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Reducing meat production and consumption: should the focus be on ruminants or monogastrics?

Health and environmental benefits of reducing meat consumption

Many studies show that reducing meat consumption would be beneficial for both the environment and public health. High levels of consumption of red and processed meat contribute to heart disease, obesity, diabetes and certain cancers.[1, 2, 3]

There is consistent evidence indicating that a dietary pattern higher in plant-based foods and lower in animal-based foods (especially red and processed meat) is both healthier and associated with a lesser impact on the environment.[4, 5, 6] Studies show that a range of environmental benefits would flow from a 50% reduction in the consumption of meat, dairy products and eggs in the EU; these are set out in Table 1.

Table 1: Positive environmental impacts of a 50% reduction in EU consumption of meat, dairy and eggs[7, 8, 9]

Factor affected by reduction in meat consumption	% reduction from current levels
Soybean use as animal feed	75%
Use and pollution of surface- and ground-water *	20%
Cropland use	23%
Nitrogen emissions	37-42%
Greenhouse gas emissions	19-42%

* In this case the figure in column 2 refers to a 45% reduction in meat consumption

The studies that point to the environment and health co-benefits of reducing meat consumption sometimes argue that reductions in meat production would best be made in the ruminant sector. However, an increasing focus on monogastrics (pigs and poultry) would be highly detrimental for animal welfare as any expansion in pigs and poultry is likely to entail industrial production which has little or no potential for delivering good welfare.

The purpose of this paper is to:

- review the evidence showing that extensive ruminant production has major environmental, food security and public health benefits compared to industrial pig and poultry production, and
- argue that animal welfare should be included among the key factors that must be considered when formulating food and farming policy. Dietary health, natural resources, climate change and farmers' livelihoods must be taken into account by food and farming policy; any policy that is detrimental to any of these factors would generally be viewed as unacceptable. Animal welfare should be given similar weight. i.e. any policy that is detrimental to animal welfare should be recognised as being unacceptable.

Should the reduction be made in the ruminant sector or in monogastrics?

Greenhouse gas emissions
Ruminants generate greater greenhouse gas (GHG) emissions than monogastrics per unit of meat produced.[10]

Land use
Some papers argue that ruminant meat entails greater land use than meat from monogastrics.[11] However, this argument does not distinguish between different ways of raising ruminants (grain-based or pasture-based) and different kinds of land (cropland or pasture).

Grain comprises a high proportion of the diet of intensively raised cattle. In U.S. beef feedlots the usual practice is to gradually decrease the proportion of forage in the feed over time, eventually reaching rations that can be as high as 90% grain.[12] In contrast, members of the UK Pasture-Fed Livestock Association use no grain at all as feed for ruminants.[13] Between these two extremes lies a wide range of grass/grain ratios in ruminant diets.

In general larger proportions of grass in the diet entail greater land use and so can appear inefficient compared with grain-based ruminants as production of their feed requires less land. However, the use of grassland that cannot readily be utilised for other forms of food production is not wasteful. Conversely, using cropland to produce animal feed undermines food security as more people are fed when scarce arable land is used to grow grain for direct human consumption rather than for animal feed.[14] Thus, although grass-based ruminants use more land per unit of nutrition produced than grain-based ruminants, the former are more efficient when they are using land that cannot be used for other forms of food production.

Research on water use has helpfully developed the proposition that the water footprint of a product consists of three colour-coded components: the green, blue and grey water footprint.[15] The blue water footprint refers to the volume of surface and groundwater consumed as a result of the production of the product; the green water footprint refers to the rainwater consumed. The grey water footprint refers to the volume of freshwater that is required to assimilate the load of pollutants generated by the production of the product.

It would be helpful if the literature were to similarly distinguish between different types of land: pasture which cannot readily be used for other purposes; pasture which can be used for other purposes; and arable land.

Grazing animals on land which could be used for arable is beneficial when this is carried out in an integrated rotational crop-livestock system. Such systems can promote biodiversity and use crop residues as well as pasture as feed. In addition, they can substantially improve soil structure, fertility and organic matter content through the use of animal manure, green manure, legumes and fallow periods.

