THINK TANK & RESEARCH

BACKGROUND PAPER

Livestock production and food security in a context of climate change, and environmental and health challenges

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GERMANWATCH

Summary of Recommendations

Our analysis has shown that, to optimize the interrelationship between soil, climate and cattle and maximize the latter's contribution to global food security, the following steps need to be taken:

- More research on grassland management aimed at optimizing its capacity to serve as a carbon sink.
- More support for grazing.
- Land-use change should be brought under strict control, including that related to imported animal feed.
- Livestock production should have a stronger link to the regional feed base.

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Content

Introduction

There is a widespread concern that the world is "losing ground"[1]. According to the Institute of Advanced Sustainability Studies (IASS) (2013) the growing world population and its increasing demands put a greater pressure on soils than ever before. The IASS estimates that every minute 23 ha of land face desertification, 5.5 ha of land are transformed by urban encroachment and 10 ha of soil are degraded. This leads to an overall loss of 24 billion tons of soil every year. One fifth of today's cultivated land is already degraded (Bai et al. 2008). This poses major challenges for future food security. The problem becomes truly worrying if the slow formation rate of soils is considered. Soils are – in human terms – an almost non renewable resource.

The main anthropogenic drivers causing soil loss are primarily the urbanization and secondarily the growing demand for agricultural products in combination with unsustainable practices. By 2050 the urban environment is expected to grow by 81 percent (Electris et al. 2009). 80 percent of this expansion will take place on agricultural land (Holmgren 2006). At the same time an additional 120 million ha of agricultural land is needed to meet the future food demand in developing countries if current trends in income and consumption patterns prevail (Bruinsma 2009). Today, about 40 percent of land surface is used for agriculture, including crop- and pastureland. Whereas agricultural land has decreased in North America (4%) and Europe (25%), it has considerable been enlarged in South America (83%), Africa (46%), and Asia (36%) since 1960 (FAOSTAT 2010). The associated land use changes coincide with alarming rates of deforestation and, as a result, the decline of the biggest terrestrial carbon sink on earth. Between 1981 and 2003 there was an absolute fall in net primary productivity (NPP) across 24% of the global land area. This implied an overall loss of about 950 million tons of carbon (Bai et al. 2008).

Occupying roughly 30 % of the earth's terrestrial surface, the livestock sector is one of the major drivers of land use changes worldwide (FAO 2006a). Through activities such as grazing, feed-crop production and waste disposal, the production of livestock shapes local and global landscapes and is one of the most significant contributors to environmental degradation (Dickson-Hoyle & Reenberg 2009). However, differences between intensive and extensive livestock keeping make it incomparable across world regions. The major issue is not whether livestock is the world's largest user of land, but rather how the land and livestock are managed. While sustainable and animal-friendly systems are characterized by areas/space for outdoor keeping and grazing, industrial animal rearing is characterized as landless. Thus the data indicating livestock as the world's largest user of land also include a relevant part of sustainable used grasslands.

1 In conformity with the title of the 2nd Global Soil 2013 "Losing ground?" held up in Berlin on 27.-31. October 2013.

Livestock production systems and prevailing trends

Livestock production systems in the world vary substantially in their typical feeding efficiencies and stocking densities (Erb et al. 2012). Numerous studies on livestock production systems are based on the classification below:

Grassland based systems are livestock systems in which more than 90 percent of dry matter fed to animals comes from rangelands, pastures, annual forages and purchased feeds. Less than 10 percent of the dry matter fed to animals is farm produced and the annual stocking densities are less than 10 livestock units (LU) per hectare of agricultural land. Less than 10 percent of the total value of production comes from non-livestock farming activities. The grassland based system can be further distinguished into extensive and intensive grazing systems. Extensive grazing systems are mostly found in marginal zones in dry areas of the tropics and continental climates of Central Asia, North America, Western and Southern Asia and sub Saharan Africa not suitable for arable agriculture is. Therefore, this production system is dominated by pastoralism and transhumance. Intensive grazing systems can be localized in the temperate climate zones of Europe, North and South America, and increasingly in the humid tropics (e.g. Brazil). The main species is cattle for both, dairy and beef production, relying on high quality grassland fodder. In the beginning of the 1990s nearly a quarter of the global beef, about 10 percent of the milk and almost one third of the global sheep- and goat meat was produced in these grassland based systems. (Erb et al. 2012)

Mixed-farming-systems are livestock system in which more than 10 percent of the dry matter fed to animals comes from by-products or stubble or more than 10 percent of the total value of production comes from non-livestock farming activities. The system can be found in the temperate zones of Europe and the Americans, as well as in sub humid zones of topical Africa and Latin America. In South and East Asia mixed irrigated systems are most common.

Globally more than 80 percent of milk, and beef and almost half of the pork and one quarter of the chicken meat are produced in mixed-farming-systems. (Erb et al. 2012)

Landless livestock production systems are livestock systems in which at least 90 percent of the income is generated by livestock, more than 90 percent of feed is purchased and in which annual average stocking rates are above 10 LUs per hectare of agricultural land. This system is dominant around the urban conglomerates of East- and South-East Asia and Latin America as well as in regions with high animal feed production (North America) or high animal feed imports (North-West Europe). Already in the 1990s nearly three-quarters of the poultry meat and more than half of the pork production were produced in landless systems. Ruminants are generally not kept in landless systems and therefore, the world’s production of dairy and beef products is less than 10 percent in these systems. (Erb et al. 2012)

Although the above listed classification system is relatively rough (for instance, intensive dairy farms usually fall within the class “mixed farming systems”, even if they show rising industrial production features) it allows for specific insights into the dynamics of animal production.

Prevailing trends in the livestock production demonstrate an increasing industrialization of agriculture, along with landless, large-scale livestock production. Feeding systems have turned more and more from being local/regional to global over the past few decades; the basic source of fodder is less and less the farm itself. The resulting problem of expansion and intensification of livestock production is associated with the shift from a feed system based on grass and plant remains to one based mainly on crops, even for ruminants.

The intensification of livestock systems, and especially feeding systems, goes hand in hand with specialization and rationalization, thereby creating livestock systems that are increasingly dependent on energy input and foreign fodder sources. The growing demand for such feed results in a huge demand for land, leading to land-grabbing and land conversion, including the deforestation of rainforests. In a recent study, von Witzke and Noleppa (2011) estimate that in order to produce those agricultural products that were imported by the European Union (EU) in 2007-2008, 53 million hectares (ha) of arable land were used in other parts of the world. The EU, on the other hand, used only 18 billion ha for products it exported during that period. As a result, the EU imports "virtual land" in the order of 35 billion ha. This represents almost a third of the 105 million ha used in the EU as arable land. The single biggest factor that contributes to this imbalance is the import of soy, which uses 18 million ha outside the EU, mainly in Latin America (see below).

Greater standardization and specialization in industrial agriculture is closely related to the de-linking of crop and livestock production. This separation causes higher energy and fertilizer consumption, which while increasing the scale of production and yields, both of crops and livestock, gives rise to enormous risks such as pest infestation, diseases and release of greenhouse gases (GHG). The 4th IPCC Assessment Report states: "Without additional policies, agricultural N_2O [nitrous oxide] and CH_4 [methane] emissions are projected to increase by 35-60% and 60%, respectively, to 2030, thus increasing more rapidly than the 14% increase of non-CO_2 GHG observed from 1990 to 2005" (IPCC 2007: 63). The prevailing system of industrial livestock production with its specific breeding, feeding and general husbandry practices leads to ever larger numbers of animals being subjected to enormous and irresponsible performance and rearing stress.

