Peer-Review-Verfahren | Manuscript received: June 22, 2013 | Revision accepted: July 04, 2014

Instruments for sustainable meat production in Germany: the case of pork

German pork production assessed by aspects of sustainability

Markus Keller, Jürgen Kretschmer, Eva Katharina Kühner, Giessen

Summary

Pig farming in Germany is highly intensive. Although domestic consumption is stagnating, production continues to rise. One reason for this is that exports are increasing. This leads to numerous problems with respect to sustainability:
Ecological problems: over-fertilised areas, contamination of soil and water with nitrate, nitrogen and phosphate, high levels of water consumption with low levels of water productivity, greenhouse gas emissions and wastage of nutritional energy from conversion losses.
Social problems: Imported animal feed (particularly soya) monopolises areas in the producer countries that are then no longer available for domestic food production.
Health problems: Numerous diet-related diseases are associated with high meat consumption. The gas and dust emitted from pig fattening plants contain substances that are harmful to health. Economic problems: Excessive use of environmental resources causes billions in external costs and these are covered by the public.
Ethical problems: Normal conditions in pig farming are indefensible.
From the point of view of sustainability, radical changes are urgently necessary.

Keywords: meat production, pork, pig fattening, sustainability, instruments for sustainable meat production

Citation:
Keller M, Kretschmer J, Kühner EK (2014) Instruments for sustainable meat production in Germany: the case of pork. German pork production assessed by aspects of sustainability. Ernahrungs Umschau 61(10): 152–159

This article is available online:
DOI: 10.4455/eu.2014.026

Introduction

Current meat production presents numerous problems with respect to global sustainability. Pork production in Germany is also critical in this respect. The present article takes stock of the sustainability of German pork production. This is based on a study performed by the authors in 2012[1], as commissioned by MISEREOR. For this article the data have been updated and continued.

Consequences of increasing global meat production

Global meat production has markedly increased during the last 50 years (◆ Figure 1). It rose from about 70 million t in 1961 to more than 300 million t in 2012, corresponding to an increase of more than 4-fold [1]. For 2050, the FAO (Food and Agriculture Organization of the United Nations) predicted a further increase to 465 million t [2] – corresponding to an increase of more than 70 % relative to 2010 [1].

This increase in production is driven by the increasing demand for meat, particularly in the so-called developing countries. According to the FAO, the consumption of meat[2] in North America and Europe will increase only slightly by 2050 (from 83 to 89 kg/head and year); much higher increases are expected in East and South Asia (from 28 to 51 kg/head and year) and in Latin America (from 58 to 77 kg/ head and year). Aside from population growth and urbanisation, this development is mainly due to the growing purchasing power in these countries [4].

[1] Keller M, Kretschmer J. Instrumente im Sinne einer nachhaltigen, klimafreundlichen Fleischproduktion. Misereor, Aachen (2012)

[2] Consumption includes: food consumption, animal feed, industrial exploitation, losses (including bones).

