Producing animal source food with respect for human and planetary health

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How can we feed the growing population while respecting the planet? That is the challenge we face today. We currently see an ongoing debate on whether or not it would be better for the environment if we all were to consume a vegan diet. Here, we will demonstrate that the consumption of animal source food (ASF) in high-income countries needs to be reduced, but we also acknowledge that animals could play an important role in future food systems if we were to undertake a redesign towards a circular food system. These systems can allow for reduced environmental impacts, while still providing the nutrition needed by the human population.

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Avoiding feed-food competition

In a circular food system, plant-based foods are produced and processed into food for humans (Figure 1). During this processing, a portion of leftover products are produced, such as co-products or crop residues. Another leftover stream is food waste produced during food retailing, preparation and consumption. It must be our first priority to reduce the quantity of leftover streams, but if this is not possible, leftovers can be used to fertilise the soil (e.g., as compost) or to feed our farm animals (De Boer and Van Ittersum, 2018; Van Zanten *et al*., 2019; Muscat *et al*., 2021). If foods from animal sources are limited to this quantity, competition between human food and

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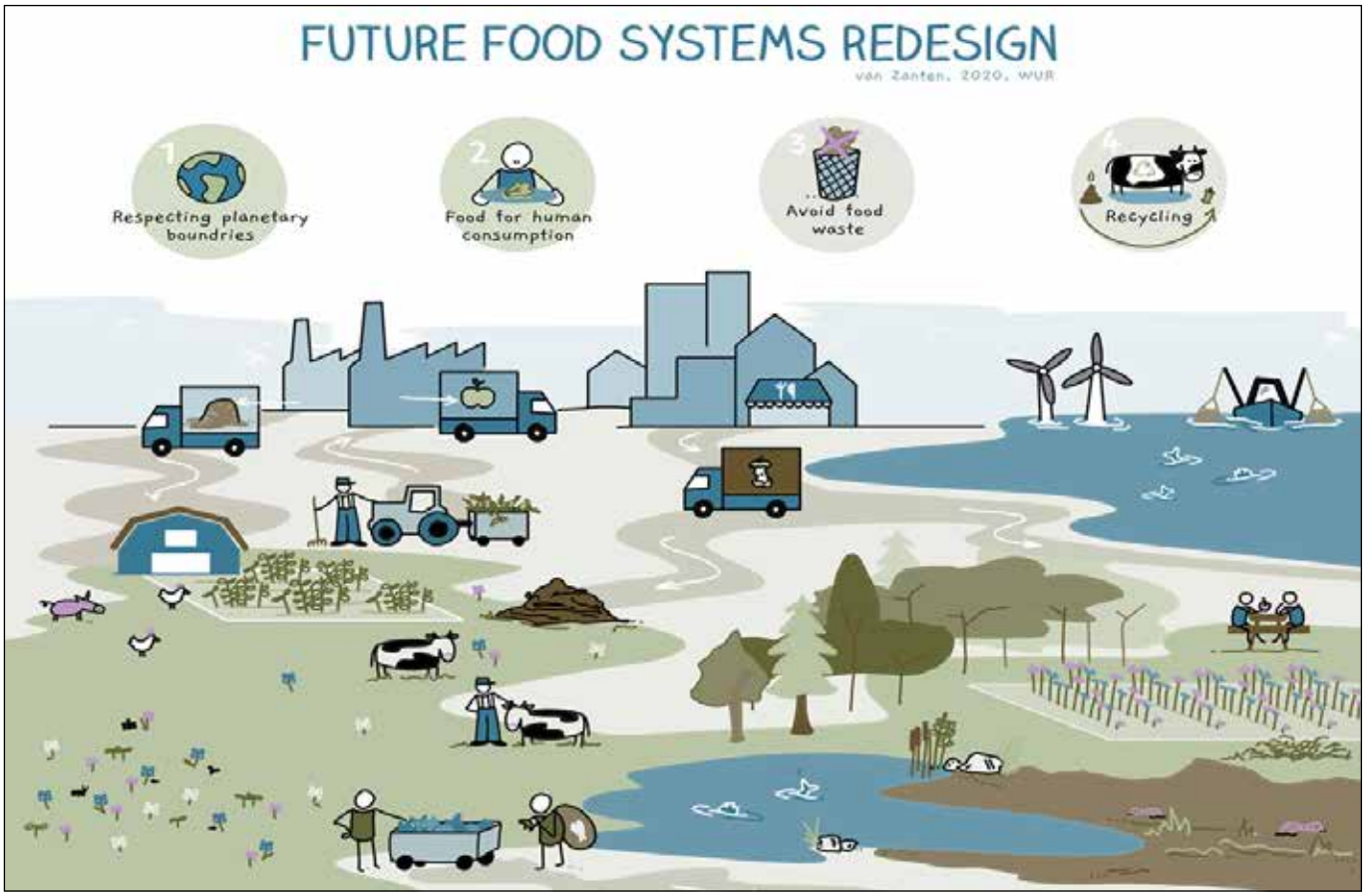

Figure 1. Example of a food system redesign.

animal feed is avoided. In other words, arable land is no longer used to produce animal feed, producing instead only human food (Van Zanten *et al*., 2018). Our results showed that, in so doing, we reduce the environmental impact of the food system (Van Zanten *et al*., 2018).