Irrespective of the animal protection aspect, the concept of "biosecurity" in livestock production can be considered a failure. This is because the attempt to treat low immunity and the increasing threat of infection by an ever increasing use of drugs and disinfectants gives rise to resistance problems, the inevitable selection of dangerous microbes and alarming levels of residues in water, soil, food and animal feed.[2]

Effects of inexpensive energy and nitrogen fertilizers on the production of food of animal origin in the context of climate change

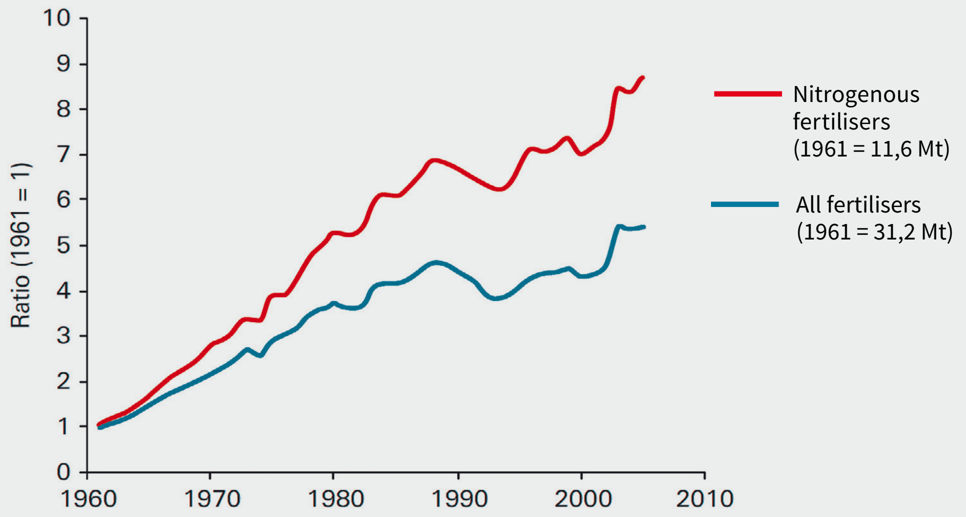
The availability of cheap fossil fuel has driven the expansion of animal production (i.e. the mast of cattle, pigs and chickens as well as the production of milk and eggs). This concerns the production, processing and transportation of animal products as well as plant and equipment. The ecological, climatic and socio-economic problems resulting from intensive animal husbandry and the related animal welfare violations analysed in this paper are largely the result of the ample availability of inexpensive energy.[3]

Energy for the production of cheap synthetic nitrogen fertilizer is the main contributing factor in the expansion and intensification of animal production. Higher nitrogen fertilizer use is the main driver of the increases in agricultural production in general. Its use has increased eightfold in the past 40 years (figure 1), while global cereal production has scarcely doubled. The increase in synthetic N fertilizer use, through its direct and indirect effects, is responsible for the biggest contri-

2 It is beyond the scope of this article to analyse the damaging effects of legal and illegal disposal of damaging and dangerous substances in animal feed for industrial livestock production and the use of contaminated sludge as fertilizer on cropland.
3 "Inexpensive" or "cheap" here means that a considerable proportion of the costs of production remain externalized in prices.

bution of agriculture to climate change. In the production of synthetic nitrogen fertilizer (through the Haber-Bosch process)[4] some 5 tons of carbon dioxide (CO_2) are released per ton of ammonia (Hellebrand und Scholz 2005), and 2–5 per cent of the nitrogen fertilizer applied to the soil is released as nitrous oxide (N_2O), which has a global warming potential 296 times higher than that of CO_2. Some ammonia (NH_3) is also released (Sutton et al., 2011, see below).[5]

Figure 1: World fertilizer consumption, 1960–2005 (FAO 2009)



Source: Royal Society, 2009 (citing FAO, Fertilizer, 2009)

Over the past few years, livestock has been identified as the main contributor to agricultural GHG emissions. One critical aspect is the increase in the total number of livestock. However, the extent of GHGs emitted depends on the agricultural system. The system boundaries are key determinants of the resulting data concerning the GHG balance. Therefore transparency regarding these system boundaries is a necessary condition for comparing the results of different studies. Since these boundaries are often either not clearly defined or set inadequately, most of the available studies are of limited analytical value and are hardly comparable.

As monocultures for animal feed cover almost 40 per cent of the global cropland, and animal feed absorbs more than one third of global cereal production (FAO 2013/2014), livestock is the main driver of climate change from agriculture.[6] In other words, the sustainability or intensity of feeding systems is key to the GHG balance of given agricultural systems (Schulze et al., 2009). Schulze et al. believe that the damage caused by N_2O as calculated by the Intergovernmental Panel on Climate Change (IPCC) is an underestimation, and suggest doubling the damage factor at the very least.

The high energy and fertilizer inputs in intensive livestock production have the following impacts, apart from the direct and indirect impacts on climate:

- The economies of scale associated with the non-internalization of ecological, social, health and climate costs allow cheap mass production of animal feed based on monocropping without crop rotation.

4 This process, used for the industrial production of ammonia, involves the nitrogen fixation reaction of nitrogen gas and hydrogen gas over an enriched iron or ruthenium catalyst.
5 Ammonia is not categorized as a GHG that has a direct impact on the climate, such as CO_2, N_2O and CH_4, but it does have a relevant indirect impact through its effect on the atmosphere.
6 For some years, monocultures for agro-energy production are increasing the amount of N_2O emitted from agriculture.

- The worldwide availability of inexpensive concentrate feed allows the rampant expansion of the number of animals, independent from the locally available animal feed supply.
- Synthetic fertilizers and pesticides substitute for crop rotation, including the green fertilizers and legumes required for nitrogen enrichment of the soil. As a result, the farm's internal supply of animal feed is drastically reduced.

With mounting numbers of livestock, the volume of animal excrements (faeces and urine) drastically soars. Most of the proteins fed to livestock in the EU originate from countries in South America, but the excrements are produced in European countries. At the same time excrements lose their importance as natural fertilizers because of the high use of mineral fertilizers on the fields. For decades, research has been focusing on how to use synthetic nitrogen fertilizers more efficiently. Due to the contamination of the excrements with animal-administered drugs and disinfectants, they pose a huge disposal problem. As excrements are used less and less as natural fertilizers, related skills diminish and research on this subject is no longer done. A common way of getting rid of slurry is to dump it on pasture lands – often as a kind of waste disposal – which greatly reduces pasture quality.[7]

Through economies of scale, farms where livestock production is still based on farm-generated feed come under increasing economic pressure. Industrial mega-farms or farms that are much larger than the regional average drive this trend.

Box 1: Key findings of the European Nitrogen Assessment

The European Nitrogen Assessment (ENA), implemented in the 6th EU Research Framework Programme, focuses on the implications of the mounting use of nitrogen fertilizers in agriculture (Sutton et al., 2011). The authors of the Assessment reviewed the direct connection between inexpensive energy and the production of synthetic nitrogen fertilizer. The Assessment recommends more research on the interplay between the carbon and nitrogen cycles and their impact on soil fertility, climate and the ecosystem.

In the technical summary of the Assessment, Sutton and Billen (2011:XXXV) emphasize that "the deliberate production and release of N(r) [reactive nitrogen] in the Haber-Bosch process can be considered as perhaps the greatest single experiment in global geo-engineering that humans have ever made. (…) What was not anticipated was that this experiment would lead to a 'nitrogen inheritance' of unintended consequences with N(r) leaking into the environment in multiple forms, causing an even larger number of environmental effects."