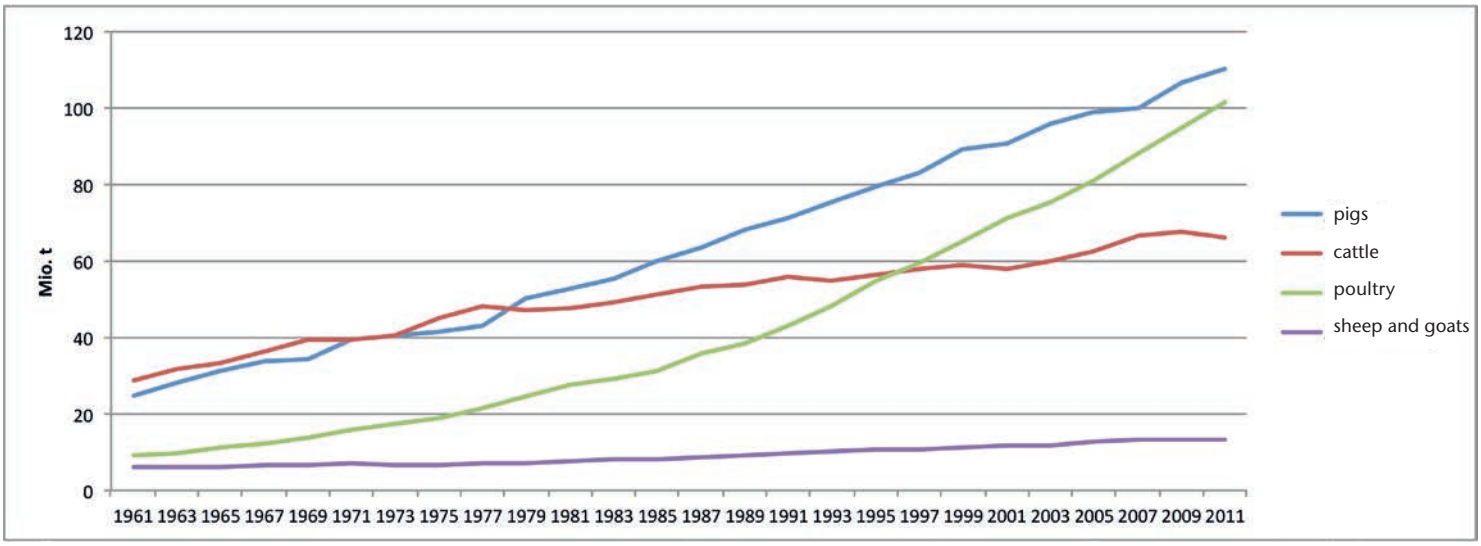

Fig. 1: **Development of the world production of the most important types of meat since 1961** [3]

The increasing global demand for meat has led to a corresponding increase in the production of pork, which has been the predominant type of meat (by weight) since the end of the 1970s (◆ Figure 1). In 2012, the global production was about 112 million t (37 % of total meat production), corresponding to a production increase of 2.6 % relative to the previous year [1]. This increase is primarily due to increases in production in China, where almost half of the world's pork is produced [5].

The global increase in meat production causes major problems:

- If the forecast increase in meat production by 2050 is to be achieved, the production of feed will have to be almost doubled. At the moment, it appears that it will be impossible to produce these quantities of feed, as the available arable land is too low, even with increases in efficiency [6].

- Animal husbandry now takes up about 80 % of the total agricultural land. Aside from grazing land, a third of global arable land is used for feed production [2]. Conversely, food from animals supplies only about 15 % of the global food calories and 25 % of the protein [4]. Meat alone corresponds only to 8 % of the global nutritional energy [7].

- As with all animal foods, there are so-called "conversion losses" in meat production, as much more feed must be invested for each kg meat [8]. The losses in nutritional energy and protein are corresponding high, when plant products are used as feed, instead of being used directly for human nutrition.

- With less than 2 %, animal husbandry makes only a minor contribution to the global gross domestic product [2], although it causes 14.5 % of global greenhouse gas emissions [9]. A further increase in meat production is diametrically opposed to the existential 2 degree objective for climatic change[3].

- Animal husbandry is responsible for about 8 % of the global consumption of drinking water (including 7 % for growing feed) [2]. Production of animal foods is very water intensive, but with very low water productivity[4]. The global average water footprint of 1 kg pork is about 6,000 L water [10]. Much less water is needed for the production of plant foods (◆ Table 1).

Thus, the production of animal foods requires overall greater environmental resources than the production of plant foods.

[3] In order to keep the consequences of climatic change within controllable limits, the mean global temperature should not increase by more than 2 °C relative to the preindustrial period.

[4] In this context, water productivity is the ratio of the produced quantity of nutritional energy or of a nutrient in a food and the volume of water used (e.g. kcal/m³) [10].

Animal Foods	Water footprint (L/kg)[a]	Plant foods	Water footprint (L/kg)[a]
beef	15 415	legumes	4 055
pork	5 988	soya beans	2 145
butter	5 553	wheat	1 827
cheese	5 060	maize	1 222
chicken	4 325	fruit	967
eggs	3 265	vegetables	322
cow's milk	1 020	potatoes	287

Tab. 1: **Water footprint of selected animal and plant foods (global averages)** (taken from [11, 12])

[a] The water footprint of a product is the total quantity of water used directly and indirectly for the production of a product. This includes water consumption and water contamination along the whole production chain. For agricultural products, the water footprint is given in L/kg or m^3/t [10].