In summary, meat from ruminants entails higher GHG emissions than monogastric meat though account must be taken of the carbon sequestration that can arise from rearing ruminants on pasture and the GHG emissions involved in producing feed crops for monogastrics. The notion that ruminants use more land than monogastrics is potentially misleading. Grain-fed ruminants use more cropland than monogastrics but pasture-fed ruminants use less cropland than monogastrics. Moreover, as will be explained below, in many respects extensive ruminants compare favourably with monogastrics; this is important to note in light of the tendency of some papers to advocate a switch from ruminant to monogastric production.

Food policy needs to satisfy a wide range of criteria
Many of the scientific papers that point to the benefits of reducing meat consumption focus on a limited range of factors in considering whether the reduction should be in ruminants or monogastrics. However, a successful food policy must take account of a wide range of concerns; these are set out in Table 2.

Food policy needs to take an integrated approach, ensuring that one objective is not achieved at the expense of another. It must strive to satisfy all these objectives; synergies should be maximised and trade-offs avoided as far as possible. Identifying and addressing interlinkages between the different facets of food policy is necessary to avoid working in silos and to ensure balanced progress.

Table 2: The factors that must be considered by food policy

Core Factors	Criteria
Food security	Is sufficient food being produced?
	Resource use efficiency
Public health	Impact on non-communicable diseases
	Nutritional quality
	Antibiotics use
Environment/Natural Resources	Amount of land used: (i) cropland & (ii) grassland
	Soil quality including fertility, soil organic matter & soil biodiversity
	Amount of water used especially blue water
	Water pollution
	Impact on biodiversity
	Impact on air pollution
Climate change	Impact on GHG emissions
Animal health	Freedom from disease
Animal welfare	Ability to perform natural behaviours
	Good housing & environmental enrichment
	Absence of mutilations
	Absence of selection for productivity levels that have a detrimental impact on health & welfare

In the developed world and much of the developing world most monogastrics are farmed industrially. In contrast to this, although many ruminants are farmed industrially, many are raised extensively. When considering the full range of factors and criteria set out in Table 2, extensive ruminant production has a number of important benefits compared with monogastric or intensive ruminant production. Indeed, it will become apparent that the distinction that needs to be made is not so much between monogastrics and ruminants but rather between monogastrics and intensive ruminants on the one hand and extensive ruminants on the other.

Animal welfare
From the animal welfare point of view the suggestion that livestock production should switch from ruminants to monogastrics is extremely disturbing. Well-managed extensive rearing of cattle and sheep has the potential to deliver good animal welfare outcomes. However, industrial systems (and most monogastric production is industrial), even with good management, have little or no potential for providing good welfare outcomes.

Indeed, industrial systems are going to find it increasingly difficult to achieve acceptable welfare standards as a more ambitious approach to welfare is emerging. A new paper by Mellor stresses that it is necessary not only to minimise negative experiences but also "to provide the animals with opportunities to have positive experiences".[16] Such experiences can arise "when animals are kept with congenial others in spacious, stimulus-rich and safe environments which provide opportunities for them to engage in behaviours they find rewarding. These behaviours may include environment-focused exploration and food acquisition activities as well as animal-to-animal interactive activities, all of which can generate various forms of comfort, pleasure, interest, confidence and a sense of control."

Resource efficiency and food security

Industrially raised animals are mainly fed on concentrates which are predominately made up of cereals and vegetable proteins such as soybean meal. For pigs farmed industrially nearly all the feed is concentrates.[17] The same is true for industrially produced broiler chickens and laying hens in most regions. As indicated earlier, industrially raised ruminants have a high proportion of grain in their diet while those farmed extensively are fed much less grain.

Some studies point out that monogastrics have higher feed use efficiency than ruminants.[18] This is indeed the case when ruminants are fed on grain.[19, 20] However, when ruminants are fed on grass, though the conversion rate into meat is low, they are highly efficient as they are converting materials people cannot eat into edible food.