The Assessment focuses on "five key societal threats" from excess nitrogen use, in terms of its impact on water quality, air quality, greenhouse balance, ecosystems and biodiversity. The authors state that "the understanding of N cycling has undergone a paradigm shift since 1990. Until then, the perception was that: (1) N(r) mineralization is the limiting step in N cycling; (2) plants only take up inorganic N(r); and (3) plants compete poorly for N(r) against microbes and use only the N(r) which is 'left over' by microbes. Since then studies have shown that plants compete effectively for N(r) with micro-organisms and take up organic N in a broad range of ecosystems" (Sutton and Billen, 2011: XXXVII). The authors also point out that till 1990 the impression that plants only take up inorganic N(r) demonstrates how industrialization of agriculture has influenced research and extension services in a one-sided way, and has eroded the importance of related local farming knowledge.

7 Besides the general use of animal excrements, this also concerns the separate use of urine and faeces. Normally the separation is done through pasturing: the natural separation for mammals prevents the modification of the nitrogen compounds in the urine through the bacteria contained in the faeces.

The authors highlight how little that "paradigm shift" has been taken into account in agricultural extension services. They note, "In cereal farming, the use of only mineral N(r) fertilizers, instead of animal manures or composts, as well as the simplification of the crop rotation scheme that this had made possible, has in some cases resulted in a decline of soil organic matter. In the long-term this practice of using only mineral fertilizer has decreased the buffer capacity of the soil towards inorganic N inputs, thus increasing its propensity to N leaching." They add that "nitrogen-enriched terrestrial ecosystems lose significant amounts of N via nitrate leaching and gaseous emissions (N_2, N_2O, NO, NH_3) to the environment. Estimates of denitrification to N_2 remain highly uncertain, due to difficulties in measurement and a high degree of temporal and spatial variability. There remain substantial uncertainties in the average fraction of N(r) applied to fields that is emitted as N_2O, ranging from 1% to 3,5-4,5% of fertilizer N applied, using bottom-up and top-down estimates, respectively." And regarding ammoniac, the authors conclude: "Further research is needed to better understand the relative contribution of direct and indirect N_2O emissions." (Sutton and Billen, 2011:XXXVIII).

How ineffective enforcement and implementation of existing nitrogen and related EU directives [a)] have been becomes apparent in the authors' summary: "Europe (EU-27) is a hot spot in this sense, producing 10% of global anthropogenic N(r) even though its surface covers less than 3% of the total world continental area." (Sutton and Billen, 2011: XXXV). The authors also criticize the low procurement costs: "(…) the low price of N(r) fertiliser, combined with its clear benefits to agricultural production, does not provide a strong incentive for farmers to use less than the (private) economic optimum" (Sutton and Billen, 2011: XXXVI).

Note [a)] For instance, Nitrates Directive, Water Framework Directive, Groundwater Directive, Ambient Air Quality Directive, National Emissions Ceilings Directive, Urban Waste Water Treatment Directive, Marine Strategy Framework Directive, Integrated Pollution and Control (IPPC) and Habitats Directive.

Source: (Sutton et al., 2011)

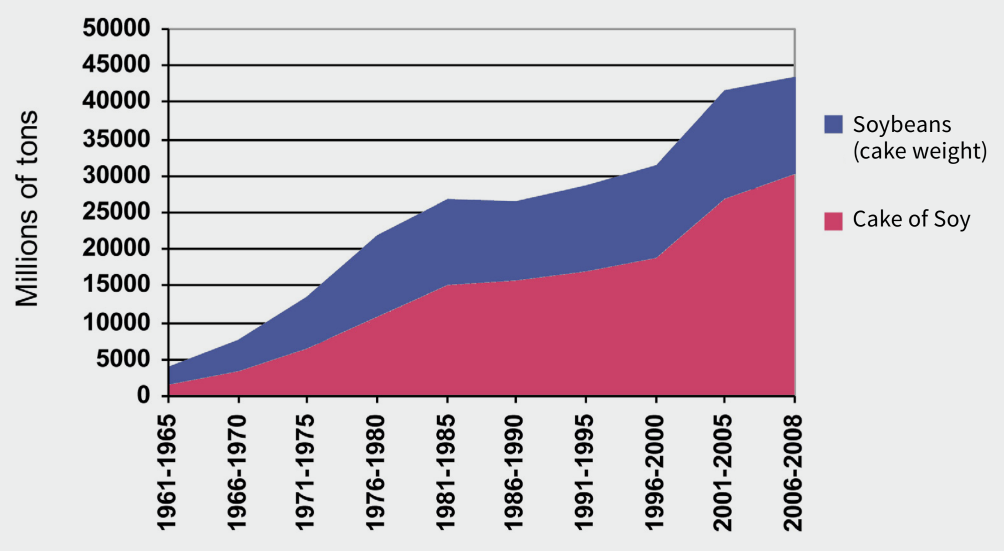
Sustainability requires a new definition of the terms productivity and growth

The approach to agricultural growth aims at increasing crop yields per hectare, taking into account the costs of procured inputs such as energy, fertilizer, pesticides and labour. This calculation fails to consider not only the externalized costs (damage to soil, water bodies and air pollution through residues and contamination, as well as the social implications), but also the decline in soil fertility through soil erosion, compaction and nitrification – a development that has not yet been fully appreciated because of the ample availability of cheap synthetic fertilizers (Troeh, Hobbs and Donahue, 1991). For example, farmers in the United States apply fertilizers worth about $20 billion annually to offset the effects of soil nutrient loss due to soil erosion (Troeh et al. 1991, cited in Nkonya et al., 2011).

There is a deplorable problem of perception, because efforts to strengthen intensive agricultural production and increase yields through enhanced use of synthetic fertilizers give the wrong impression that the production of animal feed is not in competition with food production. The negative impacts of the enhanced use of synthetic nitrogen fertilizers are not taken into account, and related costs remain externalized. According to the European Nitrogen Assessment (Sutton et al., 2011), the total costs of nitrogen pollution of water, the atmosphere, and other impacts on ecosystems and climate change are estimated to be between €70 billion and €320 billion per annum (i.e. €150–€736 per person per year), which is more than twice the monetary benefits derived from agriculture.

Between 1961 and 2009 the number of animals reared for meat and dairy production increased rapidly. According to FAO (FAOSTAT, 2011), in 2009 1.38 billion heads of cattle and buffalo were reared globally – the number doubled during the last 50 years (while the number had been mostly restricted by the available pasture, the basis for the increase is the use of biomass from croplands) During the same period, the number of pigs more than doubled, from 406 million to 941 million. The number of chickens grew the most dramatically: almost fivefold, from 3.8 billion to 18.6 billion. Since not only the number of animals increased, but also the average weight per animal, meat production rose at an even faster rate: beef production more than doubled, to 62.8 billion tons in 2009, pork production quadrupled, to 106.3 billion tons, and chicken meat production increased tenfold, to 80.3 billion tons. This rapid expansion of global meat production was only possible because the feed supply for the animals increased at a similarly dramatic rate. The EU is a prime example in this respect. Its imports of soybean cake – a crucial source of protein in intensive and industrial animal production – rose tenfold between 1961 and 2009, and now stand at almost 44 billion tons per year (figure 2). The focus on cake is because only this is used as animal feed, while soybean oil is used for human consumption, industrial and energy use.

