With Cow Efficiency #PhenotypeIsKing

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The basic driver for dairy and beef farming (as in most businesses) is the relationship between the cost of inputs and the value of outputs. Other drivers unpredictably appear over time e.g. climate crisis, short term input price shocks and these may lead to short term tactical decisions required to stay in business. All strategic decisions taken must be on the basis of remaining profitable in light of expected changing circumstances. Other less tangible outcomes are now entering the farming profit equation such as benefits to society (eco system services payments) but for the purposes of this discussion, those are being ignored for now. In the text below the phrase 'efficiency' is used generally to describe better use of ingested feed but of course, farmers are paid at the system level efficiency which is the sum of all the component part efficiencies and so will include unproductive days, wastage of animals, extra treatment costs etc.

Most dairy farms have operated on marginal profit from increasing inputs where each unit of input created a positive but progressively lower increase in output leading to an industry on the whole of high input and high output. This policy made economic sense in the past because inputs (fertilizer, concentrates) were relatively cheap. Increased outputs per cow were more profitable and had the added benefit of raising individual cow gross efficiency by diluting cow fixed maintenance feed costs. This has led to ever increasing average herd sizes as fixed costs are diluted over more animals (and more income).

A relatively small number of dairy farmers have practiced grazing only systems of production which are, by their nature, low input and low(er) output. These farms have a different profit outcome based on minimum inputs possible (machinery, effort, purchased inputs) with acceptable outputs and which relies on the high availability of grazed forages.

A national mixture of high and low input systems is likely required in future to produce sustainable human edible proteins based on the available resources at the geographical location of the individual farm.

The climate crisis and recent extreme prices shock have emphasised the urgent need to rapidly alter existing farming practices to ensure food security, to make farming systems more resilient to both market and weather perturbations and to enable the target of net zero production to be achieved under these new and emerging constraints.

Energy inputs to farming have always been used judiciously by farmers to increase food output from a fixed area of land; the recent large and rapid increase in price of energy inputs have demonstrated a need to accelerate the journey of change where many different practices need to be investigated and refined to achieve the UN goal of sustainability. This text is about doing things we know *now* to create change that addresses sustainability on dairy and farms.

Genomic selection has advanced rapidly in the UK and US over the last 10 years resulting in increasing rates of gain for production, health and welfare traits but also the exploitation of a small number of expensive and difficult to record phenotypes on feed intake. The creation of a

SNP key (prediction equation) from a few thousand feed intake records allows all other farmers that genotype their cows to exploit that information and select for more feed efficient animals. Thus, the landscape for genetic improvement has altered rapidly and now allows for widespread improvement across the whole population based on a small number of farms/animals being recorded and genotyped.

Size of dairy cows

The size of dairy cows has risen alongside the rise in production. The reasons are many and mostly it's a by product of selection rather than a specific requirement to increase the size of cows (with some exceptions). The size of the UK dairy herd is some 60,000 tonnes heavier than it was 20 years ago. This equates to about 90,000 mature cows that have to be fed each day for the same national output.

With recent rapid and large price spikes in energy costs, increased attention is now being given to cow size and there is a general acceptance that cows are unnecessarily big and need to be reduced in size (not made small but made smaller) to improve energetic efficiency. The UK average mature sized dairy cow would be around 700kg.

Beef on dairy

The rapid increase in the use of sexed semen over the last 5 years (now over 80% of all semen used) has resulted in 2 major outcomes.

1. Dairy farmers can now select their replacement heifers from the top 25% of their herd rather than the top 50%, effectively doubling the selection intensity of their dairy females
2. Leaving an additional 25% of cows that can produce a beef calf.

This means a dairy farmer can choose sexed semen for the top 25% of cows and beef semen for the remaining 75% potentially all from the same supplier and at the same time. The main selection criteria at present is calving ease – a live calf and healthy cow is the dairy farmers prime objective. In many cases the resulting beef calf out of the dairy dam goes into a specialised and integrated supply chain that specialises in consistent management of these calves through to harvest.

Suckler beef (cow calf)

Until recently, around half of UK beef supply was from a beef dam and half from a dairy dam. In the best case scenario, a beef cow could calve at 2 years of age and have between 4 and 6 annual uneventful calvings to produce 4-6 prime beef carcasses during her lifetime. Once the calf has been weaned (and/or sold) the cow has no further product until the next calving. This makes a reasonably easy and crude measure of efficiency to be calculated as lifetime kg of beef output divided by kg days the cow is alive (on the basis that each kg day is a unit of cost). Of course there are many other measures of efficiency but this one is similar to that used in the pig industry and reflects well that each unproductive day is a high financial cost but probably more importantly, in the future a high environmental cost.

There are a few pinch points that become low hanging fruit for suckler beef production

1. Age at first calving should be 24 months. This reduces the average unproductive period by around 180,000 kg days per cow
2. Calf survival should be 100%. Each dead calf reduces efficiency by around 25% if the cow has 4 calves (16% with 6 calves). Put another way, each dead calf requires another cow to have an extra calf to keep the herd energetic status quo.
3. Additional calvings. 6 calves instead of 4 dilutes the cow rearing and maintenance costs by around 30%. However, cows that live longer are taking space of cows that could be genetically superior so a balance needs to be struck.
4. Smaller cows. The suckler cow costs are directly related to the size multiplied by the number of days alive so smaller cows cost less to maintain.
5. Age at slaughter needs to be as small as possible within the constraints that the farm resources impose.

Win Win Win.

In the UK dairy farmers have available to them an index for selection called EnviroCow that expresses all the component traits of the national profit index £PLI in units of CO2 equivalents. The correlation between the two indexes is high indicating that selection for profit also reduces environmental impact. So the farmer wins, the cow wins (because the index has a heavy component of health and welfare traits included) and the environment (society) wins because dairy products have a lower environmental cost per kg product. A large part of that index is cow maintenance costs, so the selection pressure is downwards on size whilst protecting all other valuable traits.

This exercise is being completed also for beef and EnviroBeef will be rolled out to all UK beef farmers later in 2024. It too will have a large component on size and is expected to likewise exert negative pressure on cow size.

Cow size

In the UK very (very) few farmers weigh mature cows and so estimates of mature cow weight have to be computed. We use cull cow carcass weight divided by a standard killing out percentage (KO) of 47 for dairy and 55 for beef. Clearly this could be refined if we had KO% on a per breed basis or even better at a sire level. This would require some weighing of cows pre slaughter to create prediction equations. This is being actively pursued in UK for both purposes – estimating weight and creating a KO% breeding value.

Using carcass trait records (over 10 million) we estimate the difference between the biggest suckler cows and smallest is double and around 400kg. This allows some room for improvement!

The future for beef

It is inevitable that more beef will originate in the dairy herd and this will alter the beef supply chains that operate. Beef from dairy dams produces carcasses that are 30kg lighter and take 2.5 months longer to finish and this will need to be accommodated within the existing supply chains during the transition from the current status quo to some new and different status quo. In the intervening period dairy selection may improve the beef from dairy to reduce the difference, suckler beef farmers might improve key metrics of production reducing their disadvantage in environmental credentials and supply chains may alter their purchasing and

processing habits to accommodate the changing supply. My guess is that it will be a combination of all three – AND not OR.

The changing surrounding environment in terms of machine learning, automation, technical developments and genomics suggests a rapidly changing and very exciting time to be a dairy and beef farmer. Winners will emerge and they will be characterised by a willingness to change rapidly.