Feeding the animals with the leftovers from the food system

Working with many international groups, we have been involved in assessing the potential role of animals in such circular food systems (e.g. van Zanten *et al*., 2018; Van Hal *et al*., 2019; Frehner *et al*., 2021). We found that it is possible to produce around one-third of the human population's protein requirement when only feeding animals with leftover products (Van Zanten *et al*., 2018). However, we also found very high uncertainty in our estimates. This was largely due to the assumptions made on the food products that individuals consume. Diets in different global regions vary widely: some cultures eat largely whole grains, while others eat mostly refined grains (the same applies for rice, and for potatoes with and without peel). This has an impact on the amount of animal-sourced food that can be produced under the condition that animals can only be fed with leftover stream. In the case of refined grains, more leftovers will be available as animal feed and therefore the resulting quantity of animal products will increase.

Circularity and health

Whether or not someone consumes whole or refined grains not only impacts the potential amount of ASF produced in a circular food system but also impacts our health; it is, in fact, more sustainable to consume whole grain instead of refined grains. In one of our most recent studies we therefore assessed the compatibility of animal-sourced food and circularity in healthy European diets (Van Selm *et al*., 2021). As a starting point, we took the EAT-Lancet reference diet (Willet *et al*., 2019) as a prominent example of a generic diet that aims to respect human and planetary health. Willet *et al*. (2019), however, did not account for the opportunity cost of farm animals: the potential of animals to recycle products we cannot or do not want to eat. In Van Selm *et al*. (2021) we therefore assessed whether only feeding leftovers and grass resources to farm animals within the EU-28 would be compatible with the recommended ASF in the EAT-Lancet reference diet. We ascertained that it would not be possible to produce the amount of ASF that is advised in this reference diet. However, the EAT-Lancet publication also provides a reference range for food intakes, and when we aggregated food categories (for example, considering simply 'meat' as an aggregated group, rather than 'poultry meat', 'pigmeat', etc.) we found that it would be possible to achieve the EAT-Lancet diet under conditions of circularity. In this analysis, pork and beef constituted the majority of meat availability, with less chicken. In case the food intake ranges of the EAT-Lancet diet are not satisfied and protein production from animals is maximised while maintaining circularity, it would be possible to produce 40 g of protein per person per day from ASF (about two-thirds of the protein required on a daily basis). Both circularity diets resulted in reduced greenhouse gas emissions and arable land use compared to the EAT-Lancet diet.

An alternative to using the EAT-Lancet reference diet is to use national food-based dietary guidelines (FBDG), which take cultural differences in dietary preferences in different countries

into account. In the study of Frehner *et al.* (2021), we considered the FBDG of five European countries. Translating their advice into recommended protein consumption, we found high diversity in the quantity of different proteins that are recommended. Moreover, there was substantial variability in the ratio of plant-based to animal-based proteins that were advised. Again, we considered whether the recommended amounts of animal protein could be produced under conditions of circularity. Our results showed that it was in no case possible to meet the animal protein recommendations using purely leftover products as feed.

To conclude

Our work showed that animal-sourced foods play an important role in circular food systems in the provision of essential nutrients. However, depending on the dietary requirements for animal-sourced foods, it is not always possible to deliver these while considering circularity principles. Our results showed that some animals are more efficient at upcycling leftover streams and grass resources (e.g., dairy cattle and pigs) than others (e.g., poultry). Dairy cattle as ruminants can, for example, efficiently utilise grass resources. But because dairy production systems provide milk as well as beef (e.g. from veal calves), the amount of red meat produced often exceeds the amount recommended in dietary guidelines.

Furthermore we would like to stress that the consumption of animal-sourced foods is on average too high compared to the dietary recommendations in many European countries and both the current consumption and the recommendations are higher than what could be produced when feeding animals exclusively with leftover products. On the other hand, if we apply circularity principles, we do reduce greenhouse gas emissions and arable land use, demonstrating the potential of these principles to provide important nutrients and to reduce the environmental impact of the food system. In other words, a redesign towards a circular food system offers the possibility of respecting both human and planetary health.

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