Figure 2: EU imports of soybean cake and soybeans 1961-1965 to 2006-2008 (millions of tons)



Source: Authors' calculations based on FAOSTAT, 2010

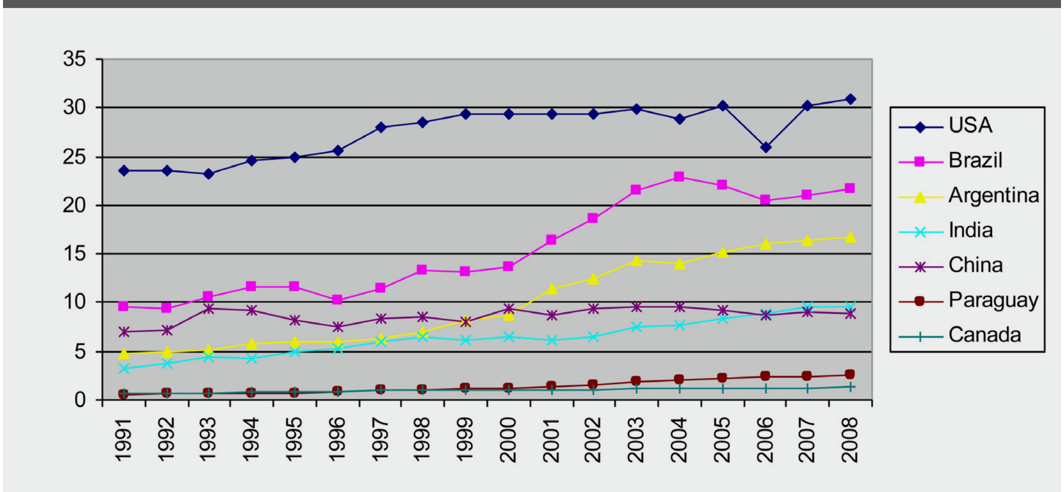
The role of agricultural and trade policy in the industrialization of animal production

An important driver of this development has been the EU's Common Agricultural Policy (CAP) and its link to trade policy. Until the early 1990s, the EU guaranteed prices for livestock products – especially beef and dairy products – that were significantly higher than world market prices. This provided an effective incentive for European farmers to increase production. At the same time, the CAP intervened in the markets for feedstock. While high prices for cereals in the EU were also guaranteed, there was no support for oilseeds and their products – oils and cakes. This situation is also reflected in the EU's agricultural trade policy: while livestock products and cereals were, and generally still are, protected by high tariffs, oilseeds and their products have experienced no, or only very low, tariffs. These tariffs were fixed multilaterally in the General Agreement on Tariffs and Trade (GATT), the predecessor of the World Trade Organization (WTO).

In the 1980s, the EU attempted, relatively successfully, to support oilseed production with policy instruments such as production premiums. However these were found to run counter its GATT commitments. With the shift from price support to payments based on the area planted with certain crops, some support for oilseed production could be provided. However, the Blair House Agreement, a bilateral agreement between the European Community and the United States, which paved the way for the WTO Agreement on Agriculture, placed a limit on the area planted with oilseeds in the EU that could benefit from payments. As a result, the EU's imports of soybeans and soybean cake, which had remained at roughly a constant level in the 1980s, started to increase in the 1990s. The BSE crisis in 2000–2001 gave an additional boost to EU soy imports. In these years alone, the EU's soy imports jumped from 33.7 million tons to 40.2 million tons (FAOSTAT and authors' calculations).

The EU's rising import demand was mainly met by South America, especially Argentina and Brazil, where the area planted with soy rose from just over 10 million ha (in both countries combined) in 1980 to over 48 million ha in 2009 (figure 3). This triggered the massive deforestation of the tropical rainforests in Brazil and the conversion of grasslands (cerrado in Brazil and pampas in Argentina) to cropland.

Figure 3: Area under soy cultivation: selected countries, 1991–2007 (millions of hectares)



Source: Authors' calculations based on FAOSTAT.

It is estimated that the land-use changes directly related to the expanded soy production in Argentina, Brazil and Paraguay were responsible for, on average, over 420 million tons of CO_2-equivalent (CO_2e) emissions annually between 2000 and 2009 (Reichert and Reichardt, 2011). This amounts to about 18 per cent of the total GHG emissions of these countries.[8]

The rapid expansion of feed imports enabled the EU not only to meet its rising demand for meat and dairy products, but also to become a net exporter of beef, dairy products and pork. Since the guaranteed domestic prices were usually significantly higher than world market prices, exports were only possible through “refunds” for exporters, which covered the difference between the internal and external prices. These “export subsidies” turned out to be a major issue of conflict in international trade. The significant European exports of animal products (as well as wheat and sugar) gave the wrong impression that the EU was producing overall agricultural surpluses. The fact that this was only possible because of the ever- increasing imports of animal feed was largely neglected in the public debate.

Consequently, the reforms of the CAP in the early 1990s focused on cutting down surplus production by reducing guaranteed prices for cereals and beef, and (initially) to a much lesser extent for milk. The income losses were partly compensated by specific area payments to farmers. One condition for receiving those payments was that a certain proportion of arable land would have to be kept idle – the most direct instrument for addressing the “overproduction” problem. The amount of land to be “set aside” was fixed by the EU on an annual basis, depending on market conditions. On average, it was around 10 per cent of the cropland. As a result, exports of cereals and beef fell significantly, and while the EU remains a net exporter of wheat, it is now a net importer of beef and sugar. At the same time, net exports of pork more than doubled, from around 400,000 tons annually in the late 1980s to around one million tons annually in recent years. The figure for 2008 was as high as 1.4 million tons (FAOSTAT). The expansion of pork production and exports was less directly linked to agricultural policy instruments, and more a result of the increasing industrialization of animal production discussed earlier.

Since the animals are separated from their natural environment, and feed can be sourced globally, the suitability of a certain area for animal and feed production is less important than the infrastructure for transporting and processing feed and animals. The animal breeds and the barns for industrial animal production have also become globally standardized. As a result, northern France, northern Germany, Denmark and the Netherlands, with their proximity to Rotterdam as the largest port for receiving imports of soybeans and soybean cake, along with a well-developed infrastructure and a mature food industry, have become the main pork (and chicken) producing regions in the EU. This has been partly supported by CAP-related investment assistance through subsidized interest rates.

In sum, the intensity of livestock production is decisively determined by the intensity of animal feed use, which in turn is correlated with the enhanced use of energy and synthetic fertilizers for the production of that feed. This is why a comparative analysis of the ecological and climate balance of livestock production requires data on where and how the animal feed was produced. In this regard, the land-use changes required for intensive and monoculture-based feed production are a particular source of concern with regard to their social, ecological and climate impacts.

The dependence on foreign fodder sources is only one outcome of the fundamental change in agricultural livestock systems. Another main driver of industrial agriculture is that food retailers are demanding increasingly standardized products in terms of quantities, sizes and fattening periods. Since the 1960s, standardization by and for industrialized meat and dairy production systems has resulted in the replacement of wild and cultured, biodiversity-rich land by monotonous landscapes. As a result, wild biodiversity suffers, as reflected in the decrease in wild bees (in many areas

8 Calculated using the Climate Analysis Indicators’ Tool of the World Resources Institute, at: http://cait.wri.org.

sufficient pollinators are lacking), butterflies and hedges, for example. The loss of breeds and the low, regular utilization of the remaining ones lead to the loss of traditional knowledge.

For many years governments have supported performance testing and estimation of breeding values which aimed uniquely at achieving more (financial) yield per unit. This has led to more uniform breeds and ran contrary to the goals relating to "genetic diversity" as embodied in the Convention on Biological Diversity (CBD) (IOeW et al., 2004). The CBD is based on three pillars: (i) conservation of biological diversity, (ii) fair and equitable access and benefit sharing of biological diversity, and (iii) the sustainable use of animal and plant genetic resources and their habitats. As wildlife and wild plants need their specific environments/habitats, plants and livestock breeds need a "cultured habitat" of which they are a part, and thus influence and are influenced by that habitat. If the genetic resources of animals and plants are not used, they disappear as part of the whole system and can no longer play their part in their system.

