Fat class	%3	70	
	%4	30	

3.5.6 Operation

Up to the end of the second grazing season the operation of the system is broadly similar to that for the *Standard Continental Steer System*. With an overall stocking rate of 1.22 animal units per ha, there are 3.66 animals per ha (1.22 calves, 1.22 yearlings and 1.22 two-year-olds) in the early part of the year. Approximately 40 % of the area is cut once for silage in late May and the entire area is available for grazing thereafter. In the months of June and July, between the dates of calf turn-out and sale of the finished animals, there are three generations (calves, yearlings and two-year-olds) of animals to be managed at pasture. The calves and yearlings are managed as in the *Standard Continental Steer System* (i.e. a leader/follower rotational grazing arrangement) and the two-year-olds are rotationally grazed separately. This ensures no restriction in herbage supply or diminution in herbage quality for the latter as their sale date approaches. After the two-year-olds have been sold there is more than adequate herbage available for the calves and yearlings.

The yearlings are housed in late October for a 5-month winter, and the weanlings remain at pasture until mid November. It is vital that the final grazing cycle is carefully managed and that paddocks are closed in rotation as they are vacated to avoid compromising grass growth the following spring.

3.5.7 Variation

The target rate of gain in the second winter is 0.5 kg/day. This could be achieved on good quality silage alone (and silage should be good quality because it is from primary growth harvested in late May). Nevertheless, an allowance of 100 kg supplementary concentrates is provided for (1 kg/per day for the first 3 months and then withdrawn for the final 2 months). Live weight gain in winter should not be obtained expensively as the animals will compensate at pasture when live weight gain is cheaper.

Of all the systems described this is the simplest to operate and the most flexible. Except for 4 months of the year it has the least number of animals per unit area. Sale can take place over a reasonably long period at a time of year when prices are generally stable. The system is suited to calves with a wide range of birth dates and has minimal high cost inputs (e.g. calves and concentrates). The downside is that the number of animal units per ha is low so output per ha is also low.

4. System of Steer Production from Autumn-Born Calves

4.1 Two-Year-Old System - All Breed Types

4.1.1 Overview

The aim of this system is to produce finished steers at the end of the second grazing season at about two years of age from autumn-born calves.

Only 13 % of the total calf crop and 10 % of the dairy calf crop are born in the 5 month period August to December inclusive. Because the number of autumn-born dairy calves is small and scattered over a long period, description of a multiplicity of different systems is not warranted as each would apply to only a very small number of calves. Thus, only one system for autumn-born calves is described here. It is assumed that mean calf birth date is mid October and the animals are slaughtered at the end of their second grazing season at about two years of age. The system as described is applicable to Holstein-Friesians, early maturing and continental cross animals.

4.1.2 Inputs

The main inputs are summarised in Table 16. The concentrate inputs are 25 kg milk replacer, 150 kg calf concentrates, 100 kg concentrates in the first grazing season, 150 kg concentrates in the second winter, and 0, 150 or 300 kg concentrates at pasture in the two month period before slaughter for the early maturing, Holstein-Friesian and continental breed types respectively. Thus, the total concentrate input is 0.40, 0.55 and 0.70 t per animal for the breed types as listed.

Table 16. Summary of inputs for autumn-born early maturing x Holstein-Friesian (EM), Holstein-Friesian (FR) and continental x Holstein-Friesian (CT) steers in a two-year system.

	EM	FR	CT	
Concentrates (kg)				
Calf indoors – 1st winter	150	150	150	(1.4 kg/day for 105 days)
Calf at pasture	110	110	110	(1.5 kg/day for 6 weeks in spring and 1 kg /day for 6 weeks in autumn)
Yearling – 2nd winter	140	140	140	(1 kg/day for 140 days)
Finishing – at pasture	-	150	300	(2.5 or 5.0 (CT) kg/day for 60 days)
Total	**400**	**550**	**700**	
	All breed types			
Grazed grass (kg DM)				
1st season	1302			(6 kg /day for 217 days)
2nd season	2163			(10.3 kg/day for 210 days)
Total	**3465**			
Silage (kg DM)				
1st winter	170			(1.57 kg /day for 105 days)
2nd winter	980			(7 kg/day for 140 days)
Total	**1150**			
Land				
ha per animal unit	0.59			(0.23 ha silage, 0.36 ha grazing)
Animal units/ha	**1.70**			
Nitrogen (kg/ha)				
Organic N production	138			
Permitted fertiliser N (REPS 3)	122			
Permitted fertiliser N (REPS 4)	138 (or to limit of Nitrates Directive)			
Fertiliser N used (kg/ha)				
Silage	115			
Aftermath	34.4			
Early grazing	57.5			
Top dressing (twice)	13.5			
Total	**110**			

Data as per Table 1 unless otherwise indicated

From the end of the calf rearing period to the end of the first winter, the calves consume a total of 2.86 kg DM/day (1.29 kg concentrates and 1.57 kg silage). Thus, the total first winter silage requirement is 0.17 t DM. In the second winter, the animals consume 7.9 kg DM/day (0.86 kg concentrates and 7.0 kg silage). This amounts to a second winter silage requirement of 0.98 t and a total silage requirement of 1.15 t DM per animal. Thus, the silage area required (one cut) is 0.23 ha per animal. In the first grazing season the calves require about 6 kg DM/day. This amounts to 1302 kg DM or the equivalent of 0.13 ha per calf. Yearlings at pasture require 10.3 kg DM/day, equivalent to 2163 kg DM for the total season or 0.23 ha per animal. Thus, the total land area required per animal unit is 0.59 ha. This allows a carrying capacity of 1.70 animal units per ha.