Description of pork production in Germany

Germany produces 5.5 million t pork, making it the third largest producer in the world – after China and the USA – and the greatest producer within the EU [13, 14]. In 2012, most commercially produced meat in Germany was pork (about 68 %) [14].

Pig husbandry in Germany is highly intensive. It is concentrated in specific regions and the number of farms is decreasing. German pig production is concentrated in Lower Saxony and North Rhine Westphalia, with about 54 % of all German pigs [15]. In spite of the high prices of feed and the inadequate profits, the 2012 pig stock in Germany had increased by 3.1 % from the previous year. In November 2012, there was a total of 28.3 million animals [16].

About 33 % of all pigs are kept in large farms with 1,000 to 1,999 animals. 17 % are in farms with 2,000 to 4,999 animals and 13 % in farms with more than 5,000 animals. 64 % of pigs are in farms with at least 1,000 animals. These large farms correspond to 15 % of all farms. Conversely 42 % of the farms have fewer than 50 pigs; however, this only makes up 1 % of the total number of pigs [17, 18]. Thus, pig husbandry is one of the most concentrated branches of husbandry. Most of the animals (92 %) are kept on slatted floors. Only 0.6 % of all pigs – corresponding to 156,000 pigs in about 1,900 farms – are kept in accordance with ecological guidelines [17].

The overall slaughter volumes of German pigs have been rising for years and increased by 41 % between 2000 and 2011 [19]. However, in 2012 it was lower than in the previous year for the first time since 1997 (– 2.5 %) [14]. On the other hand, the exports of German pork are still at a record level. Since 2005, the exports of German pork have exceeded the imports. In 2011, the exports were 2.5 million t, which was more than twice the imports. Thus, Germany is still the greatest pork exporter in the world. Most of these exports were sold in the EU; the most important export markets were Italy (particularly for local speciality products), as well as the Netherlands and Poland. With increasing production volumes, export to third countries is becoming more important – particularly to Russia and China [20, 21]. Between 2000 and 2011, overall German pork exports (EU and third countries) increased almost four-fold [5]. Because of the stagnating domestic consumption and increasing self-sufficiency in pork – new maximum: 115 % in 2011 [22] –, the German government has commented that: "The significance of foreign markets for German producers and the necessity of exports have increased" [23]. It is thought that the main possibilities for expansion are in Eastern Europe and Asia [24]. It must therefore be assumed that there will be further surges in export, as well as a continuous increase in pork production – supported by government politics.

The tendency is to build new pig fattening plants, with larger and larger units of 15,000 to 100,000 feeding places, which are unconnected to farming areas [25].

Sustainability in German pork production

The term "sustainability" originated in forestry. It means a system of forest mangement in which only as much wood is taken as can regrow, so that the wood can regenerate and its overall stock is unchanged [26].

This principle has been applied to the concept of "sustainable development", which fulfils current needs, without endangering the ability to satisfy the needs for future generations [27]. Pork production in Germany will now be considered under various aspects of sustainability.

Ecological aspects

From the ecological point of view, intensive pork production in Germany is one cause of severe environmental pollution:

- Concentration of nutrients in soil and water (particularly nitrate and nitrogen contamination): High numbers of animals and extensive use of imported feed lead to the production of large quantities of farm fertiliser (pig slurry). For this there is not enough available area to use it without being harmful to the environment [28],
- Emissions from pigsties that may be hazardous to health [28],
- Land use and land use changes by feed cultivation outside Germany, particularly soya beans ([29], see ◆ Box "Virtual land imports for German pig fattening").

Current pork consumption in Germany requires about 4 million ha of agricultural arable land for animal feed cultivation. This corresponds to about 24 % of the total available arable land in Germany (17 million ha) [29]. However, domestic production is far from being able to cover the total requirements for feed – particularly protein-rich feed. This is the reason that arable land in other countries must be used (see ◆ Box).

After dairy cattle and beef production, pork industry is responsible for the emission of most greenhouse gases in German agriculture. It causes 15 % of total greenhouse gas emissions in agriculture and 20 % of the emissions within animal products (◆ Figure 2).