Risks associated with selective breeding for higher productivity

Although selection is aimed at high performance in both animal and crop breeding, there is a major distinction between the two. A certain and increasing proportion of crops, such as vegetables, are grown in greenhouses or under plastic foil for commercial purposes. However, the vast majority of crops is still planted in the open and is exposed to the vagaries of the weather. Since the 1950s, animal production, by increasingly relying on animal feed, synthetic growth hormones, vitamins, amino acids and mineral supplements, has become less dependent on location (Idel and Petschow, 2004). A growing number of chickens, pigs and, increasingly, cattle are raised in a way that completely shields them from the effects of the sun and the weather.[9]

Breeding increasingly overburdens animals that have been selected to maximize their production. For example, hens that are bred to maximize egg production generate about 300 eggs per annum; chickens selected for meat production reach their slaughter weight after less than five weeks of intensive raising; young pigs, less than six months old, are slaughtered when they reach about 100 kg; and some cows are bred to maximize milk production, delivering over 10,000 litres during one lactation period alone (as a result most of them do not survive more than five years). Many of these animals suffer from "occupational" diseases, such as inflammation of the fallopian tubes in hens, udder inflammation of cows, or problems with joints in pigs, hens and cattle caused by excessively rapid weight gain.

The tenet that "performance is an expression of good health" is no longer valid. Indeed, forcing their enhanced performance causes animal stress and "burnout" (in poultry, pigs and cattle for mast) resulting in a short life span (dairy) and requiring the frequent administering of drugs such as antibiotics and analgesics. In addition, hormones are being widely administered to overcome fertility problems of cows that are bred for maximizing milk production. Generally, high external input systems aim at minimizing the energy losses of animal bodies caused by physical movement and adaptation to changes in temperature and feed. This ostensibly reduces the energy consumption of body functions and maximizes the production of animal products. These consistently restrictive conditions are a major factor that contributes to the breeding of uniform animals and their selection for high performance.

9 The fact that animal breeding is more advanced than crop breeding does not reflect a higher level of technological innovation. By way of illustration, the commercialization of some transgenic crops is far more developed than transgenic animals.

As a result, the flexible adaptive capacity of animals to changing and divergent production conditions has been replaced by inflexible, static and location-specific behaviour. An extreme example is the use of standardized cages for hybrid hens, whether in California, Hong Kong, Norway or Oman. The light and temperature in the sheds where the cages are kept, along with the concentrated feed and limited physical movement, are all designed to ensure maximum and standardized egg production. The animals have few reserves to respond to changing environmental conditions such as variations in temperature, feed or stress from transport. Despite this being common knowledge, this stress from breeding is dealt with not by changes in breeding practices, including breeding goals, but only by changing the raising methods: chickens' beaks and pigs' tails are trimmed and the animals are often held in stress-reducing dimmed light in order to reduce the extent and consequences of cannibalism among the animals that results from enhanced stress (Compassion in World Farming, 2009). In addition, antibiotics are increasingly used to treat the greater incidence of illness among animals resulting from high-performance breeding. The development of a solid immune system in animals, which is so important for open-air rearing of animals, receives little attention under such conditions. Besides the greater susceptibility to illness in animals, the targeted selection for maximum performance raises other animal protection and welfare issues. As the performance of female animals directly correlates with the targeted selection in breeding, fattening performance declines and with it the performance of male animals. For example, the fattening of brothers of egg-producing hens is considered uneconomical. As a result, in the EU more than 300 million male chickens are killed each year as soon as they hatch. Similarly, in the United Kingdom, for instance, male calves of breeds that are selected for maximizing milk performance are killed – some 150 000 each year (Weeks, 2007).

Ignoring the animal health and welfare issues associated with this development, genetic engineering has been used for decades to maximize animal performance. And in spite of extensive public and private research on genetic manipulation over the past 30 years, until today no transgenic animals are used for commercial agriculture purposes owing to significant biological and technical problems (Then 2011, 2012). As early as the mid-1980s, some researchers envisaged the technology-linked failure of transgenic manipulation. This failure became the engine for cloning research (Idel, 2008). The objective was to clone transgenic individuals in those exceptional cases where they had desirable properties and no or few unintended problems. Yet cloning too has been relatively unsuccessful in the past 25 years, with the rare successes due mainly to coincidence.

Only a few viable animals have been produced using the "Dolly method"[10] According to the European Food Safety Authority (EFSA 2007: 9), "The overall success rate of the cloning procedure is still low and differs greatly between species. The overall success rate, expressed as the percentage of viable offspring born from transferred embryo clones, ranges approximately from 0.5 to 5 %, depending on the species." Of the surviving cloned animals, "Dolly" remained a unique specimen. The hope that whole stables could be filled with animals cloned from one individual in order to achieve an identical fattening result with a standard and economical feeding and treatment regime – a hope of unlimited mass industrial production – has remained a distant dream. In any case, sameness in terms of desirable fattening and other performances would lead to greater vulnerability to sickness and contagion.

Already, the current practice of the use of only a few commercial animal races and hybrids for industrial livestock production is leading to a loss of genetic diversity, and carries the risk that animals are more vulnerable to infectious diseases and pests. This interrelationship has been analyzed at length by an international team of researchers (Muir, Gane and Zhang, 2008). With regard to chickens, for example, the findings confirm that almost all animals raised for poultry meat (some 19 billion worldwide) are based on only three races, and hens raised for maximum egg production stem from only one race.

10 In 1996, the cloned sheep "Dolly" was born after thousands of attempts with embryos. Dolly was the first mammal that was created by and survived the technology of somatic cell nucleus transfer (SCNT). Although armed with a patent the "dolly" method is (as all other genetic and cloning methods) not a blue print to get identical copies.

The push for biosecurity poses a threat to animal and consumer protection

Over the past few decades, the immune system has increasingly been perceived as a mere protection system, primarily against bacteria, rather than as an interface between the worlds of micro- and macroorganisms. As a result, two facts have been overlooked: bacteria are an indispensable component of our immune system; and bacteria have existed much longer on our planet than humans, so that our development over millions of years has been more with rather than against bacteria.[11]

Since the immune system links us to our environment, reacting to each pathogenic problem by enhancing sterility (by attempting to eradicate all microorganisms) poses a risk to our future development. Thus the belief that this strategy enhances security – also called biosecurity – is a fallacy. It may work in some individual cases, but it increases the inherent risks and may compound future problems. In particular, the regular and extensive use of antibiotics and disinfectants for human and animal health unavoidably leads to the emergence of pathogens with higher resistance and infection potential. By way of illustration, the bacterium Pseudomonas aeruginosa, which is resistant to many antibiotics, can survive disinfectants and even thrives on hygiene products. Such extremes have been known for decades as "hospital germs", because they have mushroomed in hospitals. The principle is the same: the unintentional selection of more and more dangerous germs. The more resistant a germ already is to treatment with antibiotics, the greater the likelihood that it will survive the next wave of treatment with antibiotics and disinfectants.

Against this background, "biosecurity", through repeated use of new antibiotics and disinfectants, is not only no solution, but in the long term it is also highly risky. Humans and animals need the contact with microorganisms for strengthening their immune system, in particular at the juvenile stage. Thus ostensible "biosecurity" in intensive livestock production is a problem in that it hampers the development of a healthy immune system and it strengthens the resistance of germs and pathogens, making it increasingly difficult for the chemical and pharmaceutical industry to contain those germs and pathogens. The evolutionary dynamics of germs allows them to (quickly) adjust to new antibiotics or antiviral drugs. This often happens much faster than the time required by research teams to develop new and effective medicines.

Box 2: Reasons for the insufficient perception of the potential of sustainable agriculture to contribute to food security and sustainable rural development

- The destruction, waste and contamination of resources associated with the industrialization of agriculture have created a misconception that agriculture always and generally poses a problem. Thus it proves to be extremely difficult to perceive the potential for sustainable agricultural development in grassland, livestock and cropland management.
- For decades, more and more intensified agricultural practices have damaged the environment. Thus, one of the main objectives of nature protection has been seen as taking land away from any kind of agricultural production. This has indirectly and unwittingly led to more „collateral damage" by creating greater pressure for further intensifying production on the remaining agricultural land. It has been based on the perception that the more

11 Indeed the human-microbial relationship is extremely close. A massive amount of 1014 bacteria exist on and in humans – a number 10 times higher than the 10 billion cells in a human body.

intensively existing land is used, the greater will be the available area for nature conservation. It overlooks the fact that it is industrial agriculture that has exerted pressure on resources and land use, and led to widespread contamination of land in general.

