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Intensification of animal production and its relation to animal welfare, food security and 'climate smart agriculture

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Abstract

In this note livestock production systems,
developments in intensification and their
consequences for animal welfare issues are
categorized and discussed.

Keywords

Livestock production, intensification, animal
welfare, climate smart agriculture

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Summary

Food security is a long established topic in national and international policy, especially in relation to developing countries. In developing countries many poor people are dependent on livestock for food security and livelihood. Food security is seriously affected by climate change and livestock production has a major impact on climate change. 'Climate smart agriculture' (CSA) is agriculture that is resilient to climate change and/or reduces the effects of agriculture on climate change. Intensification of livestock production (more product with less animals) is a form of CSA as it reduces the effects of livestock production on climate change per unit of product. Intensification of animal production might have consequences for animal welfare. Animal welfare is more and more subject of national and international policy discussions. Sentience, intrinsic value and the so-called 'five freedoms': freedom from hunger and thirst, freedom from discomfort, freedom from pain, injury or disease, freedom to express normal behavior and freedom from fear and distress are at the basis of animal welfare policy.

In this note livestock production systems, developments in intensification and their consequences for animal welfare issues are categorized and discussed.

In pastoral and mixed livestock systems (major categories in developing countries) animals are often kept under natural conditions, but suffer from lack of feed, diseases and climatic conditions. In industrial systems (increasing in importance and replacing pastoral and mixed systems) nutrition, health and climatic conditions are in general better, but natural behavior tend to be compromised.

The relation between production system and animal welfare is complex and dependent on the specific situation. However, win-win situations for animal welfare and improved livestock production are definitely present at low levels of productivity, where improvements in animal health care and nutrition imply increases in productivity, animal welfare and livelihood for the human population, while the production of greenhouse gases (effects on climate change) is reduced.

At higher levels of productivity the relations between intensification of livestock production, animal welfare and production of greenhouse gases become more variable and are dependent on the specific situation.

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Annex 1 Livestock in a changing landscape (Steinfeld et al., 2008)

Annex 2 Categories for livestock production systems

1 Introduction

Livestock production is important to meet the global demands for food and many people depend on it for livelihood. Livestock production has also an important contribution to the production of greenhouse gases, causing 14-18% of the overall amount (Steinfeld, et al., 2006). On the other hand, well managed grass lands, which can be used for livestock production, are able to sequester CO₂ and reduce the effects of greenhouse gases on global warming.

Reduction of consumption of animal products and consequently less animal production is one way to reduce the effects of livestock production on climate change. However, for the time being the global demand for animal products will increase due to population growth and increasing consumption of animal products per capita in less developed countries (FAO, 2011a). Although there are movements towards reduction in consumption of animal products among part of the population in a number of rich countries with a high consumption of animal products, global consumption of animal products will increase. Besides, livestock is a crucial factor in the livelihoods of 1 billion poor people and creates employment for 1.3 billion. Around 70% of the rural poor and 10% of the urban poor are dependent on livestock (FAO, 2011a). Improvements in livestock production are an important way to escape poverty (Grace et al., 2012).

In livestock production man is directly responsible for animal welfare. Thus, food security, poverty reduction, global warming and animal welfare are all related to livestock production.

The leaflet *Livestock in a changing landscape* gives an overview of the characteristics, positive and negative aspects of livestock production worldwide and recommendations for actions to reduce detrimental effects of livestock production (Steinfeld et al., 2008). The recommendations are summarized in Annex 1. *Sustainable intensification* is one of the six recommendations. Sustainable intensification is defined as increased efficiency in resource use with appropriate technology in feeding and waste management.

The relationships between productivity and overall sustainability are extremely complex and require insights in animal and crop production systems, their effects on greenhouse gas emissions, eutrophication, biodiversity, food security, land use, income generation, animal welfare and their interactions (De Boer, et al., 2011).

Papers on the effects of livestock on climate change, food security and poverty reduction tend to focus on production, ecology and human health and wellbeing. Animal welfare is seldom discussed in these papers, although developments in livestock production can substantially affect the wellbeing of animals in positive or negative ways. Illustrative are the FAO guidelines for preparation of livestock sector reviews (FAO, 2011b). National development goals should be described in these reviews and among those are economic efficiency, food security, poverty relief, natural resource, environmental protection and protection of human health and food safety, but not animal welfare. Only in the analysis of specific issues animal health and welfare are mentioned with an emphasis on animal health. Most important is registration of (notifiable) diseases. In relation to animal welfare transportation, slaughter, access to feed and water and finally handling/herding of animals is mentioned.

For decisions on supporting specific developments in livestock production the effects on animal welfare should be taken into account.