On average, the production of 1 kg pork gives rise to the emission of a little more than 3 kg CO_2 equivalents [31]. Nitrous oxide ("laughing gas") is an important problem and makes up more than half of the emissions (53 %) throughout the whole production chain [32]. The major climatic effects come from the production of feed – including energy consumption for the manufacture of fertilisers and pesticides, as well as application and transformation of fertiliser in soil and plants, conversion losses ("refinement losses") of the plant feed within the animals, as well as the emissions from the sty or from the stored and spread manure (manure management) [31, 33]. The downstream processes in pork production – e.g. slaughter, transport and packaging – make only a small contribution to greenhouse gas emissions (less than 10 %) [34]. Moreover, the overall balance is highly dependent on the extent of land use changes for feed production [34, 35]. According to the calculations of Kool et al. [36], including this factor, this can almost double the contribution of feed production to total emissions.

Virtual land imports for German pig fattening

Between 2008 and 2010, the mean annual imports into the EU were about 35 million t soya and soya products (including 21 million t soybean meal and 13 million t soya beans). Soya beans are processed to soya oil and soya chips. Soya chips are used almost exclusively as animal feed. Germany makes a major contribution to the import of soya products, with an annual total of 6.4 million t. About 88 % of the net imports are from South America, mainly from Brazil and Argentina. As a result of the imported feed, about 40 % (about 7 million ha) of the available arable land in Germany is additionally occupied overseas 40 % of this is for soya. This so-called virtual land trade for Germany corresponds approximately to the area of Bavaria [29].

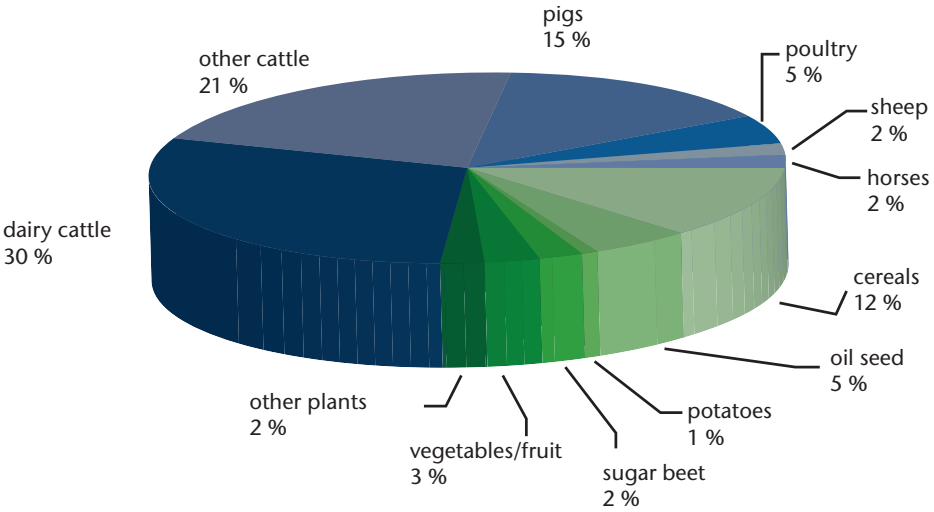

Fig. 2: **Greenhouse gas emissions in the agricultural sector in Germany by products in 1999** [30]

Economic aspects

The economic situation is that there is increasing pricing pressure on

German pork production. The ratio between revenues and sales prices has been decreasing for years, so that the farmers' incomes from the sales prices have also decreased. 40 years ago, farmers received about 46 % of the sales price for each kg meat sold, but the corresponding figure is now only 20 % [24]. This price development has led to severe rationalisation pressure and has forced the spread of intensive animal husbandry.

Excessive agricultural use of the environment (soil, water, air) has led to external costs. These are not born by the originator, but by the community, as they are not included in the production costs. Studies have concluded that up to 1.5 billion € annually could potentially be saved for the taxpayer if conventional pork production was switched to ecological production, without changes in pork consumption – as calculated in [28]. However, there are only rough estimates till now and more research is required.

Health aspects

Numerous negative effects on health have been linked with the current high level of meat consumption. Food patterns with high share of animal foods are usually linked to high levels of nutritional energy, fat and protein. At the same time, there is undesirably less consumption of healthy plant foods, including dietary fibres and secondary plant nutrients [37]. Many studies have shown that plant-based food patterns reduce the risk of many nutritionally linked diseases, including overweight and obesity, diabetes mellitus type 2, hypertension, cardiovascular diseases, various types of cancer and gout [38]. In addition, meat consumption, particularly consumption of red meat and meat products, is an independent risk factor for the genesis of most of the diseases noted above [39–42]. Mean annual pork consumption in Germany corresponds to 37.9 kg per person (2012), so that pork is by far the most frequently consumed type of meat in Germany [43] and makes a major contribution to the health effects listed above. Diseases related to nutrition are responsible for about 30 % of all efforts and costs in the health system [44].