- The availability of ample, relatively inexpensive energy and synthetic fertilizers has distracted attention from the importance of soil fertility, as the most basic and precious resource of agriculture, and its loss through erosion. Related to that, the potential of sustainable grassland management and pastoralism for global food security, soil and climate protection has been, and still is, underestimated, and therefore the long-term dangers of converting permanent grassland to other uses are overlooked.
- The inherent growth and productivity pressure of industrial agriculture has devastating impacts on our environment and well-being, and thus violates the third pillar of the CBD (i.e. the sustainable use of animal and plant genetic resources and their habitats).
- Any attempt at maximizing single crop yields is irreconcilable with the optimization of ecological services. Yet public and private support to seeds, cultivation, plant protection and fertilization focus entirely on such a yield maximizing strategy. Conversely, the means for exploring and studying the ecosystemic potential of agriculture and specific production systems or methods in different landscapes have been woefully inadequate.
- The economic interests of different economic actors that derive significant profits from the industrialization of agriculture, including the use of chemical inputs, are one of the main reasons for the lack of implementation of the key recommendations of the International Assessment of Agricultural Knowledge, Science and Technology (IAASTD), namely the prevention of social, environmental and climate damage; internalization of environmental externalities; and analysis and further development of the multi-functionality of ecosystems (McIntyre et al., 2009).

Deforestation and animal feed production

Box 2 lists some explanatory factors for the lack of awareness of the potential of sustainable grassland management with ruminants for achieving food security and sustainable development. There is a widespread belief, that rainforests are being destroyed only to be converted to land for pasture. In reality, however, the cutting of forests is often triggered by a sequence of income-generating cycles, of which pasture for cattle is one. Contrary to prairies and pampas, the soils of tropical rainforests have a lower content of grass seeds and are less fertile because of the washing out of nutrients. This is why deforested areas tend to be used sometimes only temporarily as pasture, and thereafter for growing crops for fodder production and, increasingly, for biofuel production.[12] The expansion of agrofuel production and related land-grabbing offer the opportunity to raise the public's awareness of the ecological and social consequences of animal feed production on former forest and pasture land.

The extraction of soybean oil generates around 20 per cent of oil in volume terms and 80 per cent as cake (bruised seeds). In spite of very different shares in volume terms both products provide

12 Against this background, biofuel certificates that confirm that the feedstock was not produced on cropland derived from deforestation are only useful if the time span before conversion is well defined.

approximately the same income as the 20 per cent share of the soy oil used as vegetable oil and biodiesel.[13] It is likely that demand in the three market segments for these products – soy cake for animal feed, soy oil for vegetable oil and biodiesel – will increase further.

As is the case for permanent grassland, in (mostly non-rain-)forests too the largest share of the stored carbon can be found in the soil. Because of the visible above-ground biomass, it is generally perceived that forests are more important for carbon storage than grasslands, when in fact grasslands are globally as important. In addition, there are two distinctions between grasslands and forests: unlike permanent grasslands, the storage of carbon in forests is subject to saturation; and, in contrast to permanent grasslands, commercially used forests will, in the long term, always be harvested and large parts of the carbon stored in the biomass of the soils will end up being released into the atmosphere. Instead soils under grazed pastures are always covered.

Grasslands and ruminants: an example of misconceptions and opportunities[14]

Animal husbandry is an illustrative example of how non-transparent and illogical system boundaries can lead to wrong conclusions, including the misconception of the cow being a major contributor to climate change.

First, there is the issue of an excessively generic analysis of animal husbandry, which does not distinguish between different production systems. Instead of a comparative analysis of data of resource-efficient sustainable production, on the one hand, and energy-intensive industrial production, on the other, very often average values are used. Second, the analysis is mostly confined to only one GHG – methane – and excludes N_2O emissions mainly caused by the use of synthetic nitrogen fertilizers for intensive production of animal feed. Third, a sound assessment of the effects of agricultural production on climate requires taking into account not only emissions, but also cycles, as sustainable agriculture and forestry are the only economic activities with the potential to provide natural sink functions (carbon sequestration).

However, regarding the relevance for climate, in the relatively common emission comparisons between cattle and cars, cattle tend to fare badly. As an apparently logical result of such comparisons, even more intensive livestock production is being advocated to reduce emissions per unit of meat or milk produced. (Würger, 2010) But this neglects to take account of carbon and nitrogen cycles, and, in particular, the positive effects of sustainable grassland management for the climate as a whole. The related importance of grassland is based on the vast area it covers, accounting for 40 per cent of the global land surface. Sustainable pasture management enhances soil fertility linked to carbon-rich humus, and thereby 1,0 to of humus removes 1,8 to CO_2 from the atmosphere, as each ton of humus contains more than 500 kg of carbon.[15] A prominent example in this regard is grazing, which allowed prairie soils over millennia to reach a depth of several metres.

13 For more information, see, for instance, www.indexmundi.com/commodities/?commodity=soybean-oil, and Fairlie, 2010. Imbalances in the patterns of fatty acids through the rejection or replacement of other oils by cheaper soy oil are not further elaborated here. For more information in this regard, see Blasbalg, 2011.
14 For a more elaborate analysis, see Idel, 2010.
15 0.55 to C + 1.25 to O_2 = 1.8 to CO_2.

Why do cows generate methane, which has a global warming potential 25 times higher than CO_2?

Cows can only digest grass through the symbiosis of billions of microorganisms in their rumen (paunch). Part of these microorganisms can decompose cellulose and lignin in grass and thus make the nutrients contained therein available to the cows. In the course of this digestion process methane is generated by microorganisms. And just as humans exhale CO_2, cows exhale both CO_2 and methane. Through this symbiosis, ruminants such as cows do not have to compete with human beings for food – an ability inevitably linked to methane production.

The exclusive focus on methane from cows in the climate debate is short-sighted, if the analysis is confined to emissions and their potential negative effects. Some data from Europe illustrates this crucial point. It is N_2O, and not methane, that constitutes the largest threat to climate in the context of livestock production. Livestock production is responsible for 75 per cent of all N_2O emissions and 90 per cent of all ammonia emissions, in particular due to intensive fertilizer use including for the production of animal feed. Whereas methane has a global warming potential 25 times higher than CO_2, the global warming potential of N_2O is 296 times higher than that of CO_2. It is assumed that, on average, 2–5 per cent of consumed nitrogen fertilizers are converted into N_2O (Sutton and Billen, 2011; Schulze et al., 2009)

Against this background, besides its adverse ecological impacts, intensive feeding of livestock in the context of global hunger and warming has three additional adverse effects:

- Livestock are competing with humans for food. Normally, livestock, particularly cattle, (should) derive their feed from agricultural land or soils that cannot be used for direct food production for humans. On the contrary, cattle can generate milk and meat from grass.
- The intensive production of animal feed has direct and indirect impacts on climate through
  - Nitrous oxide, ammonia and CO_2 emissions caused by synthetic nitrogen fertilizers;
  - Increased methane emissions linked to the large scale of industrial livestock production and the excessive use of concentrate feed;
  - Excessive generation of animal excrements related to large-scale production;
  - Higher gas emissions through the mixing of urine and faeces caused by a lack of pasturing that would allow natural segregation.
- The increased use of concentrate feed displaces the consumption of grass, and thereby removes the following positive effects of pasture on climate:
  - The permanent and dense grass cover protects soils and prevents their erosion.
  - Sustainable pasture and grassland management promotes the biological activity (photosynthesis) of grass and its roots. In addition, microorganisms, particularly worms, convert biomass into humus, which contains over 50 per cent of carbon.[16]

16 There is a crucial interplay between grassland and ruminant management; as mentioned above, 40 per cent of all land is grassland and perennial grass is very effective for carbon sequestration. Whilst forests expand their biomass volume by only about 10 per cent per year, savannahs can reproduce 150 per cent of their volume (Idel, 2010, 2011; Paul et al., 2009).