The OIE (World Organisation for Animal Health, <http://www.oie.int/en/animal-welfare/animal-welfare-key-themes/>) adopted in 2005 its first global guidelines for animal welfare. Rules for transport, slaughter for human consumption and humane killing in case of disease control were adopted, as well as guidelines for housing and management of beef cattle. Since 2005 animal welfare is one of the two pillars of the OIE, with regular conferences and evaluation of the international situation with regard to animal welfare. Fraser (2008) gives an overview of the international situation and how animal welfare might improve globally. Bracke (2009) made a survey of animal welfare regulations, practices and perceptions, with case studies on poultry meat from Brazil and Thailand, eggs from India and the USA and for farmed fish. In 2011 FAO published a report on legislative and regulatory options for animal welfare (Vapnek and Chapman, 2011). They conclude that regardless the ethical concerns, many countries may choose to enact and enforce animal welfare legislation in the interest of increasing production and trade in animal products in international and domestic markets, but it is work in progress. In this respect incorporation of animal welfare in WTO rules is considered to be an effective stimulant (McLeod and Sutherland, 2012).

The Netherlands has policy briefs on global food security¹ and on animal welfare². Both items are closely linked to livestock production. For decisions on Dutch policy to stimulate improvements in livestock production internationally in relation to food security and poverty reduction, animal welfare is an issue. This note intends to describe the effects of livestock production systems and their intensification on animal welfare and takes the policy briefs on animal welfare and food security and developments in livestock production systems as starting point.

¹ Kamerbrief Voedselzekerheid (oktober, 2011)

² Nota Dierenwelzijn en Diergezondheid (februari, 2012)

2 Definitions and assessment of animal welfare and livestock production systems

2.1 Animal welfare and its assessment

Internationally welfare of production animals is based on the notion that animals are sentient beings. Animal welfare can be defined as the quality of life as perceived by the animals themselves (Bracke et al., 1999). Practical criteria for assessment of welfare of kept animals (livestock production) are often based on the concept of the Five Freedoms laid down in the Report of the Technical Committee to Enquire into the Welfare of Animals kept under Intensive Livestock Husbandry Systems, the “Brambell Report” (1965). The interpretation by the FAWC (1992) is generally used:

- **1. Freedom from Hunger and Thirst** - by ready access to fresh water and a diet to maintain full health and vigour.
- **2. Freedom from Discomfort** - by providing an appropriate environment including shelter and a comfortable resting area.
- **3. Freedom from Pain, Injury or Disease** - by prevention or rapid diagnosis and treatment.
- **4. Freedom to Express Normal Behaviour** - by providing sufficient space, proper facilities and company of the animal's own kind.
- **5. Freedom from Fear and Distress** - by ensuring conditions and treatment which avoid mental suffering.

In the EU-research project Welfare Quality® (<http://www.welfarequality.net>) the five freedoms were used to formulate protocols for on farm assessment of animal welfare for different species. The protocols allow for evaluation of animal welfare measured on the animals themselves. The principles and criteria as defined in the Welfare Quality project will be used to discuss the risks for animal welfare in relation to developments in animal production (sustainable intensification) in developing countries. The principles and criteria are:

Welfare Principles	Welfare Criteria
Good feeding	1 Absence of prolonged hunger and malnutrition
	2 Absence of prolonged thirst
Good housing	3 Comfort around resting
	4 Thermal comfort
	5 Ease of movement
Good health	6 Absence of injuries
	7 Absence of disease
	8 Absence of pain induced by management procedures
Appropriate behaviour	9 Expression of social behaviours
	10 Expression of other behaviours
	11 Good human-animal relationship
	12 Positive emotional state

The currently available protocols are developed for intensive, more or less industrial, systems in developed countries. However, the principles of Welfare Quality can be used to identify animal welfare issues and animal welfare risks across systems.

2.2 Dutch food security policy

Food security is the primary focus in Dutch policy for cooperation with developing countries. There are four pillars: sustainable increase in productivity of food, access to improved nutrition, more efficient operating markets and an improved entrepreneurial situation. For livestock production this implies increased productivity (pillar 1), increased consumption of animal products in areas with malnutrition (option for pillar 2) and more emphasis on semi-commercial and commercial livestock production (pillars 3 and 4).

2.3 Livestock production systems

Livestock production systems affect animal welfare depending on the animal (species) and the system (hardware as well as 'software', i.e. management). For agricultural production standard classification schemes are available that take type of production and climate/geographical conditions into account. Annex 2 gives such a system as used by FAO and World bank to assess livestock systems in general.