4.1.3 Nitrogen

At 1.7 animal units per ha, total organic N production is 138 kg/ha. Under REPS 3, this permits the use of 122 kg fertiliser N. For silage and aftermath the fertiliser N requirement is 58 kg N/ha leaving 64 kg/ha available for grazing. The N requirement for early season grazing is 35 kg N/ha leaving 29 kg N/ha available for top dressing. Of this, only 17 kg/ha is required giving an actual fertiliser N usage of 110 kg/ha.

The calves are reared as described for spring-born animals, but instead of going to pasture after two months they are introduced to good quality grass silage with concentrate feeding continuing ad libitum to 3 months of age. Concentrates are then gradually scaled back to average 1.5 kg/day for the remainder of the winter.

As both generations of animals are 5 months older and so have higher feed requirements at pasture than corresponding spring-born animals, the yearlings are housed earlier in autumn than spring-born calves. This results in a longer winter for the yearlings but it maximises the availability of pasture for the finishing animals.

Concentrate feeding at pasture commences in mid August for Holstein-Friesians and continental crosses, and over the final two months before slaughter a total of 150 kg (Holstein-Friesians) or 300 kg (continentals) concentrates are fed. As the early maturing animals need to gain only 20 kg live weight after mid August, this can be achieved without concentrate supplementation.

4.1.4 Animal performance

The target live weight gains and live weights throughout life for the 3 breed types are shown in Table 17. Live weight gain during the rearing period is the same as for spring-born calves. During the remainder of the winter when concentrates comprise about 45 % of the total DM intake with good quality silage, the live weight gain is 0.75 kg/day. This results in a live weight of 170 kg at turn-out in spring for continentals and 165 kg for the Holstein-Friesians and early maturing animals. Because the calves are relatively mature at turn-out and able to utilise good quality grass, the target live weight gain at pasture of 0.80-0.85 kg/day should be readily achieved. This results in autumn yearling live weights of 340-355 kg across the breed types.

Target live weight gain (on silage + 1 kg/day concentrates) in the second winter is similar to that for the spring-born weanlings in their first winter (0.60-0.65 kg/day) resulting in turn-out weights at the start of the second grazing season of 425-445 kg. During the second grazing season, the target live weight gain up to mid August is 0.85 to 0.90 kg/day resulting in live weights at that time of 560-585 kg. Over the final finishing period, target live weight gains are 0.70 (4 weeks), 1.05 (8 weeks) and 1.15 (8 weeks) kg/day for the early maturing, Holstein-Friesian and continental breed types, respectively resulting in corresponding slaughter weights of 580, 620 and 650 kg at about two years of age. Mean life time live weight gains are 0.76, 0.79 and 0.82 kg/day for the early maturing crosses, Holstein-Friesians and continental crosses, respectively.

Table 17. Target live weight gains and live weights for autumn-born early maturing x Holstein-Friesian (EM), Holstein-Friesian (FR) and continental x Holstein-Friesian (CT) steers in a two-year system.

		Gain (kg/day)			Total (kg)[1]			Live weight (kg)				
Date	**No. days**	**EM**	**FR**	**CT**	**EM**	**FR**	**CT**	**EM**	**FR**	**CT**	**Age (wks)**	**Event**
Mid Oct.								45	45	50	-	Start calves (1st winter)
Mid Dec.	58	0.65	0.65	0.65	40	40	40	85	85	90	8	Wean calves
Late March	105	0.75	0.75	0.75	80	80	80	165	165	170	23	Turn-out 1st summer
Early Nov.	217	0.80	0.80	0.85	175	175	185	340	340	355	54	House 2nd winter
Late March	140	0.60	0.60	0.65	85	85	90	425	425	445	74	Turn-out 2nd summer
Mid Aug.	154	0.85	0.85	0.90	135	135	140	560	560	585	96	Start concentrates at pasture
Mid Oct.	56[2]	0.70	1.05	1.15	20	60	65	580	620	650	104	Slaughter
Total/Mean	**730[3]**	**0.76**	**0.79**	**0.82**	**540**	**575**	**600**	**580**	**620**	**650**	**104**	
Carcass weight (kg)[4]								**300**	**320**	**350**		

[1]For Period; [2]30 for EM; [3]704 for EM; [4]Based on kill-outs of 517, 516 and 538 g/kg for EM, FR and CT, respectively.

4.1.5 Output

The slaughter weights (Table 18) for early maturing crosses, Holstein-Friesians and continental crosses are 580, 620 and 650 kg, respectively. Corresponding carcass weights are 300, 320 and 350 kg. Carcass conformation is slightly poorer and carcass fat class is lower than for spring-born animals of the same breed types.

