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THE ROLE OF LIVESTOCK IN AGROECOLOGY AND SUSTAINABLE FOOD SYSTEMS

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Livestock play an important part in food systems. They are a source of high quality protein and other nutrients, such as vitamins and minerals; and raising livestock is a way of utilizing otherwise unusable areas and resources for food production – namely grasslands, by-products of food production, and organic waste. Livestock also play a significant role in on-farm and regional nutrient cycles, and they provide people with incomes, assets and livelihoods. However, over the last 50 years we have seen a more than fourfold increase in global meat and egg production, and milk production has more than doubled. At the same time, there was just a twofold growth in the global human population (FAOSTAT, 2015).

Over the same period, the livestock sector has become increasingly specialised and industrialised, and its environmental impacts have grown accordingly, most notably in terms of greenhouse gas emissions, nitrogen overload, land-use change and deforestation (Ripple et al., 2014; Steinfeld, 2006). The outlook remains bleak as, according to recent FAO forecasts, production is expected to rise by a further 70% by 2050 (Alexandratos and Bruinsma, 2050). Actions to curb the adverse effects of livestock production are therefore of paramount importance, and it is vital to reflect on the role of livestock in future sustainable food systems. Here it is necessary to take a whole food system perspective, especially when talking about 'feeding the people' and not merely about agricultural production.

LIVESTOCK IN AGROECOLOGY

As in organic farming, livestock could play an important role in agroecological production systems. Unlike in organic production, this has not traditionally been the rule in agroecology. This situation might be changing, however, as several research contributions show (e.g. Dumont and Bernués, 2014; Bonaudo et al, 2014; Dumont et al 2013). Dumont et al (2013) suggest five principles for agroecological livestock production:

1. Improving animal health.
2. Reducing inputs.
3. Reducing pollution by optimizing metabolism in the farming system
4. Enhancing diversity for greater resilience.
5. Preserving biological diversity.

Integrated crop-livestock systems are therefore a key aspect of agroecological and organic livestock production (Dumont and Bernués, 2014). Such integration allows for better management of nutrient flows and of landscape structures, with beneficial effects, for example, on biodiversity. Achieving integration and greater diversity, for instance by combining different animal species with differing feed preferences on the same pastures, or using integrated crop-livestock-forestry systems, can lead to higher productivity and reduce the use of inputs, while improving the overall economic performance (Latawiec et al, 2014, Accatino et al, 2014). It should be emphasized that such combined systems can be quite knowledge-intensive and their implementation can pose considerable challenges, particularly in contexts where no such tradition already exists. It can cause problems, for example, if new species or varieties are introduced in places where they are not reared traditionally.

Nitrogen flows are particularly relevant for identifying potential reductions in inputs and for optimising farm system metabolism. External and internal nitrogen sources and sinks need to be clearly identified. Feed and mineral or organic fertilizers (including manure and compost) imported to the farm are clearly external sources. Internal sources include manure, crop residues, compost, litter and roots, as well as the soil nitrogen pool. External sinks or losses include nitrogen runoff and emissions of various compounds such as nitrous oxide and ammonium, as well as the produce that leaves the farm. Nitrogen fixing by legumes actually counts as an additional external source of nitrogen, as it produces reactive nitrogen from atmospheric molecular nitrogen. Finally, the deposition of atmospheric nitrogen must be considered as another external source, as it can reach high levels in relative terms, in particular on grasslands (Stevens et al, 2004).

However, when assessing the nitrogen cycle and a potential imbalance between inputs and outputs, it is not the source of fertilizer that counts, but the ultimate source of the nitrogen it contains. All the nitrogen in manure stems from nitrogen in the feed. Therefore, unless it is imported into the system, manure is not a source of nitrogen, but merely a means of storage and spatial redistribution, where the nitrogen is partly sourced from grasslands. This enables farmers to collect external nitrogen from rather low intensity but extended grassland areas for use on more intensive croplands. They can also store it to optimize the timing of its application. This is one important role of livestock in agriculture.

In light of the fact that integrated crop-livestock systems are important for sustainable food production, and since grasslands and reusing organic waste are important for the crop-livestock system in general, the question arises as to whether the farm is the best unit of analysis. A regional focus should be adopted instead, enabling the assessment of nutrient cycles at the regional level. This is more appropriate for the dynamics of many ecosystems for which a regional scale is relevant. Examples include structural elements in the landscape that affect biodiversity or hydrological features. It is also better suited to grasslands, which are a representative reference point for systems on this regional scale. A farm-level perspective can impose an artificial division that is not appropriate for the relevant system dynamics. The landscape perspective is more often seen in the context of agroecology, while in organic farming, the farm-level perspective is still more common.

