Measure 38: Shift from Specialised Dairy Cattle to Dual Purpose Breeds

Category
Livestock management: Structural and management changes

Overview
Traditional cattle breeds have gradually been replaced by the specialized high-yielding dairy breeds Holstein and British Friesian over the last century. However, recent research suggests that the use of dual purpose breeds (i.e. those suitable for both meat and milk production) can reduce the emissions from milk and meat production (Vellinga and de Vries, 2018; Zehetmeier et al., 2012). The reason is that specialized, pure beef production systems show higher GHG emission intensities, compared to beef produced in dairy systems.

Mitigation summary

Effect on GHG categories*	Rating	Notes
Enteric CH_4		
Manure CH_4		
Manure N_2O		
Soil N_2O: applied N		
Soil N_2O: grazing		
Energy CO_2: fieldwork		
Energy CO_2: other		
CO_2 liming and urea		
CO_2 sequestration below ground		
CO_2 sequestration above ground		
Pre-farm emissions		
Post-farm emissions		
Substitution of higher C products	-	Substitutes suckler beef with dairy beef
Production increases by more than the emissions		
Confidence in mitigation effect	Moderate	
Cost-effectiveness**	Low-moderate	
Confidence in cost-effectiveness	Low	

* "-" GHG reduction, "+": GHG increase, " ": no significant effect
** low: =< £0/tCO_2e, moderate: £0/tCO_2e< >SCC, high: >SCC

Related measures and potential synergies

Measure	**Impact on other measures**
Breeding measures	
37 Increased milking frequency	
Any measures that reduce the EI of suckler beef will reduce the AP and CE of this measure, e.g. 3NOP	

Inclusion in other marginal abatement cost curves

UK 2008	UK 2010	UK 2015	Ireland 2012	France 2013	France 2019
N	N	N	N	N	?

What does the measure entail?

Most dairy cattle in the UK are from high milk yield specialized dairy breeds, i.e. Holstein and British Friesian (Figure 1). The measure entails switching from these breeds to dual purpose breeds that have good milk yields and meat production, i.e. fast growth rates and carcass quality. Examples of dual purpose breeds include: Fleckvieh, Norwegian Red and Red Poll.

The meat produced by the dairy herd has a lower emissions intensity (EI) than beef produced in suckler beef systems. This is because in dairy systems, most of the GHG emissions are allocated to milk, whereas in suckler systems most the emissions from the herd are allocated to beef only (a small amount may be allocated to manure or slaughter by-products). Consequently, the EI of suckler beef is on average 70% higher than that of beef from the dairy herd (De Vries et al. 2015).

Milk yields have increased significantly since WWII as the dairy sector has sought to optimise milk production (Figure 2). This is likely to have reduced the EI of milk, as EI and milk yield are closely related (Gerber et al. 2011). Increasing milk yield can lead to significant reductions in EI, by diluting the “maintenance overhead”, i.e. the baseline GHG emitted by the cow (the emissions arising from the maintenance requirements of the cow, rather than the emissions associated with lactation). For example (Capper et al. 2009) estimated that the EI of milk in the USA had decreased by 37% between 1944 and 2007.

However, increasing milk yield per cow means that fewer animals are required to produce a given amount of milk, and therefore fewer dairy cattle are slaughtered and less dairy beef is produced (although the decrease in animals slaughtered may be partially offset by increasing size of dairy cow). To maintain beef production, this reduction in dairy beef has to be compensated for by an increase in (higher EI) suckler beef. One way of avoiding this may be to have dual purpose cattle that produce less milk and more beef.

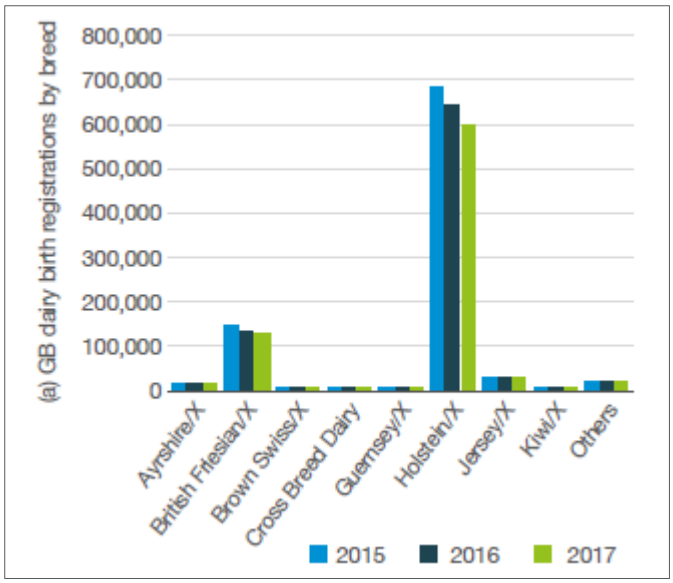

Figure 1 Predominant dairy breeds in the UK (AHDB 2018)