Intensive pig fattening can also have an unfavourable effect on human health. According to the Federal Institute for Risk Assessment (BfR), "it must be assumed that the use of antibiotics in animal production contributes to the development of resistance and to the spread of resistant bacteria". However, it is not yet clear to what extent the use of antibiotics contributes to the spread of resistance in man [45].
In regions with intensive animal husbandry, such as the so-called "swine belt" in Lower Saxony, the incidence of diseases of the respiratory tract (such as asthma) is relatively high [46]. Possible causes include gases emitted from slurry or manure (e.g. ammonia, substances containing sulphur), as well as bacteria, endotoxins, allergens, fungi,

disinfectants and pesticides which are present in the emitted dusts [47].

Ethical aspects

Extremely critical questions must be asked about the ethics of intensive pig husbandry in Germany. Keeping the animals in a narrow space leads to injuries, maiming, diseases and behavioural disorders [48, 49]. Millions of German fattened pigs live in narrow dark stalls – often almost without moving. The intelligent and energetic animals suffer from weakness in the circulation, joint and muscle disease, pressure sores, scraped skin and injuries to the claws. Boredom and lack of space lead to behavioural disorders, such as "bar biting", "mourning" – the animals sit on their hindlegs and let their heads drop –, and "tail biting", which may even extend to cannibalism [50].

Moreover, the conditions in some German slaughterhouses are catastrophic and are indefensible from the point of view of animal safety. For economic reasons, more and more animals are slaughtered within shorter and shorter times – up to 1,500 animals per hour. The German Veterinary Association therefore estimates that slaughterhouse staff have only a minimal time buffer to put the animals to sleep and for controls [51]. Studies throughout Germany and in selected slaughterhouses show that about 1 % (sometimes up to 18 %) of the pigs recover their senses and sight on the section after bleeding, because they have been inadequately anaesthetised or inadequately bled [52].

Current laws on animal protection tolerate keeping animals under conditions that are inappropriate to animals or to the species, as well as the ethically unacceptable processes in slaughtering pigs, and therefore support intensive farming with high animal numbers and conditions inappropriate to the species. This is the case, even though the Law on Animal Protection (TierSchG) states that "no one may cause an animal pain, suffering or harm without a good reason". The Law also states that "a person who holds, looks after or has to look after, an animal,

1. must feed and care for the animal appropriately to its species and its needs and accommodate it in accordance with its behaviour;

2. may not restrict the animal's possibilities to move in accordance with its species in such a way that the animal is caused pain or avoidable suffering or harm;

3. must possess the necessary knowledge and abilities needed for the appropriate feeding, care and accommodation in accordance with its behaviour" [53].

However, the positive requirements of the Animal Protection Law are often found in practice to be unfavourable to the animals, as the regulations are expressed rather unclearly, so that they may be implemented flexibly. For example, keeping farrowing sows in gestation crates is allowed in the context of the Ordinance on Animal Protection – Farm Animal Husbandry (TierSchNutztV) [54]. This is indeed the conventional practice – even though it violates both § 2 No. 1 and § 2 No. 2 of the Law on Animal Protection [55]. These and other examples show that "the Law on Animal Protection does not fulfil the claim that it protects the animal for its own sake" [56].

Conclusion and outlook

In view of the ecological challenges such as climatic change, limited arable land and loss of biodiversity, together with the increasing demand for meat, pork production in Germany is compelled to develop in a sustainable manner. There is much need for improvement, particularly in the production of animal feed, the high number of animals and animal welfare — husbandry and slaughterhouse conditions, health and well-being. The main changes must be in agricultural production.
A production of pork which is more sustainable is synonym to a production of pork which is more ecological. The initial steps to reduce the non-sustainable consequences of intensive pig fattening would be a significant decline of the number of animals and improve the husbandry conditions which are more appropriate to the animals. The following processing steps should also be more adjusted to ecological criteria. Quality not quantity is needed. It must also be checked that these changes are economically acceptable.