FOOD SYSTEMS

Much could be achieved using sustainable integrated crop-livestock systems, ideally conceived on the landscape scale. However, livestock can help farmers move towards more encompassing approaches, embracing whole food systems, as is proposed in some recent work on agroecology (Wezel et al, 2009).

Global food system modelling has shown that it is possible to devise a sustainable food system capable of delivering the necessary calories and proteins to meet the needs of over nine billion people in 2050 (Muller et al. 2015). This could be achieved, for example, by i) pursuing more sustainable production practices such as organic agriculture (certified or not), while ii) reducing the use of animal feed concentrates, using grassland-based ruminant production at the same time as reducing the content of animal products in human diets, and iii) reducing the amount of food wastage.

None of these three strategies needs to be implemented in full, but a partial implementation of all three together could bring considerable improvements in terms of all the relevant environmental indicators. Achieving partial implementation of several strategies in combination is a much more realistic ambition than full implementation of a single strategy.

The combination also alleviates the pressure on certain aspects of the individual strategies, such as the yield gap in organic production. If food wastage is reduced, for example, the pressure to reduce the yield gap also falls, as less output needs to be produced. These aspects are overlooked if the focus is only on sustainable production rather than the whole food system, which includes consumption.

Ultimately, therefore, the role of livestock is related to the bigger question of how protein is produced in the food system. Animals can play an important role in this, especially grassland-fed ruminants and monogastric animals fed on the by-products of food production such as bran, whey and food waste.

However, it would be possible to source a greater share of our protein from crops than currently happens. In this respect, innovative protein sources could also be considered in agroecology and organic farming, such as algae or insect protein (Shockley and Dossey, 2014). For example, some locusts thrive on grassland while providing a rich protein source without the disadvantage of methane emissions. It may be worth considering an investment in breeding locusts and using them in food production, and in designing systems for managing their populations and harvesting them on grasslands.

Discussing the role of livestock in agroecology therefore serves to emphasize the importance of a food-system focus that treats aspects of consumption with equal importance to production. Food wastage is also a good example of this. As long as 30-40% of food is wasted (Gustavsson et al, 2011), it makes little sense to produce that waste more sustainably unless we work at the same time to considerably reduce it.

Finally, as part of this food systems approach a discussion should be started about utilizing the nutrients from human faeces and urine. Only by including this can we complete the picture of a whole food systems approach that encompasses consumption and aims at a closed nutrient cycle. Ultimately, this would just be the same as using manure from livestock in food systems.

POLICIES AND STRATEGIES

At the strategic or policy level, the discussion described above reflects the more general discussion of 'coarse-tuning' and 'fine-tuning' (Minsch et al, 1996). Policies for sustainable development often need to be coarsely rather than finely tuned, addressing aspects that have a lot of leverage, such as the share of animal products in human diets, rather than the emissions per kg of animal products, or addressing the issue of food wastage rather than the land area required per kilogram of food.

Currently, most approaches to raising the sustainability of livestock production fall far short of this. For instance Thornton (2010) and Gerber et al (2011) focus on increasing the efficiency of livestock production without addressing the absolute size of the sector. Gerber et al (2013) propose a range of effective and important measures to increase efficiency in the livestock sector. If these were all implemented, greenhouse gas emissions from today's livestock sector could be reduced by 30%. However, without curbing demand, in 2050 those emissions would still be 20% higher than today as the production will increase by 70% (Alexandratos and Bruinsma, 2012). If, on the other hand, the amount of animal protein that people eat is reduced by two thirds, and the rest is produced with agroecological methods (concentrate-free feeding rations, grassland-based ruminant production and monogastric animals fed on by-products of food production), then the greenhouse gas emissions projected for 2050 would fall by 20% compared to today's emissions (Schader et al. 2015). This example illustrates well the problem of fine-tuning strategies such as efficiency increases, compared to the benefits of coarse-tuning, such as targeting absolute quantities.

The advantage of coarse-tuning strategies is that they can rely on generally robust rules that do not depend on further detailed research findings for their successful implementation and would not be altered by new insights into details. The disadvantage is that such strategies tend to address fundamental aspects of society. Whereas a fine-tuning strategy may inform consumers about the greenhouse gas emissions of various food products, and leave it up to them to choose the climate friendly options within their established diets, coarse-tuning aims at a fundamental change in what people eat. This cannot be achieved using ordinary policy instruments, such as those used to support increased emissions efficiency, for example. Especially in liberal societies, coarse-tuning poses a challenge as it is often perceived to interfering with individual freedoms.

It is all the more important to emphasize, therefore, that the example above illustrates a coarsely tuned strategy for a more sustainable food system which is not extreme in any of its dimensions, although its aims are high. Its strength lies in the combination of substantial but partial improvements in terms of livestock feed, ecological production, food wastage and human diets. Together, these improvements achieve the environmental goals, while none of the individual approaches has to be implemented to 100% in order to achieve the goals.

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