Grasslands of the world[17]

In 2005, the Food and Agriculture Organization of the United Nations (FAO) published a survey of worldwide grasslands (Sutti, Reynolds and Batello, 2005). Climate experts of the Grassland Carbon Working Group studied the importance of grasslands as carbon sinks and published country-specific information on grassland ecosystems. Grassland covers a total area of 52.5 million km^2, i.e. about 40 per cent of the total land surface of our planet[18] (White, Murray, and Rohweder, 2000). According to the FAO, grassland accounts for about three quarters of the 4.9 billion ha of agriculturally used land. Even so, knowledge about its specific properties for each climatic zone is surprisingly limited. As a result, the potentials of grasslands[19] are grossly underestimated and are not part of the debate on the future of our planet. This could and should change.

The giant grasslands of the world store in their soil more than a third of the global carbon stock. In savannah soils, it is estimated that more than 80 per cent of the biomass can be found in the roots (Reichholf, 2004; Grace et al., 2006). However, as grasslands receive little attention, it is highly likely that their ecological, agricultural and climate potentials are not fully perceived. The ploughing of grassland causes huge losses of carbon and biomass contained in the soil – in many regions up to a third of the stored amount (Guo and Gifford, 2002; Poeplau et al., 2011). So far, the increasing demand for protein- and energy-rich animal feed for industrial livestock production has been one of the main factors behind the removal of tropical rainforests and the conversion of grassland to cropland (Don et al. 2011). Additionally, the rising consumption of biofuels is taking its toll. Many monocultures not only destroy ecosystems, but are also questionable from an energy point of view, if one deducts the energy input for their production from the energy output (particularly due to the expanding production of both concentrate feed and biofuels) (Don, Osborne et al. 2011). Sustainably used grassland can generate a higher volume of usable energy per unit of land than ethanol from maize. At the same time, it can make a higher contribution to the reduction of GHG emissions and increase soil fertility. Trials in the United States have shown that yields from permanent grasslands over a decade surpassed those of monocultures by 238 per cent (Tilman, Hill and Lehman, 2006).

Global landscape gardeners

In grasslands, roots play a crucial role in humus generation. Simply put: the roots of today are the humus of tomorrow. Whereas crops only grow during their vegetation period until they are harvested, grass in permanent grassland forms more and more root biomass virtually on a permanent basis as long as daylight and a minimum of humidity are available and temperatures are still slightly above zero. The formation of roots directly depends on the rhythm of the pasturing. Very important in this regard is that grassland should have constructive pauses during pasturing so that grass plants can recover and obtain, besides water and CO_2, sufficient organic nitrogen and other nutrients from the excrements of grazing animals. Thereafter solar energy through photosynthesis drives the growth of new grass and additional root biomass.

An illustrative example for such a natural process – including regenerative periods – can be found in the biggest annual migration of animals on our planet: the migration of the huge herds of gnus in Africa. Safaris there offer a retrospective view of nature's history: as all other grasslands, savannahs emerged from the co-evolution of grass plants and grazing animals. Huge herds of bison and

17 On the CO_2 assimilation potential of grasslands, see FAO, 2009.
18 Not accounted for are permanent ice-covered surfaces of Greenland and the Antarctic, where there is no grassland yet. In Europe, grassland covers about a quarter of the total land surface.
19 Inter alia carbon sink function, protection for erosion, protein and energy source, source of income for about one tenth of the world population.

aurochs (ancestors of today's domestic cattle) contributed to the development of soils in Eurasia, although they have disappeared from the collective memory of human settlers. In contrast, many Americans today still recall stories of their ancestors about the huge herds of bison. The number of bison that populated the prairies of North America in the early decades of the nineteenth century is estimated to have been about 30 million animals. Today, North American soils suffer from an average humus loss of more than 25 per cent. This also applies to prairie soils several meters thick on which monocultures such as soy, maize or cereals have been cultivated for decades. In order to show that soil quality and fertility are suffering from industrial soil management systems, the humus content of soils needs to be regularly monitored and documented.

Taking account of carbon and nitrogen cycles not only leads to a different assessment of the impacts of agriculture on climate; it also provides a different perspective of animal husbandry, particularly that of ruminants. Ignorance with regard to the potential of grasslands arises from the misconception that cattle are poor feed users, which, since the end of the 1970s, has also been taught to students. In this regard, cattle and other ruminants are not contextualized as animals that developed in co-evolution with grasslands over thousand of years, using grass and hay as fodder that, without additional labour, was turned into meat and milk. Instead these ruminants are assessed in terms of their efficiency in digesting cereals, maize and soy.

The fact that cattle consume, on average, 7 kg or more of cereals per kilogram of beef (a figure which exceeds the intake of pigs and chickens[20]) is a result of a faulty system, not faulty animals. It does not take into consideration their negative impact on resource consumption because of inappropriate system boundaries. The widespread assumption that one cow which produces some 10,000 litres of milk annually would be better for the ecosystem and the climate than two animals providing 5,000 litres each is questionable because:

1. The higher the production performance of cows per day or per year, the more intensive the required feeding practices. It is only possible to achieve a production of more than 6,000 liters of milk per cow per annum through greater intensity of feeding based on concentrate feed. Such feed in turn is produced as a result of very high inputs of biological and fossil resources, involving higher emissions of CO_2 and N_2O.

2. Non-high-performance cattle can satisfy their entire demand for feed by consuming roughage without any external fodder supply.

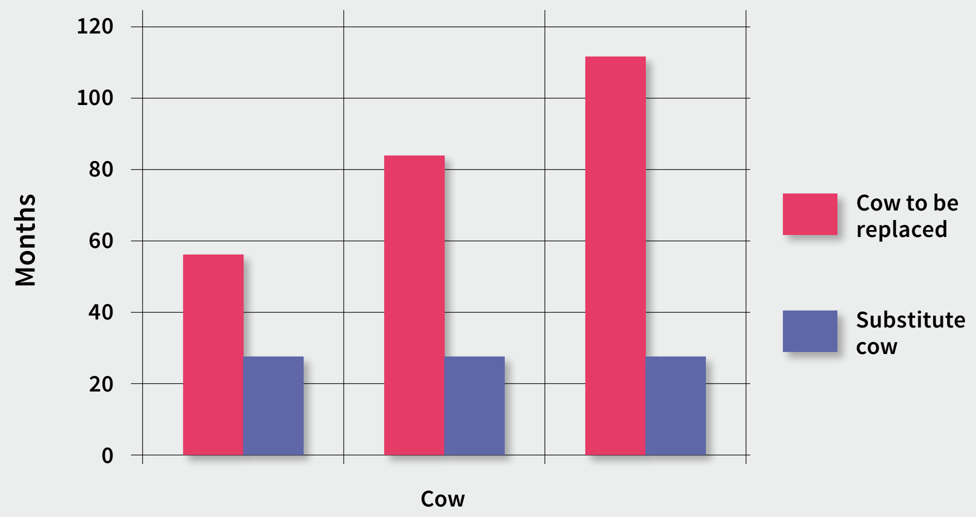
3. Sustainably used pastures can contribute to humus accumulation and thus help to reduce atmospheric CO_2 through carbon fixation.