Output per ha is 986, 1054 and 1105 kg live weight for the early maturing, Holstein-Friesian and continental crosses, respectively. Corresponding carcass outputs are 510, 544 and 595 kg.

Table 18. Summary of output for autumn-born early maturing x Holstein-Friesian (EM), Holstein-Friesian (FR) and continental x Holstein Friesian (CT) steers in a two-year system.

		Per animal			Per ha		
		EM	FR	CT	EM	FR	CT
Live weight (kg)		580	620	650	986	1054	1105
Carcass (kg)		300	320	350	510	544	595
Conformation	%R	20	-	70			
	%O	80	90	30			
	%P	-	10	-			
Fat class	%3	40	60	80			
	%4	60	40	20			

4.1.6 Operation

The system commences with calves that have a mean birth date of mid October. The overall stocking rate is 1.7 animal units per ha. In the early part of the year 40 % of the land area is reserved for silage which is cut in late May. Thereafter, the entire area is grazed.

4.1.7 Variation

While the system can fit all breed types, it is least suited to continental crosses. This is because they have the highest slaughter weights, and feed supply and quality are declining just when both need to be optimum. Therefore, there is a risk that a proportion of continental carcasses would be unfinished. This could be overcome by feeding concentrates for a longer period and/or at a higher level before slaughter.

Early maturing animals should have no difficulty in finishing at the target slaughter weight without concentrate supplementation in the final weeks. Since the range in birth dates for any batch of calves used in the system is likely to be quite wide, there may be more variability around the live weight targets than for spring-born calves, but for the same reason the "sales window" should also be wider.

5. Systems of Heifer Production

5.1 System of 19- to 21-Month-Old Heifer Production from Spring-Born Calves

5.1.1 Overview

Two systems (slaughter at 19 months and at 21 months) which differ only in the final finishing stage are described together.

The 19-month-old system is designed for early maturing crosses slaughtered off pasture at the end of the second grazing season. The 21-month system is designed for continental crosses managed similarly to the 19-month system and then finished indoors for a two month period. Both systems are based on calves with a mean birth date of mid March. General management is as described for the *Standard Continental Steer System*.

5.1.2 Inputs

The main inputs are summarized in Table 19. The non-forage inputs consist of 25 kg milk replacer, 80 kg calf concentrates in the indoor rearing period, 60 kg concentrates at pasture in the first grazing season and 110 kg concentrates in the first winter. This brings the total concentrate input to 250 kg for the early maturing animals in the 19-month system. The continental crosses receive an additional 300 kg concentrates in the finishing period. The pasture requirement is 2.35 t grazed grass DM (0.66 t in the first grazing season and 1.69 t in the second grazing season). The silage requirement is 500 kg DM (4.0 kg/day DM in the first winter) for the early maturing animals. The continental crosses require 910 kg DM in total (500 kg in the first winter and 410 kg in the finishing period). The grazing area required early in the season is 0.26 ha per animal unit. The silage area required is 0.11 ha for the early maturing animals and 0.19 ha for the continental crosses. Thus, the total area required per animal unit is 0.37 ha for early maturing, and 0.45 ha for continental crosses, giving potential stocking rates of 2.70 and 2.22 animal units per ha for the early maturing and continental crosses, respectively.

Table 19. Summary of inputs for spring-born early maturing x Holstein-Friesian (EM) and continental x Holstein-Friesian (CT) heifers in a 19 to 21-month system.

	EM (19-months)	CT (21-months)
Concentrates (kg)		
Calf indoors	80	80
Calf at pasture	60	60
Weanling – 1st winter	110	110
Finisher – 2nd winter	-	300
Total	**250**	**550**
Grazed grass (kg DM) – both breed types		
1st season	660	660
2nd season	1680	1680 (mean of 8.0 kg/day for 210 days)
Total	**2340**	**2340**
Silage (kg DM)		
1st winter	500	500
2nd winter	-	410 (6.5 kg /day for 63 days)
Total	**500**	**910**
Land – both breed types		
ha per animal unit	0.37 (0.11 ha silage, 0.26 ha grazing)	0.45 (0.19 ha silage, 0.26 ha grazing)
Animal units/ha	**2.70**	**2.22**
Nitrogen (kg/ha)		
Organic N production	157	151
Permitted fertiliser N (REPS 3)	103	109
Permitted fertiliser N (REPS 4)	157[1]	151[1]
Fertiliser N used (kg/ha)		
Silage	115	115
Aftermath	34.4	34.4
Early grazing	57.5	57.5
Top dressing (once)	13.5	13.5
Total	**94**	**104**

[1]Or to limit of Nitrates Directive; Data as per Table 1 unless otherwise indicated.

5.1.3 Nitrogen

At the stocking rates shown, organic N production is 58 and 68 kg per animal unit for the early maturing and continental crosses, respectively. The corresponding values per ha are 157 and 151 kg. Under REPS 3, this leaves 103 and 109 kg/ha available for application as fertiliser N. The silage plus aftermath requires 44 kg and 63 kg N/ha for the early maturing and continental crosses, respectively. This leaves 59 and 46 kg N/ha available for grazing. The N requirements for early grazing are 40 and 33 kg/ha for the early maturing and continental crosses respectively, leaving 19 and 13 kg/ha available for top dressing on the grazing area. This is sufficient for two standard top dressings which should be sufficient.