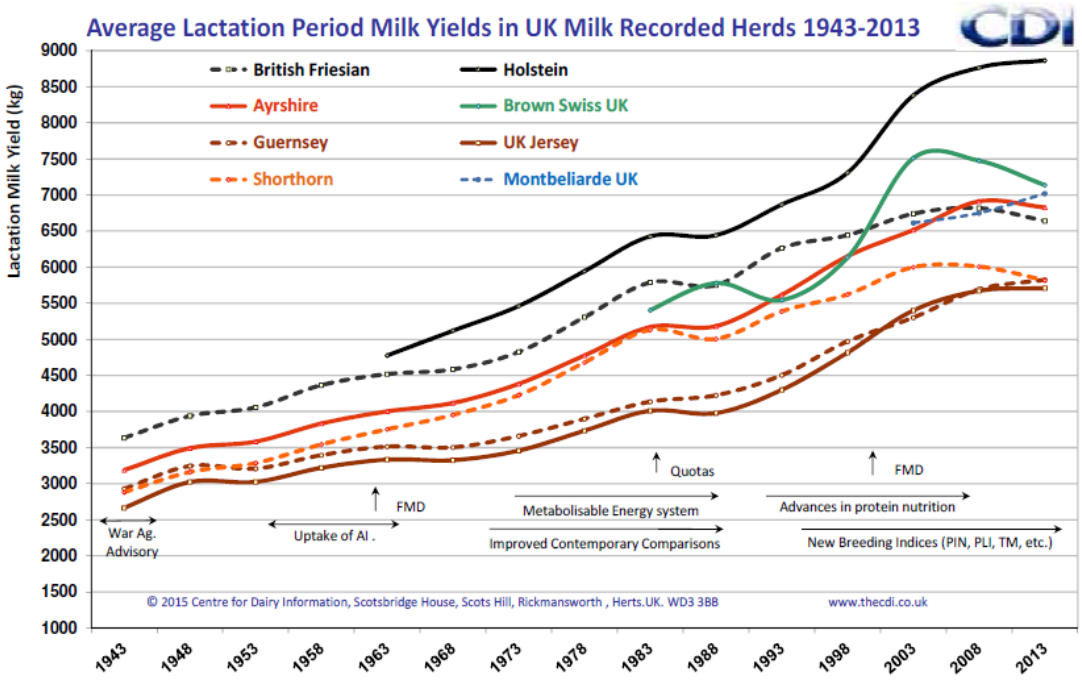

Figure 2 Average milk yields in UK herds 1943-2013 (CDI 2015)

Abatement rate

Vellinga (2018) argued that “dual purpose breeds have a good potential for integral reduction of environmental impacts of milk and beef/veal production” because of the high GHG emission intensities of suckler beef.

Vellinga and de Vries (2018) studied four mitigation measures that optimize milk production efficiency (higher milk yield, a longer productive life span of cows, a longer calving interval and a lower live weight of the cows). They found that the measures led to “reduced emissions per unit of milk and beef, but also to a reduction in the amount of beef produced by the dairy system. When this reduction in beef was compensated by beef produced in pure beef systems, similar or even higher amounts of GHG would be emitted”. The concluded that “dual purpose systems can be advantageous over specialized dairy systems.” while noting that the “effect depends on the emissions of the compensation for the lower meat production”.

Estimate of abatement potential and cost-effectiveness

In order to compare specialised dairy and dual purpose cattle, an illustrative calculation has been done for a Holstein herd, and a herd of dual purpose cattle producing the same amount of meat and milk (Table 1).

The GHG emissions and production were quantified using the Scottish Agricultural Emission Model (SAEM, MacLeod et al., 2017), a model based on GLEAM, the Global Livestock Environmental Assessment Model, which was developed by the UN-FAO (FAO, 2017, 2018; MacLeod et al., 2018).

Systems expansion is used to enable a like for like comparison, i.e. the additional meat from the dual purpose herd is calculated, and is assumed to displace suckler beef production. The avoided (suckler beef) emissions are subtracted from the dual purpose herd total, to give the emissions for the same amount of meat and milk as the Holstein herd. The input data for the systems is primarily derived from MacLeod et al. (2017), Sommerseth (2018) and SAC (2018). The number of adult females is set equal to the number of female breeding aged 2 years or older in the dairy herd in England in December 2018 (Defra 2019).

