Beef cow research programme

Assessing the impact of infectious diseases on key reproductive and health traits in Irish suckler beef herds, is outlined by Dr Mervyn Parr BAgrSc PhD and Professor David Kenny BAgrSc PhD DipStat DipMolMed DipLeadDev, Teagasc, Animal and Grassland, Research and Innovation Centre (AGRIC), Grange, Co Meath; and Damien Barrett MVB MVM MSc Cert CHP DipECBHM, Department of Agriculture, Food and the Marine, Backweston, Celbridge, Co Kildare

Improving reproductive efficiency will be one of the key factors in achieving the productive and economic targets set out for the beef industry in the Food Wise 2025 report. The target calving-to-calving interval for a suckler herd is 365 days (Diskin and Kenny, 2014). However, according to recent statistics provided by the Irish Cattle Breeding Federation (ICBF), the average calving interval for Irish suckler herds in 2016 was 399 days, with only eight in every 10 beef cows producing a calf on a 12-month cycle (ICBF, 2016).

Numerous bacterial, viral and protozoan pathogens, including leptospirosis, bovine viral-diarrhoea (caused by bovine viral-diarrhoea virus; BVDV), infectious bovine rhinotracheitis ([IBR] caused by bovine herpesvirus-1; BHV-1) and neosporosis (caused by neospora canium), have been associated with poor reproductive performance in cattle.

Depending on timing of exposure and the animal's immune susceptibility status, these pathogens can have a significant impact on the cow's ability to produce a viable healthy calf and can result in abortions, stillbirths, or the birth of weak calves. Specifically, a reduction in conception rate has been shown in cows infected with IBR (Parsonson and Snowdon, 1975), BVDV (McGowan et al, 1993) and leptospirosis (Guitian et al, 1999), in particular. However, it must be noted that the impact on fertility recorded in these studies followed various methods of inoculation of animals with the pathogens in question at, or immediately before insemination.

Furthermore, cows infected with *Neospora caninum* were shown to be two to seven times more likely to abort in comparison to their seronegative herd mates (Van Leeuwen et al, 2010).

QUESTIONS ADDRESSED BY THE RESEARCH

- What proportion of Irish beef cow herds are routinely vaccinating breeding females for BHV-1, BVDV and leptospirosis?
- What is the prevalence of BHV-1, BVDV, leptospirosis, and neosporosis in suckler beef herds on the island of Ireland?
- What effect (on cows and progeny) are these pathogens having on key economically important traits such as calving interval and calf mortality?

BEEF COW RESEARCH PROGRAMME

An all-Ireland beef cow fertility research programme funded by the Department of Agriculture, Food and the Marine (DAFM), led by Teagasc Grange, University College Dublin (UCD), the DAFM's Regional Veterinary Laboratory Service (RVLs), the Irish Cattle Breeding Federation, and the Agri-Food and Biosciences Institute in Northern Ireland, was developed to examine a range of factors affecting the fertility of beef heifers and cows.

BREEDING AND REPRODUCTIVE MANAGEMENT SURVEY

The first of these initiative involved the design and roll out of a comprehensive breeding and reproductive management survey, which was completed by 537 beef cow herd owners across the island of Ireland. One of the key aims of the survey was to gain a greater understanding of the herd health strategies currently being employed on Irish suckler herds. Respondents provided information on their management approach to herd fertility as well as to their attitude towards various technological aids.

EPIDEMIOLOGY

Almost 6,000 cows from 161 spring calving suckler herds from across the island of Ireland were enrolled in a large on-farm study. A total of 139 herds were sampled in the Republic of Ireland and 22 herds were sampled in Northern Ireland. Blood sampling took place over the summer months of 2014 and 2015. Serology testing was carried out by the DAFM RVLs. Records for participating herds in the Republic of Ireland pertaining to calving interval and calf mortality were extracted from the Irish Cattle Breeding Federation database.

A total of 18%, 32% and 45% of herd owners involved in the study routinely vaccinated for IBR, BVDV and leptospirosis, respectively. For the purpose of this summary, results were summarised for non-vaccinating herds for each specific pathogen only. In assessing the effect of the respective

pathogens on reproductive and performance traits, only data from cows sampled in non-vaccinating herds in the Republic of Ireland were included.