5.1.4 Animal performance

Target live weight gains and live weights for both breed types are shown in Table 20. Assumed starting weights in mid March are 40 (early maturing) and 45 (continentals) kg. Live weight gain during the calf rearing period is 0.70 kg/day which is the same as for the *Standard Continental Steer System*. This gives live weights at turnout at 80 and 85 kg for the early maturing and continental breed types, respectively. Live weight gain at pasture is 0.8 kg/day, again the same as for the steers in the *Standard Continental Steer System*, giving weanling weights of 230 to 235 kg. Live weight gain during the first winter is 0.50 kg/day for early maturing heifers and 0.60 kg/day for continental crosses (the corresponding values for early maturing and continental steers are 0.55 and 0.65 kg/day), giving yearling weights of 300 and 310 kg, respectively. Live weight gains during the second grazing season are 0.75 and 0.80 kg/day for early maturing and continental heifers, respectively (compared with 0.90 and 0.95 kg/day for steers of similar breed types) giving end of second grazing season weights of 460 kg for early maturing heifers and 480 kg for continentals. The early maturing heifers are then slaughtered at 83 weeks of age. Mean life time daily gain is 0.72 kg.

Target live weight gain during the 9-week finishing period for the continentals is 1.1 kg/day. This is higher than for finishing steers of similar breed type but should be achievable because the animals are lighter and the finishing period is shorter. Slaughter weight is 550 kg at 92 weeks of age. Mean life time daily gain is 0.78 kg.

Table 20. Target live weight gains and live weights for spring-born early maturing x Holstein-Friesian (EM) and continental x Holstein-Friesian (CT) heifers in a 19 to 21-month system.

		Gain (kg/day)		Total (kg)[1]		Live weight (kg)			
Date	No. days	EM	CT	EM	CT	EM	CT	Age (wks)	Event
March 15	-	-	-	-	-	40	45	-	Start calves
May 12	58	0.70	0.70	40	40	80	85	8	Turn-out 1st summer
Nov. 17	189	0.80	0.80	150	150	230	235	35	House 1st winter
March 23	126	0.50	0.60	70	75	300	310	53	Turn-out 2nd summer
Oct. 19	210	0.75	0.80	160	170	460	480	83	Slaughter (house)[2]
Mid Dec	63	-	1.10	-	70		550	92	Slaughter[2]
Total/Mean	**583(646)[2]**	**0.72**	**0.78**	**420**	**505**	**460**	**550**	**83 (92)[2]**	
Carcass weight (kg)[3]						**235**	**290**		

[1]For period; [2]For continentals; [3]Based on kill-outs of 511 and 527g/kg for EM and CT, respectively.

5.1.5 Output

Output is summarized in Table 21. Mean slaughter weights are 460 and 550 kg for the early maturing and continental heifers, respectively. Corresponding mean carcass weights are 235 and 290 kg following kill-outs of 511 and 527 g/kg, respectively. Mean carcass fat class is slightly higher for the continentals because of the indoor finishing period. Carcass conformation class of the early maturing animals is predominantly 'O'. The continental crosses are 70% 'O' and 30% 'R'. Output per ha is 1243 kg live weight and 635 kg carcass weight for the early maturing heifers, and 1222 kg live weight and 644 kg carcass weight for the continental crosses.

Table 21. Summary of output for spring-born early maturing x Holstein-Friesian (EM) and continental x Holstein-Friesian (CT) heifers in a 19 to 21-month system.

		Per animal		Per ha	
		EM	CT	EM	CT
Live weight (kg)		460	550	1243	1222
Carcass (kg)		235	290	635	644
Conformation	% R	10	30		
	% O	90	70		
Fat class	% 3	60	50		
	% 4	40	50		

5.1.6 Operation

General management of the system is as already described for the spring-born steers slaughtered at 21 months of age.

5.1.7 Variation

It may be difficult to maintain performance of both the calves and yearlings late in the grazing season as herbage growth and quality decline and fertiliser N availability is limited to two top dressings under REPS 3. In this situation, it would be better from an economic view point to reduce stocking rate than to abandon REPS in order to improve performance. While the two breed types are presented as separate systems, in practice it would be sensible to mix them. This would allow for a longer "sales window" and give greater flexibility towards the end of the grazing season. Some continental cross animals might be finished for slaughter off pasture while a proportion of early maturing animals might benefit from a short period of indoor finishing.

5.2 System of 15-Month-Old Heifer Production from Spring Born Calves

5.2.1 Overview

The aim of this system is to produce young "Irish butcher heifers" with light, well-finished carcasses. The system is most suited to early maturing breed types but continentals can be also used. As good overall performance is required and as there is a long expensive finishing period, it is desirable that the animals be as advanced as possible at the end of the first grazing season. Thus, an early starting date of mid February is assumed for calves of 45 kg. Later born backward calves are not suited to the system as they require too long a finishing period.

