Future-proofing European cattle production: GenTORE results and their potential impact

Breeding Strategies for Mitigation

The issue:

Almost half of the land in the European Union (EU) is farmed (Perpiña et al. 2018). It plays an essential role in maintaining the environment in a healthy state in terms of aesthetic appeal, social utility, sustainability for future farming and biodiversity (Balázsi et al. 2021; Bernués et al. 2016). However, agriculture adds to greenhouse gas (GHG) emissions and so can also play a vital role in providing solutions to the EU's overall climate change challenges (Pérez Domínguez et al. 2020). There are many possible technical mitigation options for livestock systems (Herrero et al. 2016). These could be delivered through improved livestock and livestock system efficiency - converting more energy into product output, thereby reducing GHG emissions per unit of product. One of the tools available to farmers is genetic selection (de Haas et al. 2017).

Genetic improvement of livestock is a particularly cost-effective technology, producing permanent and cumulative changes in performance. Mechanisms by which genetic tools could be used to reduce emissions per kg product include (Wall et al. 2010):

1. Improving productivity and efficiency
2. Reducing wastage at the herd or flock level
3. Reducing emissions by direct selection, when individual animal emissions are measurable

GenTORE contribution to solutions:

Many production and fitness traits have been shown to have a genetic component and have scope to be improved via genetic selection. Current broader breeding goals that select on both production and fitness traits can help to mitigate GHGs from many livestock systems and GenTORE has added to these.

A key aim of GenTORE is to breed more efficient cows and herds, which will not only improve profit margins, but also reduce environmental impact. Breeding strategies investigated by GenTORE include:

- Improved fertility to reduce calving intervals and inseminations, resulting in shorter dry/unproductive periods, as well as fewer replacement females required. This reduces management costs as well as emissions (WP5.3, Deliverable 5.4 and Deliverable 5.5, Rostellato et al., 2022 WCGALP).
- Improved longevity, reducing the number of growing replacement females required which avoids additional emissions and costs to the farmer. Selection for improved efficiency across the lifespan of the animal, not just for a short period, is important (WP 5.1) (Rostellato et al. 2021).
- Improved health, again reducing unproductive periods or minimising production losses, as well as reducing involuntary culling (for example by using sensor data such as in WP3, Aguerre et al., 2022 WCGALP).
- Improved feed efficiency, for example selection for improved residual feed intake (WP 2), which will directly affect emissions, as animals which eat less tend to produce fewer GHGs, but also indirectly by reducing emissions associated with feed production (Costa-Roura et al. 2020; Martin et al. 2021a; Martin et al. 2021b; Puillet et al. 2021).
- Improved resilience of cattle and farms which can minimise production losses and enable animals to live longer in the herd (WP 4). This results in improved efficiency and

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reduced emissions. (Bouquet et al., 2022 WCGALP; Mattalia et al., 2022 WCGALP; Bunning et al., 2022 WCGALP; Bonekamp et al., 2022 WCGALP ; GenTORE Deliverable 6.3; Barreto-Mendes et al. 2022; Burns et al. 2022)

Broader breeding goals have become the norm in many livestock species, usually incorporating production and "fitness" (health, fertility, longevity) traits. A lot of the example traits given earlier have been incorporated into indices for particular livestock sectors. However, livestock industries have more recently needed to consider societal views of aspects of farming systems, including issues such as animal welfare, biodiversity, food safety, health properties and environment. Also critical to this is understanding trade-offs between sustainability drivers of alternative breeding goals (i.e., economic and environmental).

How will potential environment policies/legislation be enforced?

This will help to determine how producers will respond. If the "emissions" from a farming system will be based simply on animal numbers, farmers will drive efficiency optimising animal numbers and product output. If system type is also considered (e.g., forage vs. concentrate diets) producers will drive efficiency within system type by considering genotype by environment interaction and potentially customisation of selection indices. If there will be specific farm auditing for environmental impact, especially if future technology simplifies the recording of emissions and environmental traits, producers will have to start looking at entire system efficiencies and balance the environmental budget of their system. In this latter situation it will become important to select animals with improved metabolic efficiency (e.g., low vs. high methane producers).

Applications and potential impact:

Overall, the outlook for GHG mitigation in agriculture suggests that there is significant potential. Current initiatives suggest that synergy between climate change policies, sustainable development and improvement of environmental quality will lead the way forward to exploit the mitigation potential in the sector. In future, energy costs will rise and the use of nutrients by farmers is likely to be regulated. Nutrient leakage from farming systems will attract costs and so breeding strategies will be tailored to optimise production within nutrient use constraints. New farming- systems that reduce nutrient waste will evolve and may be facilitated by integrated food supply chains. Further modelling work is required at the whole system level to identify sensitive areas and to help policy makers identify methods of encouraging farmers to adopt different production methods over time.

The results and tools described above are designed to allow the different actors in cattle production; farmer, advisor, breeder, to be able to select and breed cattle with improved efficiency and resilience, resulting in reduced environmental impact.

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