For discussions on animal welfare this classification can be simplified. Differences in animal welfare between the systems are partly dependent on climatic conditions, but much more on type of management, housing and husbandry. Therefore three categories are proposed:

- Pastoral systems; animals are kept in herds on pastureland, which is often, but not exclusively, communal. Animals and animal products are the main source of income. In traditional (nomadic) pastoral systems animals often also function as savings and bank account. Large numbers of animals tend to increase the status of their owner, independent of the condition of the animals. Pastoral systems focus on herbivores, mainly ruminants.
- Mixed systems; animal, crop and/or horticulture production are all present. Animals provide services (traction, manure) and animal products. They obtain feed from crop residues, forage on weeds and pests, etc. Animals also function as savings and bank account. All domesticated species can be found in mixed systems, farmed fish included. There is a direct link between crop farming or horticulture and animal farming. Fish often forages on animal manure.
- Industrial systems; often landless. Animals are kept in confinement and fed on purchased feed. Industrial systems are often 'landless', i.e. do not have a direct connection with cropland. All species can be kept in industrial systems.

Pastoral systems are extensive systems. Often deeply embedded in (nomadic) culture and a traditional way of live, rather independent of the 'money economy' (Africa, parts of Asia), sometimes as a commercial meat production system (South America). Mixed systems can be extensive or intensive. Industrial systems are intensive. With intensification there is a trend towards industrial systems.

From all three systems animal products are marketed, but in pastoral and mixed systems animals might be present without contributing to cash income. For industrial systems significant investments in housing, purchased feed etc. have to be made. Consequently, in industrial systems the animal products have to be marketed for the system to survive.

2.4 Trends in livestock production systems

McLeod and Sutherland (2012) distinguish three types of supply chains in livestock: local/informal, semi-regulated and formal. In developed countries almost all livestock products are supplied by formal chains, while in developing countries informal chains dominate. They estimate that worldwide 20-60% of the eggs, 30-70% of the meat and around 40% of dairy products are in the formal market. The share of formal markets is increasing. Formal markets rely heavily on industrial systems.

Local/informal markets are in general related to pastoral and mixed systems. The table gives an overview.

Production system → Market system ↓	Pastoral	Mixed	Industrial
Local/informal	++	++	Not present
Semi regulated (small scale commercial)	+	+	-/+
Formal (commercial)	+	-/+	++

In urbanised areas the demand for animal products is increasing and these are predominantly provided by industrial production systems. In mixed systems there is a tendency to gradually develop from more or less free ranging (scavenging) animals to small scale commercial production, which might grow into industrial production. Due to the demand for animal products around urban areas investors and/or governments are starting industrial animal farming on a large scale.

Poultry and pork production tend to increase faster than production from large (cattle, buffalo) and small (sheep, goat) ruminants (Grace et al., 2012; FAO statistics).

Industrial systems require inputs from several sources: capital, building materials, energy for heating and ventilation, equipment, purchased feed and infrastructure, including knowledge. Pastoral and mixed systems require less input from outside: housing and automation are minimal, feed is on pasture or present as left overs and crop residues and the products are for home consumption or the local market. Traditional knowledge on health and management of livestock is passed on from generation to generation.

Health problems can occur in all systems. In industrial systems investments in health care are in general in line with investments in other inputs. Diseased animals directly affect profitability and imply loss of income. Prevention of disease and thus investments in health care are part of the system. In pastoral and mixed systems animals often just are present. Investments other than labour are rare and consequently setting up an infrastructure for and implementation of modern animal health care is a huge step. In pastoral systems animals are part of the culture and way of live. They are often kept as 'capital on hoofs' and not for direct production or sale as a 'cash crop'. Loss of some productivity due to diseases in such a system does not affect the value of the animal and is accepted as fact of live.

In all systems (availability of) labour is a crucial factor, both in quantity and in quality. The quality of care for the animals is important in relation to wellbeing. In general animal health care will be at a higher level in industrial systems compared to pastoral and mixed systems because of the availability of infrastructure and capital. On the other hand, in industrial systems the animals might become 'instruments' instead of sentient beings.

3 Animal welfare policy

Animal health is an important feature of animal welfare, but also a prerequisite for the economic success of livestock production. Animal health (and more specifically control of contagious diseases) is already for a long term subject of international policy. In the OIE 178 member states agreed on procedures to combat contagious diseases. Since 2005 the OIE members have adopted also several animal welfare standards. For production animals these standards focus on transport of live animals, slaughtering of animals (farmed fish included) and killing of animals in case of contagious diseases. For beef cattle there are also management standards. Currently the OIE is exploring further standards for welfare of production animals.

In the EU animal welfare is part of the Common Agricultural Policy since 1989. The EU recognizes animals as sentient beings and has adopted regulations for housing and management of most farmed species, as well as for transport and slaughter (see for an overview http://ec.europa.eu/food/animal/welfare/index_en.htm). The EU-regulations have a wider scope and are stricter than the OIE procedures.

Dutch animal welfare policy is on some aspects stricter than EU-policy (see Staat van het Dier 2, 2011).