5.2.2 Inputs

The main inputs are summarised in Table 22. The non-forage inputs are 25 kg milk replacer, 150 kg calf concentrates in the indoor rearing period, 50 kg concentrates at pasture in the first (only) grazing season, and 780 kg concentrates during the finishing period, bringing the total concentrate input to 980 kg per animal. The grazed grass required is 0.65 t DM in the only grazing season. The grazing area required is 0.07 ha per animal up to the availability of silage aftermath (but as shown later more is available). The silage requirement is 0.69 t DM which can be provided from 0.14 ha cut once. Thus, the total area required per animal is 0.20 ha giving a potential stocking rate of 5 animal units per ha. However, this stocking rate cannot be carried within the 170 kg/ha organic N limit of the Nitrates Directive, the context in which the system is described. Operation of the system at the maximum potential stocking rate would require derogation from the Nitrates Directive.

Table 22. Summary of inputs for spring-born early maturing x Holstein-Friesian (EM) heifers in a 15-month system.

Concentrates (kg)	
Calf indoors	150 (as for 21-month steer system)
Calf at pasture	50 (1 kg /day for 20 days after turn-out and for 30 days before housing)
Finishing – 1st winter	780 (4 kg/day for 196 days)
Total	**980**
Grazed grass (kg DM)	
1st season	650 (3.87 kg/day for 168 days)
Total	**650**
Silage (kg DM)	
1st winter	690 (3.5 kg/day for 196 days)
Total	**690**
Land	
ha per animal unit	0.21 (0.14 ha silage, 0.07 ha grazing but using 0.087)[1]
Animal units/ha	**5.0 (Using 4.4)**
Nitrogen (kg/ha)	
Organic N production	170
Permitted fertiliser N (REPS 3)	Cannot be operated in REPS 3
Permitted fertiliser N (REPS 4)	170 (or to limit of Nitrates Directive)
Fertiliser N used (kg/ha)	
Silage	115
Aftermath	34.4
Early grazing	57.5
Top dressing (once)	13.5
Total	**142**

[1]To comply with Nitrates Directive; Data as per Table 1 unless otherwise indicated

5.2.3 Nitrogen

Organic N production is 38 kg per animal. Thus, a maximum of 4.4 animals per ha can be carried under the 170 kg organic N per ha limit. This leaves 90 kg/ha of fertiliser N available under REPS 3. At 4.4 animals per ha the silage area required is 0.62 ha. This area alone (plus aftermath) has a fertiliser N requirement of 93 kg, so the system cannot be operated within REPS 3 (it could be operated under REPS 4).

For present purposes it is assumed that it is operated at 4.4 animal units per ha and within the 170 kg organic N per ha limit of the Nitrates Directive. Fertiliser N requirement for early grazing is 22 kg. With surplus grazing area available there should be little need for N top dressing but two top dressings of the total area (27 kg/ha) (in addition to the aftermath application on the silage area) are included. Thus, the total fertiliser N requirement is 142 kg/ha.

5.2.4 Animal performance

Target live weights and live weight gains are shown in Table 23. The system must be based on early born calves as it is vital that they weigh at least 100 kg at turn-out. This, together with good grassland management will ensure good performance during the (only) grazing season. Live weight gain at pasture is 0.85 kg/day, slightly higher than for the 21-month heifer system (0.80 kg/day) described earlier. This higher gain is achievable because the calves are heavier at turn-out and they are housed 3 weeks earlier in autumn when performance normally declines. The animals are finished over the first winter. The finishing period is 196 days and mean daily gain is 0.90 kg. This high target is achievable because the feeding level is high (50 % of the dietary DM is concentrates and the remainder is good quality silage) and slaughter weight is low. Kill-out proportion at 524 g/kg is higher than for the early maturing heifers slaughtered at 18 months (511 g/kg) described earlier. This is because they are 3 months younger but only 40 kg lighter and they are slaughtered off a high quality diet. Mean life time growth rate is 0.84 kg/day.

Table 23. Target live weight gains and live weights for spring-born early maturing x Holstein-Friesian heifers in a 15-month system.

		Gain				
Date	**No. days**	**kg/day**	**Total (kg)[1]**	**Live weight (kg)**	**Age (wks)**	**Event**
Feb 17	-	-	-	45	-	Start calves
May 12	84	0.70	60	105	12	Turn-out 1st summer
Oct 27	168	0.85	140	245	36	House 1st winter
May 11	196	0.90	175	420	65	Slaughter
Total/Mean	**448**	**0.84**	**375**	**420**	**65**	
Carcass weight (kg)				**220** (kill-out 524g/kg)		

[1]For period

5.2.5 Output

Output is summarised in Table 24. Slaughter weight is 420 kg and carcass weight is 220 kg. Carcass fat class distribution is 60 % 3 and 40 % 4. Mean carcass conformation class is predominantly 'O'. Continental crosses have a lower carcass fat class but better carcass conformation. Output per ha is 1848 kg live weight and 968 kg carcass weight.

Table 24. Summary of output for spring-born early maturing x Holstein-Friesian heifers in a 15-month system.