In a consecutive article, instruments and possibilities are discussed how pork production in Germany can be made more sustainable.

"If we reduce individual meat consumption in rich countries and could decrease it by 2050 to the level of 2000, […] then about 400 million kg cereal could be released for human consumption. This is enough to supply 1.2 billion people with enough calories" (Olivier DE SCHUTTER, Special United Nations Correspondent for the Right for Food, Speech on 03.12.2009 before the European Parliament) [57].

Dr. Markus Keller
Dipl. oec. troph. Jürgen Kretschmer
M. Sc. Eva Katharina Kühner, Ärztin

Institut für alternative und nachhaltige Ernährung (IFANE)
Am Lohacker 2
35444 Biebertal/Gießen
E-Mail: markus.keller@ifane.org

Interessenkonflikt
This study was financed by the Diocesan Charity MISEREOR e. V., with the help of the European Union. Markus Keller and Jürgen Kretschmer received payment for performing the study.
Markus Keller is an honorary member of the Scientific Advisory Committee of the German Vegetarian Society, as well as the Albert Schweitzer Foundation for Our Contemporaries. The authors declare no conflict of interest according to the guidelines of the International Committee of Medical Journal Editors.

References

1. *FAO. Food Outlook November. Rome (2012)*
2. *FAO. Livestock's long shadow. Rome (2006)*
3. *FAOSTAT. Production. URL: www.faostat.fao.org. Zugriff 29.04.13*
4. *FAO. The State of Food and Agriculture. Rome (2009)*
5. *DBV (Deutscher Bauernverband). Situationsbericht 2011/2012. Trends und Fakten zur Landwirtschaft. Berlin (2011)*
6. *Flachowsky G (2008) Treibhausgase und Ressourceneffizienz – Aspekte der Erzeugung von Lebensmitteln tierischer Herkunft. Ernährungs Umschau 55(7): 414–419*
7. *UNEP (United Nations Environment Programme). The environmental food crisis. Nairobi (2009)*
8. *FAO. Greenhouse gas emissions from pig and chicken supply chains – A global life cycle assessment. Rome (2013)*
9. *FAO. Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Rome (2013)*
10. *Hoekstra AY, Chapagain AK, Aldaya MM et. al. The Water Footprint Assessment Manual. Earthscan, London (2011)*
11. *Mekonnen MM, Hoekstra AY (2010) The green, blue and grey water footprint of farm animals and animal products. UNESCO-IHE: Value of Water Res Rep Ser 48: 25, 29*
12. *Mekonnen MM, Hoekstra AY (2011) The green, blue and grey water footprint of crops and derived crop products. Hydrol Earth Syst Sci 15(5): 1577–1600*
13. *DBV (Deutscher Bauernverband). Situationsbericht 2012/13. Trends und Fakten zur Landwirtschaft. Berlin (2012)*
14. *Statistisches Bundesamt. 2012 erstmals seit 1997 weniger Fleisch produziert als im Vorjahr. Pressemitteilung Nr. 056 vom 13.02.2013. URL: www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2013/02/PD13_056_413.html Zugriff 05.06.14*
15. *Statistisches Bundesamt. Leichter Bestandsabbau in der Schweinehaltung. Pressemitteilung Nr. 248 vom 04.07.2011. URL: www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2011/07/PD11_248_413.html Zugriff 05.06.14*