MAIN RESULTS

- A total of 8%, 17%, 6% and 2% of beef cow herd owners surveyed had a clinical case of IBR, BVDV, leptospirosis and neosporosis, respectively, in the last five years.
- Less than one in six suckler farmers (15%) routinely vaccinate for IBR.
- Just over one in four respondents (27%) vaccinate for BVDV, whereas 35% routinely vaccinate against leptospirosis.
- The data is in marked contrast to previous studies, which reported significantly lower usage of vaccines for IBR (2%; Cowley et, 2011), BVDV (2%; Cowley et al, 2012) and leptospirosis (3%; Ryan et al, 2012) in Irish beef cow herds. Such divergence may reflect differences in the survey approach taken across studies.

ON-FARM EPIDEMIOLOGY STUDY

- Mean within herd seroprevalence of BHV-1, BVDV and leptospirosis in non-vaccinating herds, was 40%, 77% and 65% respectively.
- Mean within herd seroprevalence of neosporosis was 6%; however, there is no vaccine available for *Neospora caninum* in the Republic of Ireland.
- The percentage of first parity cows recorded seropositive for BHV-1, BVDV, leptospirosis and neosporosis, were 11%, 10%, 11% and 19%. This was in contrast to cows with a parity number of six or greater, of which 37%, 38%, 36%, and 29% were sero-positive for the respective pathogens.
- Preliminary findings suggest that there was no difference in calving interval between seronegative and seropositive cows for any of the aforementioned pathogens (see Table 1).
- Similarly, we failed to establish any difference in calf mortality, recorded up to 28 days of age, in calves born to either sero-negative or sero-positive cows for any of the pathogens studied.

SUMMARY AND IMPLICATIONS FOR IRISH SUCKLER HERDS

This was one of the largest and most comprehensive studies of its kind ever to be carried out on the island of Ireland.

The findings of the reproductive management survey suggest that a sizeable proportion of beef cow herd owners are vaccinating their breeding females against a number of pathogens, despite the low incidence of clinical cases identified on these herds during the preceding five years. Seroprevalence was determined for BHV-1, BVDV, and leptospirosis in non-vaccinating herds and neosporosis in all herds.

Our results indicate that the prevalence of each pathogen studied increased with cow parity.

Furthermore, we did not observe evidence for an effect of seroprevalence for any of the pathogens measured on calving interval or calf mortality up to 28 days of age. It is envisaged that the findings of this research will contribute towards a more comprehensive understanding of the implications of pathogen status on the reproductive and productive performance of beef cow herds.

FUTURE WORK

Further examination of the data will assess the impact, if any, of the aforementioned pathogens on other reproductive performance (12-week, in-calf rate and replacement rate), animal performance (calf live-weight gain) and calf mortality (up to 225 days) traits. The risk factors associated with the prevalence of each pathogen will also be examined.

Furthermore, genetic analysis will be carried out to determine the heritability of the aforementioned pathogens, the results of which could be incorporated into future breeding programmes.

Finally, the data generated will form the basis of a comprehensive bioeconomic analysis which will quantify the economic impact of these diseases at a herd level.

REFERENCES ON REQUEST

Trait pathogen		Sero-positivity status		P-value
	No of cows	Negative (± SEM)	Positive (± SEM)	
Calving interval (days)				
BVDV	2210	388.4 (± 3.45)	386.3 (± 2.07)	0.56
BHV-1	2782	385.7 (± 1.88)	389.3 (± 2.16)	0.16
Leptospirosis	1529	385.2 (± 3.52)	384.6 (± 2.60)	0.88
Neosporosis*	3471	386.6 (± 1.42)	391.1 (± 4.08)	0.26
Calf Mortality % (0-28d)				
BVDV	2514	2.6 (± 0.9)	3.6 (± 0.5)	0.33
BHV-1	3233	2.9 (± 0.5)	3.3 (± 0.6)	0.57
Leptospirosis	1765	3.8 (± 0.9)	2.9 (± 0.7)	0.42
Neosporosis *	4174	2.8 (± 0.2)	2.1 (± 1.1)	0.57

Table 1. Effects of BHV-1, BVDV, leptospirosis and neosporosis status on calving interval and calf mortality (≤28 days) in non-vaccinating herds (animals from Republic of Ireland only).*No vaccine available for *N canium* in the Republic of Ireland thus data from all participating herds are presented.

Role of nutrition in successful fertility management

Driving fertility gains in Irish dairy herds through better nutrition management is outlined by Joe Patton BAgrSc PhD, Teagasc dairy specialist

SIX-WEEK CALVING RATE: KEY METRIC FOR BLOCK CALVING HERDS

Successful fertility management for block calving dairy herds is best defined by calculating the proportion of the eligible herd calving in the first 42 days after planned start-of-calving date. The Teagasc research target is 90% calved in six weeks; some top performing farms are now regularly achieving 80% plus. A short calving season duration (<12 weeks) and low not-in-calf rate (<10%), in combination with a high six-week calving rate, bring significant whole-farm economic gains through increased milk solids output and reduced purchased feed costs, as well as lower culling and replacement rearing costs. A perceived downside is concentrated workload through February and March but labour efficiency is often improved across the year.