		Per animal	Per ha
Live weight (kg)		420	1848
Carcass (kg)		220	968
Conformation	%R % O	10 90	
Fat class	% 3 % 4	60 40	

5.2.6 Operation

Calf rearing and management up to the end of the first grazing season are as described previously. The allowance of 50 kg concentrates at pasture is fed at 1 kg/day for 20 days after turn-out in spring and for 30 days before housing in autumn.

During finishing, the animals are fed good quality silage ad libitum plus 4 kg/day concentrates. The data in Table 23 are for early maturing breed types. Continental breed types would have a somewhat higher growth rate and a higher kill-out proportion resulting in live weights and carcass weights of 20 and 15 kg heavier, respectively. It is important to ensure that grass quality remains good throughout the grazing period but this is more difficult than for other systems because there are no adult animals to follow the calves in the grazing rotation. It would be desirable to have such animals from outside the system otherwise extensive topping of the pasture is necessary. On a dairy farm, in-calf dairy heifers or dry cows could serve this purpose and help to ensure good quality pasture for the calves.

5.2.7 Variation

This system is really better suited to autumn-born than to spring-born calves. Autumn-born calves require a shorter finishing period and so have lower feed costs. Alternatively, autumn-born continental calves could be taken to heavier weights, which would leave the carcasses suitable for export as well as for the domestic trade. However, as discussed earlier, only a small proportion of heifer calves are autumn-born and there is a wide range in birth dates. While the light carcasses produced in this system may have rather poor conformation, nevertheless because of their relative immaturity, they have a high proportion of hind quarter (more valuable cuts), a low proportion of bone and a high proportion of meat.

6. Systems of Young Bull Production

6.1 Systems of 17-Month-Old Young Bull Production from Spring-Born Calve

6.1.1 Overview

The aim of this system is to produce young bulls in summer time from spring-born calves. Because the system has a long expensive indoor finishing period, it is best suited to early born calves. Thus, the same birth date (Feb 17) is assumed as for the 21-month old steer system with spring-born calves. The system is described for both Holstein-Friesians and continental crosses. Early maturing crosses are not ruled out but their carcasses would probably be too light for the normal bull carcass markets.

6.1.2 Inputs

The main inputs are summarized in Table 25. The non-forage inputs are 25 kg milk replacer, 150 kg calf concentrates in the indoor rearing period, 40 kg concentrates at pasture in the first grazing season and 1400 kg concentrates in the finishing period bringing the total concentrate input to 1590 kg. The grazed grass required is 0.64 t in the only grazing season. Up to the availability of aftermath, this can be provided by 0.07 ha grazing area. The total silage DM required is 1120 kg. This can be harvested from 0.23 ha cut once. Thus, the total area required is 0.30 ha per animal unit giving a potential stocking rate of 3.33 animal units per ha. (The stocking rate could be increased by taking more than one silage cut but as shown later, 3.33 animal units per ha is close to the maximum stocking rate within the 170 kg/ha organic N limit of the Nitrates Directive). Surplus herbage is harvested as baled silage and is not really required for the system.

Table 25. Summary of inputs for spring-born Holstein-Friesian and continental x Holstein-Friesian young bulls in a 17-month system.

Concentrates (kg)	
Calf indoors	150 (as for 21-month steer system)
Calf at pasture	40 (1 kg/day for 3 weeks after turn out and for 3 weeks before housing)
Finishing – 1st winter	1400 (5 kg/day for 280 days)
Total	**1590**
Grazed grass (kg DM)	
1st season	640 (4 kg/day for 161 days)
Total	**640**
Silage (kg DM)	
Finishing - 1st winter	1120 (4 kg/day for 280 days)
Total	**1120**
Land	
ha per animal unit	0.30 (0.23 ha silage, 0.07 ha grazing)
Animal units/ha	**3.33**
Nitrogen (kg/ha)	
Organic N production	158
Permitted fertiliser N (REPS 3)	Cannot be operated in REPS 3
Permitted fertiliser N (REPS 4)	158 (or to limit of Nitrates Directive)
Fertiliser N used (kg/ha)	
Silage	115
Aftermath	34.4
Top dressing	13.5
Early grazing	57.5
Top dressing	13.5
Total	**161**

Data as per Table 1 unless otherwise indicated and for both breed types

6.1.3 Nitrogen

Organic N output per animal is 48 kg. At 3.33 animals per ha, total organic N production is 158 kg, just 12 kg short of the maximum allowable under the Nitrates Directive. This leaves a possible 102 kg fertiliser N for use under REPS 3. Clearly, this is not sufficient for a system that has 76% of its area harvested for silage. Thus, the system cannot be operated within REPS 3 but with minor adjustment could be operated within REPS 4. (To operate within REPS 3 would require that stocking rate be reduced to 2.8 animal units per ha). Fertiliser N required for silage plus aftermath is 115 kg and that for early grazing is 13 kg. Top dressing the grazing area four times and the silage area twice requires 33 kg. This brings the total fertiliser N requirement to 161 kg/ha. More frequent top dressing is required in this system because grass yield and quality must be maintained at the highest possible level to ensure that the performance targets are achieved.