16. *Statistisches Bundesamt. Schweinebestand weiter gestiegen. Pressemitteilung Nr. 006 vom 09.01.2013. URL: www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2013/01/PD13_006_413.html Zugriff 05.06.14*
17. *Statistisches Bundesamt. Landwirtschaft auf einen Blick. Wiesbaden (2011)*
18. *Windhorst HW (2011) Zur strukturellen und regionalen Dynamik der deutschen Schweinehaltung zwischen 2000 und 2010. Universität Vechta, ISPA-Mitteilungen 74: 16*
19. *Statistisches Bundesamt. Tierische Erzeugung – Gesamtschlachtmenge von Tieren aus dem In- und Ausland für die Jahre 2000 bis 2012. URL: www.destatis.de/DE/ZahlenFakten/Wirtschaftsbereiche/LandForstwirtschaftFischerei/TiereundtierischeErzeugung/Tabellen/Gesamtschlachtmenge.html Zugriff 05.06.14*
20. *LfL (Bayerische Landesanstalt für Landwirtschaft). Agrarmärkte 2011/2012. Freising-Weihenstephan (2012)*
21. *topagrar online. Deutschland bleibt größter Exporteur von Schweinefleisch weltweit. Pressemeldung vom 10.02.2012. URL: www.topagrar.com/news/Schwein-News-Deutschland-bleibt-groesster-Exporteur-von-Schweinefleisch-weltweit-709887.html Zugriff 05.06.14*
22. *AMI (Agrarmarkt Informations-Gesellschaft). 115 % Selbstversorgung mit Schweinefleisch. Meldung vom 05.04.2012. URL: www.ami-informiert.de/ami-maerkte/ami-fleischwirtschaft/ami-meldungen-fleischwirtschaft/meldungen-single-ansicht/article/d-115-selbstversorgung-mit-schweinefleisch.html Zugriff 05.06.14*
23. *Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV). Agrarpolitischer Bericht 2011 der Bundesregierung. Berlin (2011)*
24. *DBV (Deutscher Bauernverband). Situationsbericht 2011. Trends und Fakten zur Landwirtschaft. Berlin (2010)*
25. *Schuler C, Benning R. „Fleischfabriken boomen – Umweltstandards sinken". Der Boom der Massentierhaltung in Deutschland und seine Folgen für die Umwelt. BUND, Berlin (2006)*
26. *Leitzmann C (2011) Historische Entwicklung von Nachhaltigkeit und Nachhaltiger Ernährung. Ernährungs Umschau 58(11): 620–623*
27. *Weltkommission für Umwelt und Entwicklung. Unsere gemeinsame Zukunft. Eggenkamp, Greven (1987)*
28. *Korbun T, Steinfeldt M, Kohlschütter N et al. Was kostet ein Schnitzel wirklich? Ökologisch-ökonomischer Vergleich der konventionellen und der ökologischen Produktion von Schweinefleisch in Deutschland. IÖW, Berlin (2004)*
29. *WWF (World Wildlife Fund) Deutschland (Hg). Fleisch frisst Land. Berlin (2011)*
30. *Osterburg B, Nieberg H, Rüter S et al. Erfassung, Bewertung und Minderung von Treibhausgasemissionen des deutschen Agrar- und Ernährungssektors. Arbeitsbericht aus der vTI-Agrarökonomie 03/2009, Braunschweig (2009)*
31. *Grünberg J, Nieberg H, Schmidt TG (2010) Treibhausgasbilanzierung von Lebensmitteln (Carbon Footprints). vTI Agriculture and Forestry Research 60(2): 53–72*
32. *Dalgaard RL. The environmental impact of pork production from a life cycle perspective. Dissertation an der Aarhus Universität & Aalborg Universität (2007)*
33. *Koerber Kv, Kretschmer J. Ernährung und Klima. In: Agrarbündnis (Hg). Der kritische Agrarbericht 2009. Konstanz (2009), S. 280–285*
34. *Alig M, Grandl F, Mieleitner J et al. Ökobilanz von Rind-, Schweine- und Geflügel-*

