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**Source:** Röös, E., Patel, M., Spångberg, J., Carlsson, G. & Rydhmer, L. (2016). Limiting livestock production to pasture and by-products in a search for sustainable diets. *Food Policy*, 58, pp.1-13. DOI: 10.1016/j.foodpol.2015.10.008

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1.FAO (2013) Tackling climate change through livestock. http://www.fao.org/docrep/018/i3437e/i3437e.pdf

2. World Bank, 2014. World Development Indicators Table 3.2. http://wdi.worldbank.org/table/3.2

European Commission

# Science for Environment Policy

## 'Ecological leftovers': a route to a sustainable diet?

**Producing and consuming food has a significant environmental impact.** In the search for a sustainable diet, researchers in Sweden explored a method of food production that does not exceed the level of globally available arable land per capita, and involves raising livestock on pasture or by-products not suitable for humans (the 'ecological leftovers' principle). The researchers developed three diets based on this method and evaluated their environmental impact compared with current diets.

**Many European and American diets are environmentally unsustainable.** Central to the problem is the high amount of protein consumed, which is largely supplied by resource-demanding animal products. A huge amount of land is used to support animals, and livestock emits approximately 14.5% of all anthropogenic greenhouse gas (GHG) emissions[1].

Reducing livestock consumption could have significant benefits, but meat-free diets are not necessarily the solution, as dairy and egg production required for vegetarian or vegan diets also provide some meat, and some vegetarian diets use more land and have greater climate impact than diets with a small amount of meat. Furthermore, livestock provides essential protein in developing countries, creates jobs for 30% of the world's population[2], and delivers ecosystem services including biodiversity conservation and nutrient cycling.

This study, based on Sweden, re-evaluated the system of livestock production to balance the dietary needs of the population with environmental limits. A method was developed for designing 'fair diets', which do not use more than the available arable land per capita. The diets were based on the idea of 'ecological leftovers', in which ecological resources are the constraining factor for livestock production. In other words, animals are fed with resources that are not fit for human consumption, such as grass from marginal land or by-products from crop production and food processing. These diets were compared with an average Swedish diet, derived from the latest national food intake survey (Riksmaten adults 2010-11), conducted by the National Food Agency.

The method used to design the diets, named 'ECOLEFT', follows three principles: arable land should mainly be used for production of plant-based foods for humans; livestock should be fed biomass not suitable/desirable by humans; semi-natural grassland should be used for livestock production only if grazing can be justified by reasons other than meat and milk production (e.g. biodiversity conservation, providing livelihood).

Using these principles, sustainable diets can be designed for a region or country. It is theoretically possible to develop a global diet based on the ECOLEFT method, but the authors say this would be less relevant, due to the large variety of dietary habits across the globe and national governance systems.

ECOLEFT was used to develop three different dietary models, applied to Sweden. The scenarios all used livestock to produce food from semi-natural pastures not suitable for other food production, but they differed in the type of by-products and whether they were used to boost milk, meat or egg production. The by-products were on some occasions supplemented with cereals and legumes to achieve a nutritionally balanced diet for the livestock.

In the first scenario (*I-Milk*), milk and meat were produced in intensive systems, in which high-producing dairy cows were used to maximise milk production. By-products from the production of plant-based foods for humans were used to feed the dairy cattle, supplemented by cereals to maximise milk production. Pork was also produced using the by-products from milk production, such as whey (approximately 50% of the diets was forage, around 25% cereals and 25% by-products). This diet permitted the recommended amount of dairy (350 ml milk/day) and meat twice per week for the Swedish population.

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## *(continued)*

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The second scenario, *E-Milk*, represented extensive production. Dairy cows were fed on forage (e.g. grass or hay), while the by-products (plus cereals and legumes) were fed to poultry and pigs. This resulted in less milk (150 ml/day) but meat four times per week.
In the final scenario, *Suckler*, the pasture was grazed by suckler herds (young animals that still draw milk from suckling cows). The number of animals needed to graze the land could then be reduced (as suckling cows can survive on semi-natural grassland to a greater extent than dairy cows). By-products were again used to feed poultry and pigs. This scenario provided no milk, but meat four times per week.

The researchers compared the amounts of protein-rich foods consumed in the three diets to current consumption patterns and Swedish nutrition recommendations. Meat consumption was substantially reduced in the ECOLEFT diets, from the 10 servings per week currently consumed to four servings in the *E-Milk* and *Suckler* diets, and just two servings in the *I-Milk* diet (which still remained within the recommended range). This correlates to a yearly per-capita meat consumption of 11–21 kilograms (bone-free), less than half of the current, unsustainable level of approximately 50 kg. The diets would also reduce the amount of agricultural land used to grow feed for animals. The *I-Milk, E-Milk* and *Suckler* diets would reduce the proportion of agricultural land used to grow feed for animals from the current level of approximately 75% to 58%, 50% and 42%, respectively. It should be noted that livestock production in Sweden would not be feasible without using some arable land for the production of winter feeds.

To assess the environmental impacts of these changes, the researchers used the planetary boundaries framework[3]. They used limits for climate change, biosphere integrity, nitrogen, phosphorus and land system change, based on previously published research[3,4].

Land use for all ECOLEFT diets was within planetary boundaries, and lower than for the current Swedish population's diet. After producing the food needed and energy needed for agriculture, there was 'spare land' available in all the ECOLEFT diets, when compared with the total currently available arable land in Sweden. The results were less favourable in terms of climate impact. All diets led to the production of GHGs, varying from 0.36 to 0.62 $CO_2$ equivalents per capita and year. Although the diets did not meet the strict climate planetary boundary of zero net emissions, their climate impact was less than half that associated with current Swedish diets and compatible with pathways for limiting global warming to 2°C. The diets also exceeded the planetary boundaries for nitrogen and phosphorus, but emissions were considerably lower than current diets.

Although the diets still had negative environmental impacts, they provided nutrients within recommended ranges for a healthy diet *and* additional outputs to current diets. The *E-Milk* and *Suckler* scenarios for example saved land that could be used for nature conservation, to sequester carbon or produce bioenergy. Furthermore, *I-Milk* provided an extra 165 kg of milk per capita yearly. If this replaced other types of milk production, the climate impact of the scenario could be reduced by 30%. However, if the exported milk increased total milk consumption by adding more milk to the market, climate impact would not be reduced.

The researchers say that without further modelling or scenario analysis, they cannot fully establish the environmental impact of the diets. However, they also say it is clear that ECOLEFT techniques—which reduce climate impact and create land for other purposes—are likely to cause less overall environmental damage than techniques supporting current, established diets.

3. Rockström, J. *et al* (2009). A safe operating space for humanity. *Nature*, 461(7263), pp.472-475.

4. Steffen, W. *et al* (2015). Planetary Boundaries: Guiding Human Development on a Changing Planet. *Science*, 347 (6223).