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Limiting livestock production to pasture and by-products in a search for sustainable diets

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ABSTRACT

A method was developed for designing 'fair' diets (not using more than globally available arable land per capita) and for assessing the sustainability of such diets. The diets were based on the principle of 'ecological leftovers' for livestock production, i.e. raising livestock on pasture and by-products not suitable for or wanted by humans. The method was applied to Sweden using three different scenarios for livestock production, all taking the starting point that semi-natural pastures should be grazed by ruminants for reasons of biodiversity conservation. The scenarios also included differing use of by-products (from crop production and food processing) to either boost milk production (I-Milk scenario) or produce eggs and pig meat (E-Milk and Suckler scenarios). In I-Milk, milk and meat were produced in intensive systems in which dairy cows and their offspring only grazed to a limited extent, resulting in the human diet containing recommended levels of dairy products (350 ml milk per day) and meat twice a week. Milk could also be exported. In E-Milk, pasture was used more for dairy cows and their offspring, resulting in fewer animals and less milk (150 ml milk per day) and four servings of meat per week. In the Suckler scenario, pasture was grazed by suckler herds providing no milk but meat four times per week. The environmental impacts of the diets were assessed using the planetary boundaries framework. The results showed substantially lower environmental impacts compared with the average current Swedish diet, but the strict absolute climate boundary and the N and P input boundaries were still exceeded for all diets. The approach adopted, of letting the ecological resource capacity act as the constraining factor for livestock production, is in line with agroecology principles and efficient use of land to improve food security, and could be useful in discussions about sustainable consumption of animal products.

Introduction

Western dietary patterns are clearly unsustainable in terms of environmental impact and health (Foley et al., 2011; Sabaré and Soret, 2014; Smith and Gregory, 2013; Tillman and Clark, 2014). Most importantly, overconsumption and waste must be curbed and consumption of resource-demanding foods must decrease in order to reach environmental objectives such as limiting expansion of agricultural land and reducing greenhouse gas emissions (Garnett, 2011; Bajzelj et al., 2014). The amount and type of protein consumed are key factors, as protein is currently overconsumed in the Western diet and is largely supplied by resource-demanding, animal-based products. However, while there can be major environmental and health benefits with vegetarian or vegan diets (Scarborough et al., 2014; Tillman and Clark, 2014), such diets may not be the best option for the entire population since: (1) dairy and egg production for vegetarian diets also give meat; and (2) some land types (e.g. permanent pasture) are unsuitable for cultivation of crops for a vegan diet and may also need to be grazed for biodiversity conservation (Jerrentrup et al., 2014; Rook et al., 2004). Furthermore, some vegetarian diets are actually more land-demanding (Peters et al., 2007) or climate-impacting (Vieux et al., 2012) than diets with a limited amount of meat. It is also unclear what production systems without livestock would comprise and how they would affect environmental, economic and social sustainability. In addition, the high content of essential amino acids and micronutrients in livestock products is important for malnourished people in developing countries and people suffering from nutrient deficiency (Smith et al., 2013). Livestock products are also an important way of securing a livelihood among the poor and of creating job opportunities for

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a large proportion (30%) of the world's population (World Bank, 2014). Livestock also provide benefits other than food, such as biodiversity, other ecosystem services, and recycling plant nutrients. However, these benefits must be valued and tuned so that the system fits the land (Janzen, 2011) and the dietary needs of the population.

Important unanswered questions in this regard are what comprises a sustainable level of livestock product consumption, what types of livestock products are most sustainable and what production systems should provide these. Depending on individual values and viewpoints, there are several ways of examining these questions. One approach is to let the ecological resource capacity be the constraining factor for livestock production, i.e. to feed animals with resources not suitable for human consumption, such as grass from marginal land unsuited for other production and by-products from crop production and food processing, thus also recycling resources and managing landscapes. This principle is referred to as producing livestock on 'ecological leftovers' (Garnett, 2009). In a future in which livestock production is restricted by the principle of feeding on ecological leftovers, food systems would need to be more localised and the availability of land, water and by-products would constitute site-specific constraints and opportunities for agriculture (Garnett, 2009).