The rationale for maximising six-week calving rate is self-evident for spring calving herds, but most liquid/winter calving herds will also gain through a consequent reduction in the proportion of late calving and carryover/recycled cows within the herd. The national average spring six-week calving rate stands at approximately 58% so there is ample scope for improvement.

SIX-WEEK CALVING RATE: A COMBINATION OF SUBMISSION AND CONCEPTION RATES

A high herd six-week calving rate occurs through a combination of high submission rates for service in the first three (and six) weeks of breeding, plus good conception rates to first and second insemination (see Table 1).

	Conception rate (average)		
Submission rate	**40**	**50**	**60**
High*	62	**74**	**82**
Medium	**55**	**65**	**75**
Poor	**46**	**56**	**65**

Table 1: Projected six-week, in-calf rates for a range of conception rates and submission rates.
**High = 90% in first three weeks and 100% in six weeks; medium = 80% in first three weeks and 90% of remaining non-pregnant cows in six weeks; poor = 60% in first three weeks and 75% of remaining non-pregnant cows in six weeks.*

Many dairy herd managers have traditionally focused on conception rate or 'number of repeats' as the primary indicator of breeding performance within season. Conversely, some excellent work by the InCalf Australia Project (MacMillan, 2012) has shown that submission rate actually explains more of the between-herd variation (R^2 = 0.59) in six-week calving rate than conception rate (R^2 = 0.29) in block calving herds. Interestingly, that study also showed much less herd-to-herd variation in conception rate than submission rate. It also renders the concept of a voluntary waiting period, ie. a defined minimum number of days between calving and first service, as effectively redundant for our dairy systems.

HERD MANAGEMENT PRACTICES TO IMPROVE SIX-WEEK CALVING RATE

In terms of practical herd management, the target is to have over 90% of eligible cows submitted in the first 21 days of the breeding season, and to have 100% of eligible cows submitted for first insemination in the first 42 days of breeding. Eligible cows are defined as all cows in the herd intended for breeding that season including those not calved by mating start date, otherwise herds with a high percentage of late calving cows have positively skewed data. If this submission rate is achieved in conjunction with a realistic first service conception rate of approximately 52-55% then subsequent six-week calving rates will be on target.

A three-week submission rate of >90% is no mean feat of management however, and is virtually impossible without skilled heat detection, and good use of records and heat detection aids. Importantly, it also it requires practically all eligible cows in the herd to have recommenced ovarian cyclicity, to be free of uterine infection, and to be in the correct nutritional and body condition score status at mating start date. A comprehensive protocol needs to be in place well in advance of breeding to meet these objectives. Targets need to be regularly monitored on an individual cow basis. Some of the key herd nutrition issues to be addressed in advance of the spring breeding period are body condition score, mineral supplementation and managing feeding of late calved cows.

BODY CONDITION SCORE

Body condition score (BCS) is a subjective physical measure of energy balance and body reserves, conducted on a five-point scale with 0.25 increments (Buckley et al, 2003). The ideal BCS profile for good fertility status (early resumption of ovarian cyclicity, good developmental competence of embryos) is to have a BCS of 3.25 at calving, and to limit BCS loss to less than 0.5 points from calving to breeding- this means BCS should be 2.75 or higher at breeding with cows on a rising plane of energy balance. This is the primary nutritional consideration for improving fertility in grazing systems, and it explains much more herd-to-herd variation in performance than other factors such as grass protein, blood/milk urea levels, grass fibre content etc. (Roche et al, 2009).

Management to meet target BCS at calving should

commence in late lactation and continue through the dry period, where days dry and/or plane of nutrition can be altered to correct issues with individual animals. Excess BCS at calving (>3.50) reduces appetite post-calving, results in subclinical ketosis (blood ß-hydroxybutyrate >1.2mmol/L), and increases the risk of milk fever. In an Irish context, over-conditioning at calving generally is more associated with extended calving intervals and long dry periods, rather than feeding dry-cow diets with high-energy content per kg dry matter. Herds with good fertility thus tend to have lower risk of metabolic problems to begin with. Cows with very low BCS at calving have compromised immune function and remain anoestrous for longer after calving. Studies conducted in Teagasc Moorepark (Butler et al, 2011) and internationally (Douglas et al, 2006) have demonstrated that meeting the 3.25 BCS target at calving is the most important factor affecting subsequent lactation and fertility performance, rather than type of dry cow diet fed *per se*.