Indeed, all animals convert cereals inefficiently into meat. For every 100 calories fed to animals in the form of human-edible crops, we receive on average just 17-30 calories in the form of meat.[21] [22] A key study indicates that the conversion efficiency rates for both calories and protein may be even lower for some animal products.[23]

A Chatham House paper concludes that the feeding of cereals to animals is "staggeringly inefficient".[24] The International Institute for Environment and Development stresses that using cropland to produce corn, soybeans and other crops for animal feed rather than to grow food for direct human consumption is "a colossally inefficient" use of resources.[25]

Bajželj *et al* (2015) identify grazing on pasture that cannot be used for crop production as well as the use of crop residues and processing co-products as efficient forms of feed. They say that together these support about 30% of current global livestock production. They stress that the remaining 70% (the use of human-edible crops as feed) "has to be seen as a very inefficient use of land to produce food".[26]

The UN Food and Agriculture Organisation (FAO) warns that further use of cereals as animal feed could threaten food security by reducing the grain available for human consumption.[27] Livestock contribute to food security when they are fed on materials that cannot be eaten by humans such as pasture or other grassland, crop residues, by products and unavoidable food waste. Research funded by the FAO argues that the role of livestock "is to use resources that cannot be otherwise used for food production".[28]

Environmental impact

Industrial livestock's huge demand for cereals has fuelled the intensification of crop production which, with its monocultures and agro-chemicals, has lead to water pollution,[29] soil degradation[30] [31] and biodiversity loss.[32] [33]

The FAO-funded research referred to above shows that the environmental pressures from livestock production could be reduced by focusing on grassland-based ruminant production and by reducing the amount of feed derived from cropland in both ruminant and monogastric feeding rations. This can lead to reduced arable land use and a decrease in nitrogen pollution, pesticide use, soil erosion and GHG emissions.[34]

The study compares (i) a base year comprising mean values for the years 2005-2009, (ii) a reference scenario based on FAO projections for food production and demand in 2050 and (iii) a scenario in which no 'food-competing feedstuffs' (i.e. human-edible crops) are used as feed (the 'food not feed' scenario). In this scenario animals are fed only from grassland and by-products from food production. Crucially there is no expansion of grassland.

The substantial environmental benefits that arise from adopting the 'food not feed' strategy are set out in Table 3. Food availability for people does not suffer; energy supply per capita increases and protein supply per capita increases very slightly compared with the base period. The consumption of meat, milk, fish and eggs is reduced by 53% compared with the base year. The consumption of meat is reduced by 77% compared with the base year. If the use of food-competing feedstuffs decreased by just 40%, the consumption of meat would be reduced by 32% compared with the base year

Table 3: Comparison of inputs and outcomes between base year, 2050 reference year and 'food not feed' strategy

Production inputs and environmental outcomes	Base year (mean values 2005-2009)	Reference scenario: FAO projections for 2050	Food not feed strategy in 2050	% reduction achieved by food not feed strategy in 2050 compared with reference scenario
Arable land use: billion hectares	1.54	1.63	1.20	26%
GHG emissions: Gt CO2-eq	11.0	12.8	10.4	18%
Freshwater use (for irrigation): km^3	1371	2178	1718	21%
N-surplus: million tonnes N	87.9	121.8	65.2	46%
P-surplus: million tonnes P	47.2	64.0	38.4	40%
Non-renewable energy use: exajoules	22.6	26.7	17.2	35%
Pesticide use:*	14.1	15.4	12.0	22%
Deforestation: million ha	8.2	7.2	6.5	9%
Soil erosion from water: billion tonnes soil lost	33.7	36.8	32.2	12%

* Classification of pesticide use per ha by intensity and by crop, legislation by country and access to pesticides by farmers

This study shows that if meat consumption is reduced and the emphasis is shifted from monogastrics to grass-fed ruminants, considerable reductions can be made in the use of resources: use of arable land, irrigation water and energy can all be reduced as can the use of fertilisers and pesticides. In addition, damaging environmental outcomes decrease: GHG emissions, deforestation and soil erosion all diminish.

Semi-natural grasslands support biodiversity and store large carbon stocks.[35] However, care must be taken to avoid overgrazing which in marginal lands can lead to desertification. Nor should new pastures be created by deforestation or other land use change.