The principle of livestock production from ecological leftovers is attractive in several ways. Similarly to the agroecology concept, it emphasises the principles of efficient use of resources, recirculation of nutrients and development of production systems adapted to unique local conditions (Francis et al., 2003). For many consumers, a diet which contains some meat is probably more acceptable than a diet without any meat (Schösler et al., 2012; Dagevos and Voordouw, 2013). Furthermore, in studies concerned with food security in light of the increasing wealthy global population feeding animals ecological leftovers instead of products edible to humans is often proposed as a means to increase food supply (e.g. Godfray et al., 2010; Foley et al., 2011). However, little is known about what a diet based on ecological leftovers would actually comprise. Furthermore, it is not obvious how by-products from the food system could be incorporated into animal diets, depending on animal species and the nutrient content of the feed. Moreover, the supply of by-products depends on production of plant-based foods and competition for by-products for other purposes, as well as cultural traditions of what is considered edible food. Finally, it is not known whether a diet based on ecological leftovers would be sustainable.

In this study, a method for designing diets based on the principle of ecological leftovers for livestock production and for assessing the sustainability of such diets was devised. The method was applied to the case of Sweden, examining three different ways of using marginal land and by-products following different viewpoints on how to efficiently produce food. The implications for Swedish agricultural production and the environmental and social impacts of such diets were assessed and discussed.

Method

Summary of the method

The 'ECOLEFT' method proposed here builds on a set of normative principles based on the concept of ecological leftovers for livestock production (Garnett, 2009):

1. Arable land should primarily be used for the production of plant-based food for humans.
2. Livestock should be fed biomass not suitable for or wanted by humans.
3. Semi-natural grassland should be used for livestock production if grazing can be justified by reasons other than meat and milk production, e.g. biodiversity conservation, providing a livelihood for vulnerable populations, etc.

With these principles as the starting point, a sustainable diet can be designed for a region or a country. In principle, it would also be possible to develop a global ECOLEFT diet, but this would be less relevant due to the large global diversity of eating practices and diets and since governance systems function on national, rather than global, scales (discussed further in Section 'Policy relevance of the ECOLEFT diets'). These basic principles apply to most contexts, but can be applied very differently depending on the situation. For example, the role of livestock for biodiversity conservation, food security and livelihoods varies substantially between different regions and its importance in the specific context must be factored in when designing a sustainable diet. Principle 3 introduces a further specification of the concept of ecological leftovers, as it limits the use of semi-natural grassland to situations where this provides additional benefits apart from food production. By doing so, the concept of ecological leftovers acknowledges that semi-natural grassland is a 'leftover' only from a human consumer perspective. For example, it is highly valuable for conservation of wild species and natural ecosystems.

The first step in using the ECOLEFT method is to establish the amount of livestock products that the resources of the area can provide, by applying principles 1–3 to the region under study. The next step is to consider the nutrient requirements in the diet, establish how much of these are met by the livestock products and calculate the quantity and type of plant-based foods needed in the diet in order to meet the requirements. By-products from plant production are used as feed to livestock in this approach, providing additional livestock products.

ECOLEFT diets for Sweden

We applied the ECOLEFT method to the case of Sweden. Swedish agriculture used to consist of small-scale mixed farms, but recent decades have seen the emergence of large specialist pig, poultry, dairy and beef units. The reliance on domestic food supply in Sweden is approximately 50% for beef, 65% for pork and poultry, 90% for dairy, 100% for cereals and 20% for fruit and vegetables (NFA, 2011; SBA, 2013a, 2013b); hence Sweden is currently dependent on food imports from other countries. The location of Sweden in Fennoscandia makes agriculture challenging in the north of the country, where grass/clover leys and barley are the most common crops. Southern Sweden is characterised by plains and cash-crop agriculture and is also where most pig and poultry production takes place, whereas most cattle farms are located in plains and forest districts in central and southern Sweden (SBA, 2013c). Arable land occupies about 6% of total land in Sweden, while the rest is dominated by forest (50%), marsh and moorland (16%), mountain (1%) and urban areas (1%) (SS, 2000). Semi-natural pastures and meadows occupy 1% of the land, but the area is steadily decreasing due to a decline in grazing animals and production intensification (SBA, 2014a). Many of Sweden's red-listed species can be found in its semi-natural pastures and therefore preserving these pastures is one of Sweden's most important environmental goals (SEPA, 2014).

We applied the ECOLEFT principles to Sweden based on the following assumptions:

(i) Arable land is used to produce crops for human consumption, with the exception of winter feed and concentrates (if necessary) for grazing animals and feedstuffs to supplement by-products in the diet of monogastric animals.