fleisch. Agroscope, Zürich (2012)
35. *Leip A, Weiss F, Wassenaar T et al. Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS). European Commission, Joint Research Centre, Ispra (2010)*
36. *Kool A, Blonk H, Ponsioen T et al. Carbon footprints of conventional and organic pork – Assessment of typical production systems in the Netherlands, Denmark, England and Germany. Blonk Milieu Advis, Gouda (2010)*
37. *Leitzmann C, Keller M. Vegetarische Ernährung. 3. Aufl., Ulmer, Stuttgart (2013)*
38. *Keller M (2013) Das präventive und therapeutische Potential vegetarischer und veganer Ernährung. Zeitschrift für Komplementärmedizin 5(5): 47–51*
39. *Vang A, Singh PN, Lee JW et al. (2008) Meats, processed meats, obesity, weight gain and occurrence of diabetes among adults: findings from Adventist Health Studies. Ann Nutr Metab 52(2): 96–104*
40. *Wang L, Manson JE, Buring JE et al. (2008) Meat intake and the risk of hypertension in middle-aged and older women. J Hypertens 26(2): 215–222*
41. *Sinha R, Cross AJ, Graubard BI et al. (2009) Meat intake and mortality: a prospective study of over half a million people. Arch Intern Med 169(6): 562–571*
42. *Pan A, Sun Q, Bernstein AM et al. (2012) Red meat consumption and mortality: results from 2 prospective cohort studies. Arch Intern Med 172(7): 555–563*
43. *DFV (Deutscher Fleischer-Verband). Geschäftsbericht 2012/2013. Frankfurt (2013)*
44. *BMELV (Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz), BMG (Bundesministerium für Gesundheit) (2007) Gesunde Ernährung und Bewegung – Schlüssel für mehr Lebensqualität. URL: http://bildungsserver.berlin-brandenburg.de/fileadmin/bbb/schule/Gesundheit/Gesunde_Ernaehrung_01.pdf Zugriff: 18.09.14*
45. *BfR (Bundesinstitut für Risikobewertung). Fragen und Antworten zu den Auswirkungen des Antibiotika-Einsatzes in der Tierproduktion. Aktualisierte FAQ vom 11. November 2013. URL: www.bfr.bund.de/de/fragen_und_antworten_zu_den_auswirkungen_des_antibiotika_einsatzes_in_der_tierproduktion-128153.html#topic_188324 Zugriff 05.06.14*
46. *Radon K, Schulze A, van Strien R et al. (2005) Atemwegsgesundheit und Allergiestatus bei jungen Erwachsenen in ländlichen Regionen Niedersachsens. Pneumologie 59(12): 897–900*
47. *Schulze A, van Strien R, Ehrenstein V et al. (2006) Ambient endotoxin level in an area with intensive livestock production. Ann Agric Environ Med 13(1): 87–91*
48. *Richter T. Krankheitsursache Haltung: Beurteilung von Nutztierställen. Ein tierärztlicher Leitfaden. Enke, Stuttgart (2006)*
49. *Zwanzig. Informationspapier Schweine. Berlin (2011)*
50. *Albert Schweitzer Stiftung für unsere Mitwelt. Schweine. URL: albert-schweitzer-stiftung.de/tierschutzinfos/massentierhaltung/schweinemast Zugriff 05.06.14*
51. *Bundestierärztekammer. Mehr amtliche Tierärzte für den Tierschutz. Überwachung des Tierschutzes auf Schlachthöfen mangelhaft. Pressemitteilung vom 19.04.2010. URL:www.bundestieraerztekammer.de/index_btk_presse_details.php?X=20120202125609 Zugriff 05.06.14*
52. *Troeger K, Meiler D (2006) Entwicklung eines praxisgerechten Verfahrens zur Kontrolle der Tötung von Schlachtschweinen durch Blutentzug (Machbarkeitsstudie). Mitteilungsblatt der Fleischforschung Kulmbach 45/Nr. 171: 15–22*
53. *Tierschutzgesetz in der Fassung der Bekanntmachung vom 18. Mai 2006 (BGBl. I S. 1206, 1313), zuletzt geändert durch Artikel 4 Absatz 90 des Gesetzes vom 7. August 2013 (BGBl. I S. 3154)*
54. *Tierschutz-Nutztierhaltungsverordnung in der Fassung der Bekanntmachung vom 22. August 2006 (BGBl. I S. 2043), zuletzt geändert durch Artikel 1 der Verordnung vom 5. Februar 2014 (BGBl. I S. 94)*
55. *Wollenteit U, Lemke I (2013) Die Vereinbarkeit der Haltung von abferkelnden Sauen in Kastenständen mit dem Tierschutzrecht und die Zulässigkeit eines Verbots dieser Haltungsform. Natur und Recht 35(3): 177–183*
56. *Apel W. Ein glanzloses Jubiläum. Zehn Jahre Staatsziel Tierschutz. In: Agrarbündnis (Hg). Der kritische Agrarbericht 2013. Konstanz (2013), S. 213–217*
57. *de Schutter O (2009) The meatification of diets and global food security. Speech European Parliament 03.12.2009. URL: www.europarl.europa.eu/climatechange/doc/speeche_Mr_de_schutter.pdf Zugriff 05.06.14*

DOI: 10.4455/eu.2014.026