4 Livestock production systems, productivity and climate change

Livestock production worldwide is contributing significantly to climate change due to the production of greenhouse gases directly related to animals and animal production (manure) and indirectly due to deforestation (former woods transformed in grazing or crop production land) and land degradation (due to overgrazing) (Steinfeld et al, 2006). However, well maintained grass lands are to a certain extent a CO₂ sink, and decrease the effects of greenhouse gases. Deforestation is in general linked to industrialization of production, while land degradation (or CO₂ sequestration) is linked to pastoral systems, but may occur in extensive commercial systems too (f.i. extensive meat production in South America). The production of greenhouse gases directly from animals and manure occurs in all three systems. For greenhouse gases, important factors are the methane production due to rumen fermentation and from manure, and the production of NO_x from manure. GHG-production from manure is directly related to how manure is collected and stored and thus to the housing system. Consequently there is a relation between animal welfare and GHG-production through the housing system.

Feed consumption is a major factor in the CO₂ footprint of animals. Animals need feed for maintenance and for production (weight gain, milk, eggs, traction). With increasing productivity the proportion of feed required for maintenance is smaller with a higher feed efficiency, less feed required per unit of product, as a result. Higher productivity per animal implies a smaller CO₂ footprint. With ruminants the effect is more extreme than with monogastric animals due to the methane production from rumen fermentation (see f.i. De Vries and De Boer (2010), Ponsioen et al. (2010), Dekker et al. (2011), Leinonen et al, (2012)). Most of these comparisons focus on (more or less industrial) production systems in developed countries and thus on relative high levels of production. Ponsioen et al (2010) also took grazing systems in South America into account. Gerber et al (2011) compared greenhouse gas emissions per unit of milk produced across developed and developing countries. At low levels of production the effects of increased productivity on emissions are much larger than at higher levels of production. Emissions are the result of the sum of feed used for staying alive (maintenance) and feed used for production. Maintenance is constant across production levels and consequently at low levels of production it has a much larger contribution per unit of product than at higher levels of production.

To minimize effects of animal production on climate change for a fixed amount of animal product, higher productivity per animal is an effective solution, especially at lower levels of productivity. For high productivity industrial systems are necessary. Extensive grazing and pastoral systems, combined with optimal grassland management can combine carbon sequestration with (some) animal production. This is an interesting option for marginal grasslands.

5 Livestock systems and animal welfare, an overview

Animal health and liveability are important indicators for welfare. Although there are numerous studies in specific countries on effects of specific diseases, there is limited integrated information on animal health in pastoral and mixed systems. In most reports (f.i. FAO livestock sector briefs per country) the incidence of contagious diseases with consequences for trade in animals and animal products is reported according to OIE regulations, but information on incidence of more common and generally present infections is scarce. The FAO (2012, a and b) estimated mortality among different livestock species in different regions:

Species and system	Continent	Mortality (%) among young animals	Mortality (%) among adults/year	Fertility Rate
Dairy	Africa	20	7	56
	Asia	21	7	77
	America/Europe	8	3	80
Chickens, backyard	All (excl Europe)	58	21	-
Layers, industrial	Global	4	8	-

In individual countries mortality rates can be higher. The livestock sector brief of Laos (2005) indicated “a serious constraint to livestock production is the high annual mortality rate due to the widespread incidence of diseases. More than 80% of chickens are said to die every year in upland villages, sporadic disease epidemics frequently kill most pigs, and the mortality rate of buffalo calves due to internal parasites is estimated 30-40%”. Causes of mortality are diseases, starvation, malnutrition, hypo- and hyperthermia, predation and/or accidents. Especially young animals are affected. In developing countries in pastoral and mixed systems mortality rates are more than double of those in developed countries. Survival rates of less than 30% in their first year are not uncommon for those animals.

Negassa et al. (2011) found in Ethiopia that on small holder farms only 25% of the cattle, 12% of goat and sheep and virtually no chickens were vaccinated against common diseases. 15% of the cattle and over 20% of the sheep, goat and chickens were indicated as ‘diseased’.

Improvement of animal health requires an infrastructure for diagnostics, vaccination and medication programmes, improved nutrition and an extension service for implementation in the field.

Data on other welfare criteria than diseases and lack of feed and water are very limited. Rahman et al (2005) estimate, that over 100 million bullocks and buffaloes are used in India. “Outside the ploughing season the animals are often neglected (ill-fed) and during the ploughing season the animals are overworked and suffer from injuries due to non-fitting harnesses and whipping.” The same authors reported that transport and slaughter was often cruel. Ndou et al. (2011) reviewed information in cattle from Africa. They report that in pastoral systems animal welfare hardly gets attention. Interaction with people are infrequent and if present, often aversive. Animals have to deal with high parasite (worms and ticks) loads, feed shortages and poor housing (no shade, in the wet season muddy soils and no dry places for resting). Reducing availability of communal land due to increased population density and increased amounts of privately owned crop lands is a major cause of the poor condition of pastoral people and their herds. Their cultural and economic system is in conflict with the dominating commercial exploitation of land.