Table 1 Comparison of the production, emissions and gross margins of the same amount of meat and milk produced using (a) specialized dairy cattle and (b) dual purpose cattle

		Specialized	Dual purpose
Input assumptions	Units	Holstein	Norwegian Red (NR)
Number of adult females	#	1,142,529	1,142,529
Age at first calving	years	2.33	2.16
Fertility rate adult females	proportion of AF's giving birth	0.89	0.95
Adult female replacement rate	Proportion replaced each year	0.25	0.35
Milk yield	kg milk/year	8021	6717
Growth rate MM	kg LWG/day	0.95	1.13
Results			
Meat, carcass weights	kt/year	293	435
Milk sold standard	kt/year	8194	8194
Milk GHG	ktCO2e	10269	10583
Meat GHG	ktCO2e	2967	4657
Total GHG	ktCO2e	13236	15240
Systems expansion			
Assumed EI of suckler beef	kg CO2eq / kg CW		25
Additional beef production	ktCW		142
Avoided emissions	ktCO2e	=25*142 = 3504	
Emissions to produce same amount of milk and meat with NR cattle (ktCO2e)			11,736
Theoretical reduction in GHG if NR cattle were used (ktCO2e)			1,500
Theoretical reduction in GHG if NR cattle were used			11%
Financial appraisal			
Variable costs			
Feed	£m	669	505
Other	£m	336	299
Output			
Milk	£m	2363	1955
Meat	£m	1604	2112
Gross margin	£m	2962	3263
Change in gross margin	£m		301

The results suggest that switching from specialised to dual purpose cattle could reduce emissions by reducing the amount of (higher EI) suckler beef that needs to be produced. The lower milk yield of the dual purpose cows is compensated for by the

higher meat production of the herd. More meat is produced by the dual purpose herd because of the higher cow fertility, faster calf growth rates and higher cow replacement rates. The cost of replacements heifers is offset by the higher value of cull cows. In addition, Sommerseth (2018, p25) argued that:

"older cows have an increased possibility for health issues such as increased somatic cell count (Hand et al. 2012), mastitis (Valde et al. 2004), milk fever and claw diseases (Fleischer et al. 2001). Keeping cows too long could, therefore, result in increased costs for veterinary services, medical treatment, and lost milk and slaughter income due to sickness and/or death."

These calculations are intended to be illustrative only. The results are sensitive to some of the assumptions, particularly the emissions intensity of the displaced suckler beef, calf growth rates and the sale price of cull cows. In practice, the financial performance of dairy herds is quite variable, and in practice switching from specialised to dual purpose cattle may only increase profits in a small proportion of the sector.

Table 2. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Reduced milk output		
Increased meat output		
Reduced feed costs		

The cost-effectiveness is categorised as being: low-moderate.

Applicability, current uptake and potential additional maximum uptake

Dual purpose breeds are not currently used in England, so in theory this could apply to most of the dairy herd.

Assumptions used in the MACC

- Assume that 90% of the dairy herd could switch from specialised to dual purpose breeds.
- Abatement potential of ~1350ktCO2e (England) (assuming that the difference in performance of specialized and dual purpose breeds is broadly the same in 2050 as it is now).
- Cost-effectiveness of -10£/tCO2e

Ancillary effects

Table 3. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG		
Production		
Adaptation		
Environment	Increased genetic diversity?	
Negative effects		
Off-farm GHG		
Production		
Adaptation		
Environment		

Identified implementation challenges and barriers
Specialised dairy cattle dominate the UK dairy sector, and have done so for several generations. Switching to dual purpose cattle is likely to face significant (farmer) attitudinal barriers, although there may be opportunities for producers to gain a premium for their milk via niche marketing.

An alternative approach (that is being adopted) is to use genomic breeding information to improve the performance of the dairy cow, and to use sexed semen to maximise the number of surplus dairy calves that have beef sires. The abatement potential of sexed semen is estimated in Eory et al. (2014, 2015) and Martineau et al. (2016).

Vellinga and de Vries (2018)
"An option is to keep the female fattening animals for a longer period and let these produce a calf before they are slaughtered. This additional live weight production has the potential to compensate for the reduced beef production due to the longer productive life span of dairy cows. Other options are the use of sexed semen to produce more bulls or the use of meat type bulls to inseminate part of the dairy herd. There is little economic incentive, however, to increase beef production from dairy systems."

Table 4 Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Farmer attitudes	
Other key risks/uncertainties	
EI of suckler beef Growth rates of dual purpose calves Prices of cull cows	

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