4. Nearly all cows with an annual milk production of 5,000 liters have a longer than average life span. Conversely, most cows with an annual milk performance of 10,000 liters have a shorter than average life span. The higher the milk production of the animal per day or per year, the higher the risk of its vulnerability to diseases and burnout. This is the reason why the average life span of a cow in Germany, for instance, has fallen to less than five years. Burnout, infertility and mastitis have become "occupational diseases" of dairy cows, resulting in their being slaughtered prematurely, and statistically they produce only 2.3 calves.

5. In addition to the life span of the cow to be replaced, fodder and additional labour as well as GHG emissions by the substitute cow need to be taken into account.

20 As hybrid pigs and chickens are fed with concentrates in intensive production systems, grass-fed land races of rare pigs, geese, chickens and others cannot compete against them, so that they end up on the list of species that are threatened with extinction (for more information, see FAO: The State of the world's animal genetic resources for food and agriculture. http://www.fao.org/docrep/010/a1250e/a1250e00.htm .

Figure 4: The importance of cow longevity to protect the environment, the climate and the economy



Source: Idel, A. 2012, P. 36

Figure 4 shows that irrespective of the age of the cow destined for slaughter, the age of the substitute cow is always the same. The latter is about 28 months old: 19 months at the time of insemination plus nine months gestation. The replacement rate of a production unit indicates the percentage of cows that will have to be replaced annually to keep the dairy production rate unchanged. In production units with a very high dairy performance, the replacement rate often surpasses 50 per cent. That is why longevity leads to lower replacement rates. High replacement rates thus imply that, in addition to the direct ecological effects of dairy cows, the ecological and climate impacts of the substitute cows have to be taken into consideration in evaluating their dairy performance. The earlier a dairy cow has to be slaughtered, the longer is the period that a substitute animal needs feeding and emits GHGs. For a dairy cow younger than 5 years, a substitute animal will have to be reared during half of the lifetime of the cow to be replaced. Thus, any productivity calculation of a dairy cow should not be confined to its annual milk, but should also take into account its performance over its lifetime (Idel 2008).

6. In the performance balance, all too often only data for produced milk are provided, which do not represent the volume of marketable milk. Pressures for increasing dairy production result in a certain share of milk originating from diseased cows, which cannot be sold because the cows are being treated with antibiotics.

7. To arrive at a correct calculation of the productivity and the impact on climate of a dairy cow, its own beef production and that of its progeny also have to be taken into account. Dairy and beef performance are normally negatively correlated – the higher the dairy production of a cow breed, the lower its meat output, in particular that of the sons and brothers.[21] Comparing a production system with an average milk production of 5,500 litres relative to one producing 9,000 litres per year, Rosenberger and Rutzmoser (2002) note that the latter shows significantly higher emissions of methane (15.7 per cent higher), nitrogen (32 per cent higher), and phosphorous (31.7 per cent higher).[22]

21 This effect is a logical consequence of the increase of the sex-specific performance of female animals. The focus on boosting dairy performance is at the expense of the energy being used for meat generation. Based on the same logic, the brothers of hybrid laying hens gain weight very slowly.

22 In the United Kingdom, due to unsatisfactory fattening performance, a large percentage of male calves of high performance dairy cows (i.e. Holstein, Friesian, Jersey) are being killed every year immediately after they are born (Weeks, 2007).

Accordingly, it is only at first glance that milk and meat from intensive production appear to be cheap. The true costs of intensive animal feed production are reflected in terms of: (i) damage to the ecosystem and the climate; (ii) reduction of biological diversity; (iii) the conversion of permanent grassland and converted rainforests (including the CO_2 thus released from their carbon-rich soils); (iv) oil consumption for the production of synthetic nitrogen fertilizers and agrochemicals; (v) N_2O emissions caused by excessive use of synthetic fertilizers; (vi) the nitrification of soils and water courses; and (vii) enhanced ammonia load in the atmosphere.

It is true that cattle emit methane, but they and other ruminants are indispensable for global food security. Under sustainable pasture conditions, cattle produce milk and meat from grass and forage, and thereby make a significant contribution to the preservation of soil fertility and to climate change mitigation. This is why not only do cows have to be rehabilitated, but the correct agricultural system needs to be adopted. The decision whether we will protect or destroy the climate through the way we choose to rear cattle is up to us.

Recommendations

There is the need to reduce the consumption of livestock products as well as to implement a legal framework for sustainable production methods to address their medium and long-term effects on climate, environment and animal welfare.[23] Industrial livestock production should be curbed so that the total stock of raised animals such as cattle, pigs, chickens and sheep is reduced and the consumption of animal feed should be commensurate with sustainable local production potential. Reduced consumption of animal products is a particular challenge for those countries where animal protein consumption is high – representing a false model of imaginary prosperity. The fact that an increasing number of people are becoming vegans may help (in terms of the reduced demand for animal protein and energy-rich food), but "to conclude that a vegan agricultural and food system would be the preferable solution, is far too simplistic" (Garnet, 2010: 34-56; Fairlie, 2010, D'Silva and Webster 2010).

A sustainable approach requires a drastic reduction of industrial animal feed production and a concomitant decline in the production of animal products. Instead of replacing the production of human food by animal feed, animal and crop production should be reintegrated in order to:

- Use the nutrients contained in grass and harvesting residues as animal feed that cannot be directly used for human consumption; and
- Use manure as fertilizer on grasslands and croplands.

This requires a move from the existing one-sided orientation and selection aimed at maximum performance of both crops and livestock, towards a more holistic view that promotes interactions and the productivity of the system as a whole. Furthermore, it is imperative to reduce the environmental, health and climate-related impacts from the massive use of synthetic nitrogen fertilizers, and promote the use of animal excrement as natural fertilizer. Discarding the latter and defining it as waste constitutes a huge loss of nutrients and minerals (similar to post-harvest losses of food).[24]

National and international research, investigating in grassland and pasture management, must focus on the reduction of overgrazing and degradation and beyond that, on the conservation and enhancement of soil fertility. In the field of breeding, further research is needed for a more effective feed conversion of roughage by ruminants. Other feed ingredients should only be of complemen-

23 Animal suffering and welfare are directly affected by industrial livestock production. For more information see also D'Silva and Webster, 2010.
24 This article does not discuss the non-recycling of human faeces in soil; for a discussion of this issue, see King, 1911.

tary nature. It is also important to examine wheather meat and bone meal can be re-introduced into feedstuff.

At the policy level, subsidies must be linked to the sustainable use of permanent grassland. Furthermore, there is a need for regional upper limits for animal husbandry based on the regional feed basis and the capacity for manure utilization. At the European level the elaboration of sustainability standards concerning the feed production within the EU but also the imports of feedstuff is required. Moreover, it would be meaningful to expand these standards to other agricultural products such as meat.

The sustainable production of food of animal origin requires the development of cooperation on a regional level, as well as cooperation between small and medium-sized farms and pastoralists. There is a significant untapped potential for sustainable grassland and ruminant management, including their use by pastoralists. The importance of working animals has also been underestimated. Yet they are particularly useful in the context of peak oil, which leads to higher costs of mechanization. However, their effective utilization needs to be optimized at the local level, in particular as regards feed selection, right of passage[25] and the functionality of mostly inadequate equipment.

25 By way of illustration, after its accession to the EU, Romania restricted the free movement of horse- or cow-drawn transport in favour of motorized transport.

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Germanwatch

Following the motto "Observing, Analysing, Acting", Germanwatch has been actively promoting global equity and the preservation of livelihoods since 1991. In doing so, we focus on the politics and economics of the North and their worldwide consequences. The situation of marginalised people in the South is the starting point of our work. Together with our members and supporters as well as with other actors in civil society, we intend to represent a strong lobby for sustainable development. We attempt to approach our goals by advocating for the prevention of dangerous climate change, for food security, and compliance of companies with human rights.

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