In traditional pastoral systems grazing land is often communal. High numbers of animals tend to increase status of the owner and are valued more than less animals in better condition. Storing feed for dry (cold) periods is rarely practised. The animals have to forage on what is available in the field, often material with a very low digestibility. As a consequence food shortages, malnutrition and starvation of animals are quite common.

Tradition, social customs and beliefs also might influence animal welfare, specifically if traditional slaughter techniques are considered.

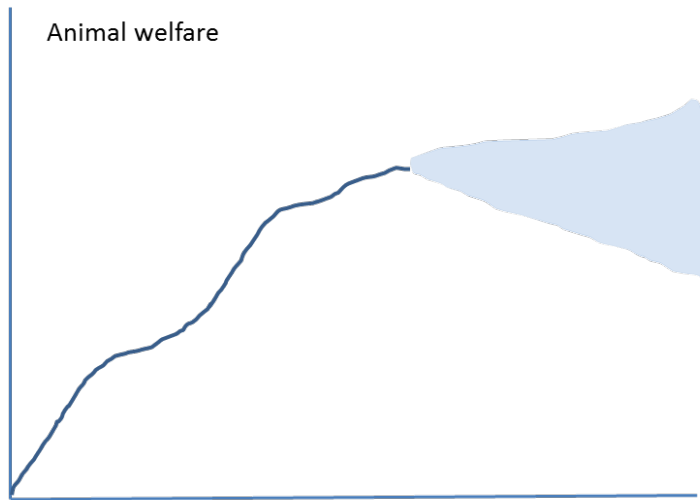
In mixed systems tethering of animals ('zero grazing') is quite common for cattle, while small ruminants, pigs and almost all poultry often have to scavenge the surroundings to get their feed. Imported animals, from stocks and countries with higher care levels, have more difficulties to cope with the situation than endogenous animals.

Animal welfare issues vary with the type of supply chain (McLeod and Sutherland, 2012). In local/informal markets the main concerns are feed supply, health care and inhumane slaughter techniques. In semi-regulated chains transport of animals becomes an issue, as they are transported in uncomfortable conditions on their own feet, by bike, motorcycle, or lorry. In formal chains the level of animal welfare might vary according to regulations and quality systems.

Intensification of livestock production is a trend now occurring worldwide, but first in Europe and North America. With increasing economic growth the same occurred in parts of Asia and South America. Fraser (2005) describes this process in an interesting essay and discusses the drivers for this intensification. Labour costs and availability of labour is one and prevention of loss of animals due to diseases, famine, predation etc. another. Very strong drivers are globalization of trade and market economics, requiring standardisation and quality systems. His definition for intensification is a combination of the trend towards more confined production system and the trend towards concentration of production on fewer units. He indicates that animal welfare will increase with intensification on several aspects, but might be at risk at the extreme end of intensification. Farm management rather than the system itself he considers as the major determinant for animal welfare, although housing design is directly related to animal welfare (f.i. cage housing, floor type, space per animal, heating and ventilation).

Important for management procedures are cultural factors, especially in systems where animals and people have a long standing and close relationship as in traditional pastoral systems (Mills, 2012). Mutilations (branding, castration, disbudding and dehorning) without anaesthesia are an important welfare concern, but nutrition (availability and quality of feed) is the cause of most welfare problems. Not only because of hunger, but due to insufficient nutrition disease problems become more severe.

At low levels of productivity an increase in productivity will improve animal welfare. At higher levels of productivity the relation between increased productivity and animal welfare is variable and dependent on the specific situation (see Fig 1 for a schematic representation).



Increasing production (improved feeding, health care, housing, etc.)

In general attention for animal welfare increases with increasing wellbeing of the human population and with economic growth. Nutrition, prevention of diseases and shelter are basic physiological needs, the lowest levels of Maslov's pyramid describing the hierarchy of needs of human beings. At low levels of animal production, also the human population will very likely suffer from lack of food, health care and security. Attention for animal welfare based on the intrinsic value of animals is an aspect of the higher levels of the pyramid. Worldwide public debate on animal welfare in relation to animal production is becoming more and more manifest. See f.i. the activities of the WSPA (<http://www.wspa-international.org/whoarewe/Default.aspx>) and the discussions on animal welfare in FAO and OIE.

More attention for animal welfare in national policies can be expected.

6 Livestock systems and Welfare Quality criteria

When the welfare criteria from Welfare Quality® are confronted with the three production systems not only the system itself is important, but many more features as quantity and quality of feed, climatic conditions, attention and care for the animals, availability of veterinary care and medication (preventive and curative). All three systems show a large variation in those features, but some general risks can be indicated.