While the nutritional standards for dry cows to meet BCS targets at calving are quite straightforward, the situation becomes complicated by genotype-dependent differences in the balance of nutrient partitioning to lactation or body reserves after calving. Selection for generations of increased peak milk yield, without reference to changes in BCS, has resulted in certain cow genetic lines that preferentially partition ingested nutrients to milk production while mobilising body fat in early lactation. Such differences favour BCS loss and are mediated through changes in the ratio of insulin to growth hormone in early-to-mid lactation. This further impacts the somatotropic (GH-IGF-1) axis with negative consequences for resumption of normal ovarian function (Lucy, 2016). The effect is exacerbated by further selection for stature and angularity as linear type score objectives.

The practical upshot is that it is very difficult to maintain BCS for these cow types in early lactation, even where cows are fed to maximum daily dry matter intake capacity. As shown in Figure 1 (McCarthy et al, 2007), the rate of BCS change from day 1-100 of lactation was unaffected by additional concentrate feeding on a high-quality diet, however, high Economic Breeding Index (EBI) genotypes held a consistent BCS advantage over low EBI genotypes across all feeding levels. Extra concentrate input does increase BCS later in lactation, but not in time to significantly alter BCS for current breeding.

This may also explain, at least in part, why fertility responses to extra concentrate feeding in early lactation have consistently been poor across numerous studies. That is not to say that feed deficits should not be supplemented, but rather that the BCS responses to additional concentrate feeding are slow, genotype-dependent and unlikely to result in a major shift in herd fertility levels in isolation.

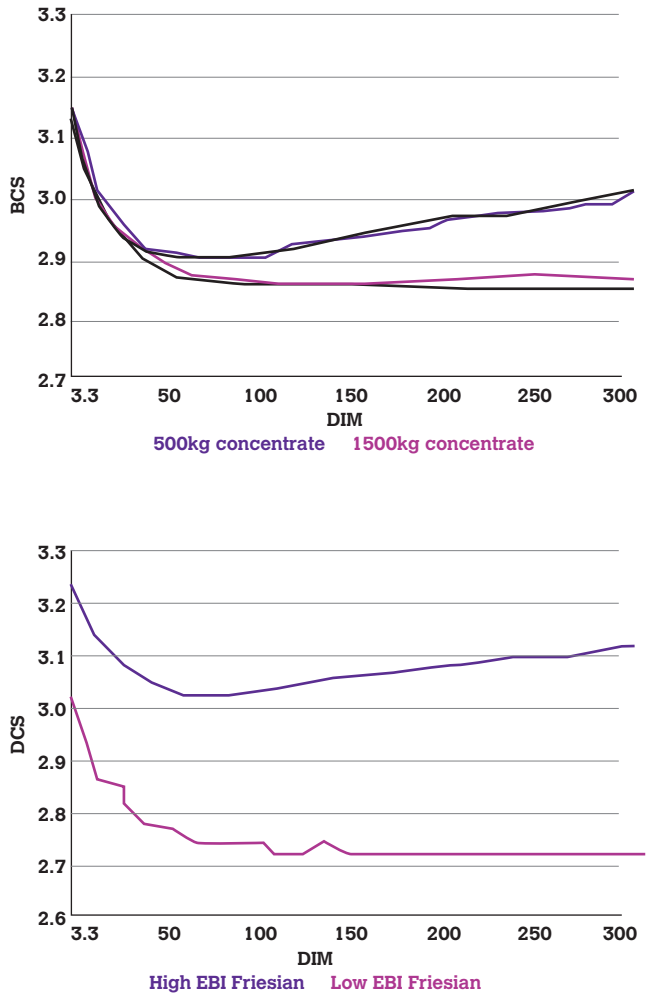

Figure 1: Effects of concentrate feeding and genotype on body condition score profiles.