6.1.4 Animal performance

Target live weight gains and live weights for both Holstein-Friesians and continental crosses are shown in Table 26. Daily live weight gain during the 12-week rearing period is 0.70 kg, similar to that for the 21-month steer system described earlier. Thus, calves weigh 100 kg or more at turn-out. Live weight gain during the grazing season is 0.90 kg/day for continentals and 0.85 kg/day for Holstein-Friesians. The value for continentals is slightly higher than for the 21-month system described earlier but the animals are housed one week earlier and do not experience the negative effects of castration. During the 40-week finishing period, mean daily gain is 1.15 kg for Holstein-Friesians and 1.25 kg for continentals. While these gains are high they have been frequently achieved under experimental conditions.

Mean life time daily gain is 1.01 and 1.06 kg/day for Holstein-Friesians and continentals, respectively. Estimated kill-out proportions are 526 and 550 g/kg, respectively.

Table 26. Target live weight gains and live weights for spring-born Holstein-Friesian (FR) and continental x Holstein-Friesian (CT) young bulls in a 17-month system.

		Gain							
		kg/day		Total (kg)[1]		Live weight (kg)			
Date	**No. days**	**FR**	**CT**	**FR**	**CT**	**FR**	**CT**	**Age (wks)**	**Event**
Feb. 17	-	-	-	-	-	40	45		Start calves
May 12	84	0.70	0.70	60	60	100	105	12	Turn-out 1st summer
Oct. 20	161	0.85	0.90	140	145	240	250	35	House 1st winter
July 27	280	1.15	1.25	330	350	570	600	75	Slaughter
Total/Mean	**525**	**1.01**	**1.06**	**530**	**555**	**570**	**600**	**75**	
Carcass wt. (kg)[2]						**300**	**330**		

[1]For period; [2]Based on kill-out proportions of 526 and 550g/kg for FR and CT, respectively.

6.1.5 Output

Output is summarized in Table 27. Mean slaughter weights are 570 and 600 kg for Holstein-Friesians and continental crosses, respectively. Corresponding carcass weights are 300 and 330 kg. Mean carcass fat class is 3. It is somewhat lower for continental crosses than for Holstein-Friesians and a small proportion of carcasses may fail to reach fat class 3. Bull carcasses of fat class 2 are accepted in continental EU markets but they may not be accepted in Ireland. This should be checked with the meat plant in advance. Carcass conformation is predominantly 'O' for Holstein-Friesians and predominantly 'R' for continental crosses. Output per ha is 1898 kg live weight and 999 kg carcass for Holstein-Friesians, and 1998 kg live weight and 1099 kg carcass for continental crosses.

Table 27. Summary of output for spring-born Holstein-Friesian (FR) and continental x Holstein-Friesian (CT) young bulls in a 17-month system.

		Per animal		Per ha	
		FR	CT	FR	CT
Live weight (kg)		570	600	1898	1198
Carcass (kg)		300	330	999	1099
	% R	-	70		
Conformation	% O	90	30		
	% P	10	-		
Fat class	% 3	80	90		
	% 4	20	10		

6.1.6 Operation

As the finishing period is long and expensive, it is desirable that the animals are well grown at pasture. Accordingly, a mid February birth date is assumed but an even earlier birth date is desirable. Later born calves can be used but they are lighter at housing and the finishing period is longer and more expensive.

Because there is only one generation of animals in the system, the maintenance of a high quality sward is difficult and it would be better if the system could be operated in conjunction with older animals that would facilitate leader/follower grazing. In the absence of older cattle, removal of surplus herbage as baled silage and/or topping of paddocks is necessary.

The system described is based on one silage cut. This is not ideal. Taking at least two, and probably three cuts would facilitate better matching of the grazing area to the animal requirements and result in better quality herbage. Extra silage is not required in the system at the stocking rate specified and the stocking rate is constrained by the Nitrates Directive.

With such a high proportion of the system area cut for silage, it is not possible to operate within REPS 3 without a considerable reduction (> 20%) in stocking rate (but it could be operated under REPS 4). A reduction in stocking rate would only exacerbate the problem of surplus herbage and maintenance of high quality swards. In view of this, it would be better if this system could be integrated with one having mature animals.

6.1.7 Variation

Although the system may be difficult to operate it does give high output both per animal and per ha. The carcass weights shown are likely to be the minimum commercially acceptable both in terms of weight and finish. Heavier, better finished carcasses can readily be produced by feeding for longer, but before embarking on this, it should be ascertained that the value of the extra carcass gain and better finish cover the extra costs. Producers should also have an understanding with a processing plant on acceptable carcass weight and finish criteria together with a disposal schedule for the animals. Otherwise, there may be difficulties in disposing of the animals at the intended time.

Early maturing breed types have not been mentioned for this system but they can be used. Growth rate and weight for age are similar to those for Holstein-Friesians up to housing. During the finishing period, daily live weight gain is somewhat lower than for Holstein-Friesians but as kill-out is higher, daily carcass gain and carcass weight are about the same. Early maturing breed types are similarly finished to Friesians at 30-40 kg carcass weight lighter, but such light carcasses may not be suitable for the markets available.