If, however, reduced meat consumption involved a shift from extensive ruminants to monogastrics more cereals and soy would be needed for feed.[36] Some of this could perhaps be produced on erstwhile pasture land if it was suitable for crop production. However, increased demand for feed crops could also lead to an expansion of arable land, for example into forests and savannahs resulting in biodiversity loss and increased GHG emissions. Alternatively it could lead to an intensification of crop production with a concomitant rise in the use of fertilisers and pesticides and an increase in water pollution, use of water for irrigation, soil degradation and biodiversity loss. Davis *et al* (2015) report that the move away from ruminants towards monogastrics has led to increased demand per calorie produced for nitrogen and irrigation water to support rising feed requirements.[37]

Nutritional quality

The FAO states that the modern western diet lacks nutrient quality and highlights the need to integrate the dimension of nutritional quality into food policy.[38] Animals (ruminants and monogastrics) reared extensively outdoors consume fresh forage and have higher activity levels. As a result they often provide meat of better nutritional quality than animals that are reared industrially.

Pasture-fed beef is of higher nutritional quality than grain-fed beef. It has less overall fat, higher proportions of the beneficial omega-3 fatty acids and a healthier ratio of omega-6 to omega-3 fatty acids than grain-fed beef.[39] Similarly, meat from free-range chickens contains substantially less fat and generally a higher proportion of the beneficial omega-3 fatty acids than meat from chickens reared industrially.[40]

Infectious diseases

The European Medicines Agency has said that in animal production systems with a high density of animals, the development and spread of infectious diseases is favoured. Indeed, disease is inevitable when a large number of animals are housed together in close confinement. A report by the FAO, *Industrial Livestock Production and Global Health Risks*, points out that industrial livestock production plays an important part in the emergence of highly pathogenic avian influenza and other diseases.[41] The US Council for Agriculture, Science and Technology has warned that a major consequence of modern industrial livestock production systems is that they potentially allow the rapid selection and amplification of pathogens.[42]

Stress is often linked to immune suppression. The causes of stress in industrially farmed animals are already well established; they include overcrowding, barren environments, inability to engage in natural behaviours and selection for excessive production levels.[43]

Antibiotics use

Because pigs and poultry reared industrially are highly vulnerable to disease, antibiotic use in industrially produced monogastrics is much higher than in extensively raised monogastrics and ruminants[44, 45]

Conclusion

A reduction in meat consumption would deliver important health and environment co-benefits. Some argue that the reduction should be made in ruminants as they have higher GHG emissions than monogastrics. It is also argued that ruminants have a greater land use requirement than monogastrics. However, papers making this point often do not distinguish between intensively and extensively raised ruminants. Extensive ruminants utilise land very efficiently when they graze grassland which cannot be used for others forms of food

production. In contrast, monogastrics (and intensive ruminants) use arable land which could be used more efficiently to grow crops for direct human consumption.

In several respects extensive ruminants make a much better contribution to sustainable food production than monogastrics (any expansion in pig and poultry production is likely to be in the industrial sector). Extensive ruminants augment food security by converting inedible materials into food we can eat. Monogastrics, however, undermine food security as they consume much more nutrition when eating human-edible crops than they deliver as meat.

Any expansion of the monogastrics sector would fuel increased demand for cereals and soy as animal feed. This could be met from conversion of pasture if there was a reduction in ruminant production and if the pasture was suitable for crop production. However, increased demand for cereals and soy as animal feed could lead to expansion of cropland into forests and grasslands and/or intensification of crop production through the use of monocultures and agro-chemicals. If, however, meat consumption were reduced by lowering monogastric production, cropland could be farmed less intensively and soil and water quality and biodiversity could be restored.

Animals raised in industrial systems are vulnerable to disease. As a result antibiotics use is much higher in such systems than in extensive ruminants. Animal welfare is poor in industrial pig and poultry operations while well-managed extensive ruminant production has the potential to deliver high welfare standards.

In summary, the fact that ruminants produce more GHG emissions per unit of meat produced than pigs and poultry is crucial. However, it does not follow that meat production should switch from ruminants to monogastrics as this would result in detrimental impacts on food security, biodiversity, use of arable land, deforestation, antibiotic resistance, animal welfare and the quality of soil, water and air. The best response to ruminant GHG emissions – while at the same time ensuring that other key factors are not undermined - is to substantially reduce meat consumption but for the bulk of meat production to be extensive ruminants as industrial pig and poultry production is responsible for a very wide range of harms.

Animal welfare should not be regarded as a peripheral consideration in the formulation of food and farming policy. Instead it should be accepted – together with food security, public health, the environment, climate change and farmers' livelihoods - as one of the core criteria that must be satisfied by food and farming policy.

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