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The need for consideration of environmental implications in developing countries' dairy research

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Editorial

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The global human population reached 7.7 billion in 2020 and it is expected to increase close to 9 billion in the next 30 years. This substantial population growth is associated with improvements in human life expectancy, growing urbanization, and increasing demand on our limited environmental resources. These facts challenge the way we farm dairy cattle and require dairy production to be managed sustainably, with environmental protection as a major factor to consider. There are many components involved in sustainable dairy production and two major components will be discussed in this short Editorial: environmental pollution quantification and mitigation.

Over the last 30 years, environmental protection has increasingly become a subject of concern for dairy production and research. However, the majority of the environmental protection research in dairying was conducted in developed countries rather than in developing countries, partly due to limited research funding in the latter but also since environmental protection has low priority for developing country investment, relative to simply feeding their population. The quantification of environmental pollution requires specific technical skills and equipment and can be very costly to research (e.g. measurement of enteric methane from individual cows or quantification of ammonia emission from dairy herd manure). However, the five countries with the largest dairy populations are mostly located in South and East Asia and are all developing countries. These five countries contribute to ~40% of the total world dairy cow population. If we take South and East Asia region as an example for comparison, the recent data published by FAO (2019) shows that the emission intensity of milk (kg CO_2 eq./kg fat- and protein-corrected milk) production was 2.3 times higher than milk produced in Europe in 2015. This clearly demonstrates that there is ample room for improvement in environmental sustainability of dairy production in developing countries.

From this, the logical question to ask is *How can developing countries consider the environmental implications in their dairy research and publication?* While developing countries are urged to conduct more dairy research projects locally to understand the implication of their studies' impact on environment sustainability, there are also opportunities for scientists from these countries to utilize well published models to estimate environmental impact from their studies. For example, when gross energy intake is quantified with forage-fed cattle, methane production can be estimated as: methane production (MJ/d) = 0.063 × gross energy intake (MJ/d) ($R^2 = 0.93$, $P < 0.001$) (Charmley *et al.*, 2016); this model being established from more than 1000 individual cattle/cow records spanning bovines from temperate and tropical pastures. In addition, routinely measured biomarkers, such as blood urea nitrogen can be used as a proxy for urine nitrogen excretion in cattle feeding trials (Kohn *et al.*, 2005). This is a major pollutant in dairy farms, causing nitrogen leaching and greenhouse gas emissions.

It is important to point out that scientists considering environmental implications in developing countries' dairy research should also try to understand the soil-plant-animal interaction within a production system. For example, despite herbal plantain being reported to reduce cattle urinary nitrogen pollution compared with ryegrass pasture (Box *et al.*, 2017; Cheng *et al.*, 2017), recent work by Cheng *et al.* (2019) demonstrated that when the annual biomass of plantain was higher than ryegrass pasture, it allowed the production system to carry more dairy cattle. While increasing total farm productivity, this also leads to higher nitrogen leaching on farm than ryegrass pasture feeding system. Furthermore, we need to be aware of potential trade-offs between effects and incorporate the indirect pollution. Life cycle assessment is useful to allow total emissions associated with production systems to be accounted (Finnegan *et al.*, 2018).

With consumers increasingly demanding lower environmental impact, we will see increasing pressure on the livestock industries to improve their sustainability and reduce their impact on the environment. Fortunately, with improved feed conversion efficiency and animal genetics combined with better management of forage land resource and feeding practise, global emission intensity of milk has decreased by 11% over the ten-year period between 2005 and 2015 (FAO, 2019). Still, more work is needed to mitigate pollution and develop sustainable

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dairy production globally. This requires the global dairy research community and, in particular, scientists from developing countries, to consider environmental implications in their dairy research.

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