Welfare criterion	Pastoral systems	Mixed Systems	Industrial systems
1 Absence of prolonged hunger	High risk, often malnutrition, starvation	High risk, often malnutrition, starvation	Limited risk, sometimes restricted feeding to improve performance
2 Absence of prolonged thirst	High risk, good quality drinking water not guaranteed	Risk, good quality drinking water not guaranteed	Limited risk, access to drinking water sometimes denied; water system sometimes contaminated
3 Comfort around resting	Risk, no specific accommodation, freedom to choose where to lie	Risk, often no specific accommodation, sometimes freedom to choose where to lie	Risk, dependent on housing design (no bedding, confinement)
4 Thermal comfort	Risk, both for hyper- and hypothermia; some behavioural control	Risk, both for hyper- and hypothermia; some behavioural control	Limited risk/manageable, dependent on housing conditions; limited behavioural control
5 Ease of movement	No risk, but ability to walk is essential	Risk, depending on confinement, tethering	Risk, depending on housing design
6 Absence of injuries	Injuries might be present	Injuries might be present (harness draught animals)	Dependent on system
7 Absence of disease	Often multiple infections and/or malnutrition	Often multiple infections and/or malnutrition	Dependent on management
8 Absence of pain induced by management procedures	Not guaranteed (mutilations and mal abuse)	Not guaranteed (mutilations and mal abuse)	Not guaranteed (mutilations)
9 Expression of social behaviours	Low risk	Limited to high risk	At risk
10 Expression of other behaviours	Low risk	Limited to high risk	At risk
11 Good human-animal relationship	Limited and variable relationship, sometimes aversive	Close interaction, sometimes aversive (scavenging animals)	At risk
12 Positive emotional state	Close to wild animals	Whole range possible	At risk, abnormal behaviour

The Welfare Quality® system focuses on housing and management of the animals. Transport of live animals and slaughter can also be considered using the same criteria. The OIE has standards for transport and slaughter of animals (fish included) for human consumption (<http://www.oie.int/animal-welfare/animal-welfare-key-themes/>). Industrialized slaughter systems are more and more controlled by quality systems because of food safety issues. In such systems attention for animal welfare can be incorporated. For traditional slaughter systems (might be used in pastoral and mixed systems) quality systems are difficult to implement because of the small scale. In traditional slaughter systems animal welfare might be at risk.

7 Conclusions and options for CSA, food security and animal welfare

7.1 Conclusions

- In pastoral and mixed systems with a low level of productivity animal welfare, food security and CSA will improve with increasing productivity. Low levels of productivity in these systems are the result of lack of feed (quantity and quality), insufficient health care (diagnostics, vaccination and medication) and lack of protection against environmental factors (climate, predation).
- Feed availability (quantity and quality) is a major limiting factor for production and animal welfare. Lack of sufficient feed is a major cause of greenhouse gas production per unit of product directly by animals and indirectly due to land degradation in pastoral systems. Finding a balance between available feed and numbers of animals is an important step in improvement programs.
- For pastoral systems grassland restoration is crucial for feed supply and as a carbon sink. Carbon sink, an ecosystem service, might be an extra asset for well managed pastoral systems.
- For a balance between available feed and numbers of animals development in veterinary infrastructure (vaccination programs) is required to guarantee reduced mortality and improved feed utilisation among the animals. If mortality among young animals can be reduced, the (supposed) necessity to breed (too) large numbers of animals for future utilization (slaughter, replacement) will reduce. In poultry and pigs the main reason for breeding too large numbers is low survival rate among young animals. In traditional pastoral systems (nomadic cultures) owning many animals increases status. To balance numbers of animals against available resources in pastoral systems thus requires a different approach compared to mixed systems.
- For improved nutrition, health care and survival of young animals some form of housing (confinement) is required. With confinement the relationship between housing design and animal welfare requires attention to improve productivity and animal welfare simultaneously. With improved productivity investments in animal production increase and consequently the formal market and industrial systems tend to become more important.
- Attempts to improve productivity by introduction of foreign breeds with a high production potential should be considered carefully. Endogenous breeds might be more resilient in this still vulnerable situation compared to highly productive foreign breeds. For high levels of production animals with a high genetic potential for productivity are necessary, but this genetic potential can only be expressed if health care, nutrition and management are guaranteed at a high level.
- In several developing countries private programs are introduced to meet quality criteria for international trade. This might affect animal welfare in a positive way. Masiga et al (2005), Mills (2012) and McLeod and Sutherland (2012) describe case studies that explore the possibilities to export certified welfare friendly products from extensive livestock systems. Thailand and Brazil produce for their export market certified meat with higher welfare standards than the legal minimum requirements in the EU. Certified production may appear attractive to improve welfare standards worldwide, but it is accompanied by strict quality programs, that are often out of reach of smallholders (McLeod and Sutherland, 2012). The effects of such programmes on the position of small holders should be taken into account.
- Policy options have to be considered in the specific context where they have to be applied as the relations between animal welfare, food security and CSA are dependent on the specific situation. These relations become more variable at higher levels of production.