ONCE-A-DAY MILKING

A very effective alternative management option to remedy poor post-calving BCS is to milk selected cows a once-a-day (OAD) for four to six weeks pre-breeding. The milking herd should be BCS scored in late March and any thin (BCS <2.5) cows eligible for breeding placed on OAD milking immediately. Leave these cows with the main milking herd on the same plane of nutrition; allowing cows to enter the parlour during afternoon milking is not an issue. A 15-20% reduction in short-term milk solids yield is expected, but this reduction in metabolic demand from the mammary gland quickly alters partitioning towards replenishment of body fat reserves (Patton, 2004). Where cows are anoestrous but have clean uterine scores (G1), OAD milking has been reported to reduce interval to first ovulation by approximately 10 days on average. It is also a very effective tool to aid recovery in cases of dystocia, milk fever, surgery etc. Low SCC (<100,000 cells per ml) is a prerequisite for OAD treatment.

MINERAL STATUS IN THE MILKING HERD

Any discussion of herd nutrition-fertility interactions among dairy farmers usually turns to mineral supplementation quite quickly. The complexity of defining requirements and interactions, non-specific deficiency symptoms, and the proliferation of commercial products contribute to confusion. Dividing the issue into 2x2 matrix ie. pre- and post-calving, macro and micro minerals, can

Sample mg/kg	Grass values mg/kg	Cow Req.(mg/kg DM)	Daily Req (mg/d)	Feed mineral (mg/d)
Iodine	0	0.8	14.4	12.5
Copper	7.9	16	288	145
Selenium	0.05	0.28	5.04	4.1
Zinc	28	40	720	216
Cobalt	0.05	0.45	8.1	7.2
Manganese	69	25	450	-
			Daily req (g)	
Calcium	6500	6500	120	-
Phosphorus	4500	3800	69	-
Potassium	26000	9000	162	-
Magnesium	1500	3100	56	29
Sodium	2000	2200	40	3.6
Sulphur	2200	2000	35	-

Table 2: Calculating daily mineral supplementation rates based on grass analysis.

help to clarify some issues. In the pre-calving period, the principal concern is promotion of good blood-calcium status at calving by provision of adequate Mg and P as macro minerals, and covering the daily micro mineral requirements (iodine, copper, zinc, manganese, selenium, and cobalt) for good immune function and metabolic efficiency.

After calving with spring grass in the diet, the objective remains the same – meet the cows' total daily requirements for macro and micro minerals alike. Testing grass mineral status of numerous paddocks in the second and third grazing round (not first round) is recommended, from which shortfalls can be determined. An example is shown in Table 2; here grass values (column 2) are compared to NRC (National Research Council, 2001) recommendations (column 3) for lactating cows. At an assumed grass DMI of 18kg DM per day, the sward is deficient in iodine, copper, selenium, zinc and cobalt as a

sole feed – supplementation for two to three months after calving would be recommended, along with magnesium for grass tetany prevention. Phosphorus is also commonly deficient on low P-index swards.

While the marginal trace mineral deficiencies in pasture shown in this example would be quite typical, and would necessitate early lactation supplementation, it should be noted that recent surveys of Irish dairy herds found adequate or over-supplementation with minerals to be a more common occurrence than deficiency situations in practice. So, while it is tempting to believe that the solution to a herd's fertility issues can be found in feeding extra minerals, this is unlikely to be the case for most dairy herds.

NUTRITION AND MANAGEMENT OF LATER CALVING COWS

Cows calving from late March onwards are a key sub-group in the herd as they have a much greater risk of being anoestrus at mating start date. This is principally due to a shorter interval for uterine involution and resumption of cyclicity (<50 days), but also because late-calving cows tend to experience greater levels of dystocia, (sub)-clinical milk fever, retained placenta and ketosis. They tend to be older, have longer dry period duration and excess BCS at calving, often are in-calf to longer gestation beef bulls, and have poorer mineral status due to less regular supplementation. In short, this group have the highest risk of failing to achieve pregnancy by day 42 of breeding yet management practices aggravate the problem in many herds.

It is essential to control BCS gain to a maximum 3.25 by limiting intake in the early dry period if necessary; ensure 25g of supplementary Mg is continued until point of calving; feed a low K forage (<2.2%) before calving; and use short gestation bulls with calving difficulty of less than 2.0% as a rule.

A WORD ON GENETIC MERIT FOR FERTILITY

In contrast to the relative inconsistencies in fertility response to increasing concentrate feeding rates for grass-based herds, increasing genetic merit for fertility traits (target herd EBI sub-index of €60 or higher) has been shown to shorten days to first ovulation, reduce the incidence of metritis, improve oocyte and embryo quality, increase plasma progesterone post-insemination, and reduce embryo mortality rates (Cummins et al, 2012). These effects occurred across a range of feed input levels and were independent of any milk yield difference. While it is unrealistic to expect genetics for fertility to overcome poor management, ignoring the proven benefits of breeding for improved fertility is misguided.

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