6.2 Cereal Beef Production System

6.2.1 Overview

This system involves the rearing of animals to slaughter on ad libitum concentrate diets. It is a high cost system so the main inputs (calves and concentrates) must be relatively cheap for the system to be profitable. All types of calves can be used in the system, but the most common type is Holstein-Friesians because they are relatively cheap, have a reasonably high growth rate and do not fatten at too light a weight. The system has no specific requirement for land as the animals are never put to pasture and the small amount of dietary roughage required can be purchased. However, the requirements of the Nitrates Directive must be adhered to in management of the slurry. Calves born at any time of the year can be used and slaughter age is 12-13 months.

6.2.2 Inputs

The feed inputs are summarized in Table 28. They are 25 kg milk replacer, 150 kg calf concentrates in the rearing period and 2050 kg concentrates in the finishing period. The roughage required is 0.30 t DM of good quality hay or silage. As the animals are never grazed, the only land required is that necessary to produce the roughage if it is not purchased from outside. Assuming the roughage is home produced as silage with a consumed yield from multiple cuts of 10 t DM/ha, the theoretical stocking rate is 33 animals per ha.

Table 28. Summary of inputs for Holstein-Friesian young bulls in a cereal beef system.

Concentrates (kg)	
Calf rearing	150 (as for the 17-month young bull systems)
Finishing	2050 (ad libitum for 9 months)
Total	**2200**
Grazed grass (kg DM)	
Total	**None**
Silage (kg DM)	
Finishing	300 (max of 1 kg/day)
Total	**300**
Land	
ha per animal unit	Not applicable
Animal units/ha	**Restricted to 7 by Nitrates Directive**
Nitrogen (kg/ha)	Not applicable
Fertiliser N used (kg/ha)	Not applicable

Data as per Table 1 unless otherwise indicated

6.2.3 Nitrogen

The organic N output is 24 kg per animal. Thus, the maximum stocking rate possible within the Nitrates Directive limit of 170 kg/ha organic N is 7 animals per ha. Clearly, this system cannot be operated on a typical grassland farm and must be integrated with a tillage or similar enterprise.

6.2.4 Performance

Target live weight gains and live weights for Holstein-Friesian bulls are shown in Table 29. Starting date is assumed to be Feb. 17 as for the 17-month-old young bull system, and the animals weigh 100 kg after 12 weeks. They are then offered concentrates ad libitum to slaughter at 12 months. For the first 6 months, mean daily live weight gain is 1.30 kg resulting in a live weight of 340 kg at 9 months of age. Over the final 3 months, mean live weight gain is 1.15 kg/day. If kept beyond 12 months, mean daily live weight gain falls below 1.0 kg/day at which stage the cost of extra gain could exceed its value.

Mean life time live weight gain is 1.13 kg/day, so the animals express their full growth potential throughout life. Mean kill-out is 533g/kg.

Table 29. Target live weight gains and live weights for Holstein-Friesian young bulls in a cereal beef system.

		Gain				
Date	**No. days**	**kg/day**	**Total (kg)[1]**	**Live weight (kg)**	**Age (wks)**	**Event**
Feb. 17	-	-	-	40	-	Start calves
May 12	84	0.70	60	100	12	Concentrates *ad libitum*
Nov. 10	182	1.30	240	340	38	Continue concentrates *ad libitum*
Feb. 16	98	1.15	110	450	52	Slaughter
Total/Mean	**364**	**1.13**	**410**	**450**	**52**	
Carcass weight (kg)				**240 (kill-out 533 g/kg)**		

[1]For period

6.2.5 Output

Output is summarized in Table 30. Mean slaughter weight and carcass weight are 450 and 250 kg, respectively. Mean carcass fat class is 3 and mean carcass conformation class is 'O'. Output per ha does not apply.

Table 30. Summary of output for Holstein-Friesian young bulls in a cereal beef system.

		Per animal	Per ha
Live weight (kg)		450	Not applicable
Carcass (kg)		250	Not applicable
Conformation	%O	90	
	%P	10	
Fat class	%2	10	
	%3	90	

6.2.6 Operation

The system is simple to operate and can start and end at any time of the year. Healthy calves are vital. It is particularly important that they remain free of respiratory disease, as later in life, dust from the concentrate ration can aggravate earlier respiratory problems causing them to recur. If the animals are housed on slats or concrete, lameness can occur, so occasional foot bathing may be necessary. While on ad libitum concentrates, the animals should never run out of feed, otherwise when it is restored, they may over-eat and develop acidosis. Similarly, new feed batches should be introduced gradually by mixing with the existing batch for a few days.

There is little tradition of this production system in Ireland and carcasses are much lighter than normal. Therefore, it is necessary to ensure that there is an outlet for this type of carcass before embarking on the system.

6.2.7 Variation

There is little scope for variation in the system. All breed types, including heifers can be used but beef cross calves are generally too expensive to be profitable. Heifer calves are slower growing and less efficient than bulls. When concentrates are relatively cheap, the animals can be retained for up to 6 weeks extra and taken to 270 kg carcass weight. Such carcasses are more saleable. When calves are relatively cheap but concentrates are relatively expensive lighter carcasses can be considered, but a market outlet should be secured in advance.

Notes