7.2 Policy options

In the case of (very) low productivity

- Improvements in animal nutrition and health are a prerequisite for improved food security and, animal welfare. With improved productivity GHG production will reduce. This implies investments in knowledge on available feed resources and their optimal utilisation and investments in infrastructure for and utilization of animal health care (vaccination, diagnostics and medication).
- Balancing numbers of animals against available resources is essential in pastoral and mixed systems for improved productivity. This requires not only technical knowledge, but also insight in the cultural attitude towards having animals and animal production.

At higher levels of productivity

- At intermediate levels of productivity, the relations between improved productivity, reduction of GHG, improved food security and livelihood for the human population are still positive, but the relation with animal welfare will become variable and dependent on specific management procedures and housing design. The housing design might restrict natural behaviour of the animals. In these cases specific attention for developments in animal welfare are required.
- Improvement of market access for small holders is an important factor in developing livelihood, but leads to intensification and industrialization of animal production. Consequently, specific attention for developments in animal welfare is required.
- The 12 criteria from the Welfare Quality protocol can be used as a check list for animal welfare for specific policy options.

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Annex 1 Livestock in a changing landscape (Steinfeld et al., 2008)

See <http://unesdoc.unesco.org/images/0015/001591/159194e.pdf> for the complete leaflet or text below for the key notes from the leaflet.

Livestock production

Livestock products provide one-third of humanity's protein intake.

Livestock production, including production of food, fibre, fertilizers, energy and labour, accounts for 40% of agricultural gross domestic product (GDP).

Creates livelihoods for one billion of the world's poor.

Employs 1.3 billion people.

The demand for livestock products is increasing. Global meat production tripled from 47 million to 139 million tons per year between 1980 and 2002. Although the pace of growth is slowing down, current meat production is expected to double by 2050 to meet rising demand.

Intensive livestock production systems are associated with a concentration of animals into large units, generally focusing on a single species and rely on commercial inputs and trade.

Extensive production refers to a system of raising animals under conditions that use predominant non-commercial inputs to the system, in which more than 90% of dry matter fed to animals comes from rangelands, pastures, annual forages and purchased feeds.

Important driving forces in livestock production and agriculture are responsible for major global shifts in consumption, marketing, production and trade:

- Rising incomes.
- Demographic shifts.
- Technology in food chains.
- Liberalization of trade and capital.
- Incentive frameworks, sanitary standards instigated by policy.
- Labor and environmental policies.
- Variable grain prices: decreasing prices over the past four decades, but increasing trends due to changes in land use and crop production shifting from feed to biofuels.
- Fluctuating energy cost and substantial externalities, those by-products of activities that affect the well-being of people or impact the environment and are not reflected in market prices.
- Development of new communication and transport facilities.

The Livestock Challenge in the 21st Century:

The rapid increase of intensive (confined) livestock production and the land and livelihood needs of extensive production (rangeland grazing) are crucial challenges. The livestock sector emerges as a very significant contributor to environmental problems at every scale from local to global, including land degradation, climate change and air pollution, water shortage and pollution and loss of biodiversity.

Formulating responses to the wide range of consequences remains a complex task, but there are many promising solutions.

Growth and changes in the livestock sector increasingly contribute to a range of social, environmental and health problems.

Various scales of industrialized production systems impair air and water quality, de-value real estate and create health and well-being concerns in local communities.

Extensive systems impact biodiversity and ecosystem functioning by rangeland overgrazing practices that cause habitat loss, erosion, polluted watershed, desertification and the transmission of diseases from livestock to wildlife.

Changes in economies, production rates and systems have led to a substantial shift of livestock production from North to South, with large scale production moving from temperate to tropical and sub-tropical regions.

The emergence and continued growth of intensive systems respond to the rise in demand for animal products and market pressures.

Meanwhile, extensive systems continue to exist alongside, occupying vast territories and providing livelihoods for a large number of impoverished producers.

Negative consequences of change

Biodiversity loss

Over-grazing has resulted in loss of biodiversity and productive capacity of ecosystems, particularly in arid systems. While pastoralism and mixed farming provide livelihoods in regions where limited alternatives are available, extensive production has widespread impact.

Pollution and depletion of water

Livestock production can lead to unsustainable water use.

An increased demand for livestock products worldwide will influence water scarcity. Livestock production demands high water usage, often depleting local supplies. Inadequate waste management also causes pollution that impacts water quality.

Land degradation

An estimated 20% of the total land used for livestock production is being degraded by grazing activities; 70% of land degradation occurs in arid regions. Many livestock systems provide environmental services for terrestrial systems, improving vegetation cover, biodiversity, and carbon sequestration. However, land modification and degradation lead to alteration of ecosystem dynamics and functioning. This includes impacts on biogeochemical and hydrological cycles, erosion and desertification. Nearly 30% of the Earth's terrestrial ice-free surface is devoted to livestock production, while 8% is devoted to production of crops that are directly consumed by people. As livestock production shifts to more intensive systems, it will place more pressure on arable land for the production of feed.

Increase in nitrogen, ammonia and methane.

The global nitrogen cycle is being deeply impacted by fertilizer production and intensive grazing systems. Livestock are responsible for over 60% of global anthropogenic ammonia emissions, which contribute significantly to acid rain and acidification of ecosystems. Most nitrogen added to fields or fed to an animal is released to the environment. This nitrogen causes a cascading series of negative effects on ecosystems and humans, including photochemical smog, acid deposition, and coastal eutrophication.

Increase in greenhouse gas emissions.

Higher carbon emissions are associated more with grazing systems than with industrial livestock production systems. Livestock production is responsible for 18% of greenhouse gas emissions. It accounts for 9% of anthropogenic carbon dioxide emissions, mainly due to expansion of pastures and arable land for feed crops. It generates emissions of other gases with greater potential to warm the atmosphere: as much as 37% of anthropogenic methane, and 65% of anthropogenic nitrous oxide.

Increased social and health risks

Livestock can transmit diseases to humans and countermeasures may be a source of social inequities. International standards for food safety and animal health often restrict trade in live animals and livestock products. A key concern is the ability of exporters to meet standards and to implement procedures to protect human and animal populations. Advanced technologies are not equally available to all producers. Smallholders who cannot access these technologies cannot compete on an equal basis with businesses and livelihoods are lost.

Recommended courses of action to address the environmental, economic and social consequences of intensification of livestock production:

1. Environmental services, such as carbon sequestration, water provision and biodiversity need to be considered in management of grassland-based production systems, particularly in vulnerable areas.
2. Carbon loss caused by deforestation for pasturelands can be reduced if intensive systems are used under appropriate environmental conditions. These measures include locating high-production feed crop systems on fertile soils in regions of moderate rainfall in the tropics, rather than on highly-weathered, low-nutrient soils or in high rainfall areas.
3. Environmentally sustainable intensification of livestock production can be achieved through various measures that include:
 - Applying appropriate technology in feeding and waste management.
 - Providing efficiency gains in resource use livestock production through price corrections
 - Replacement of current sub-optimal production with advanced production methods.
 - Reducing nitrogen loads.
4. Livestock production can contribute to poverty reduction and economic growth in those poor countries that are not fully exposed to globalized food markets. In rapidly growing and developed economies, market barriers and economies of scale will continue to push smallholders out of production, thus alternative livelihoods need to be sought in other sectors.
5. Livestock products are scarce in the diets of poor and under-nourished people but they figure prominently in the eating habits of the wealthy. Both conditions lead to health problems, and steps need to be taken to move people towards healthy levels of animal product consumption.
7. Livestock can transmit diseases to humans. Vigorous bio-security measures and food safety control are required with consumer awareness to address the mounting threat of traditional and emerging diseases.

Annex 2

Steinfeld and Maki-Hokkonen (1995) made a classification of livestock production systems. Main and subcategories are:

Solely livestock systems (< 10% of total value of production from non-livestock farm activities)

- Landless livestock production systems (<10% feed is farm-produced and average stocking rate is > 10 units/ha)
 - o Landless monogastric production systems (pigs and poultry, feed is introduced to the farm)
 - o Landless ruminant production systems (ruminants, mainly cattle, feed is introduced to the farm, highly concentrated in only a few areas; f.i. US, Eastern Europe, urban areas of developing countries).
- Grassland-based systems (> 10% feed is farm produced and stocking rate is < 10 units/ha)
 - o Temperate and tropical highlands grassland systems (often marginal areas, with low production potential, subsistence oriented)
 - o Humid and subhumid tropics and subtropics grassland systems (predominantly market oriented, turns into mixed systems)
 - o Arid and semi arid tropics and subtropics grassland systems (subsistence, pastoral oriented in Africa and western Asia; entrepreneurial, labour extensive ranching in Australia, US, South Africa)

Mixed farming systems (crops contribute > 10% of farm output)

- Rain-fed mixed farming systems
 - o Temperate and tropical highlands rain-fed systems (mixed function of livestock, more and more specialisation, external inputs and open systems)
 - o Humid and subhumid tropics and subtropics rain-fed systems (often animal traction, small holders, potential for intensification)
 - o Arid and semi-arid tropics and subtropic rain-fed systems (< 180 days vegetation growth)
- Mixed irrigated systems
 - o Temperate and tropical highlands(mixed function of livestock, more and more specialisation, external inputs and open systems)
 - o Humid and subhumid tropics and subtropics (often animal traction, small holders, potential for intensification)

Arid and semi-arid tropics and subtropics (often animal traction, small holders)



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