

Livestock production systems in developing countries: status, drivers, trends

H. Steinfeld, T. Wassenaar & S. Jutzi

Animal Production and Health Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00100-Rome, Italy

Summary

This paper describes and assesses the current status of livestock production systems, the drivers of global livestock production, and the major trends in such production. The analysis covers the six major livestock species: cattle and buffaloes, goats and sheep, pigs and chickens. Global drivers of the livestock sector include economic growth and income, demographic and land use changes, dietary adjustments and technological change. The rate of change and direction of livestock development vary greatly among world regions, with Asia showing the most rapid growth and structural change. The paper also examines system dynamics, by analysing the ways livestock production has adjusted to external forces. A brief discussion of how these trends link to food safety concludes the paper.

Keywords

Driver – Livestock production system – Structural change.

Introduction

Livestock production is undertaken in a multitude of ways across the planet, providing a large variety of goods and services, and using different animal species and different sets of resources, in a wide spectrum of agro-ecological and socio-economic conditions. Within this wide variety of livestock production there are certain patterns that have been categorised into various livestock production systems (LPS). Most frequently, these systems have been defined on the basis of land use by livestock, and for this purpose the distinction between grazing systems, mixed farming systems and industrial (or landless) systems (12) has been widely accepted.

In order for decision-makers to address the livestock-related food safety challenges in global markets, it may be useful to look at LPS as the basic building blocks of the sector. Livestock production is undergoing rapid change, and this change manifests itself in the growing contribution that livestock makes to satisfying increasing

global demands for high-value food products, and in continuous adjustments at the level of resource-use intensity, size of operations, product orientation and marketing channels.

This paper describes the current status of LPS, and the drivers of and major trends in global livestock production. Due to the limitations of space, this cannot be more than a cursory analysis, highlighting the principal features and developments. Six major livestock species are covered (cattle and buffaloes, goats and sheep, pigs and chickens). First, the global drivers of the livestock sector are discussed, in particular economic growth and income, demographic and land-use changes, dietary adjustments and technological change. Second, the status of the main LPS is described, with some attention to regional differences. Third, system dynamics are examined, by analysing the adjustment of livestock production to external forces (this section is largely based on Costales *et al.*, 2006 [3]). A brief discussion of how these trends link to food safety concludes the paper.

Global drivers of the livestock sector

Individual consumption of livestock products is closely related to per capita income. That is, with growing incomes people typically increase their consumption of meat, milk and eggs until these products become fully integrated into the daily diet. In high-income countries, per capita consumption of meat ranges between 80 kg and 130 kg per year; there is practically no further increase beyond that level. As incomes in many developing countries have grown rapidly over the past 20 years, consumption levels of meat and other livestock products have also increased. The economies of developing countries' achieved an average annual growth of 3.8% (1.8% per capita) from 1991 to 2001, up from 2.9% during the ten preceding years. Developing countries in East Asia, in particular, have experienced very strong economic growth, with an annual rate of 7.4% (6.2% per capita) over the decade between 1991 and 2001, with the People's Republic of China leading as the world's fastest growing economy. South Asia and the Near East follow, with gross domestic product growth rates of 5.5% and 4.4% over the same period. Economic expansion has been more modest in Latin America, at 2.9% annually, and in sub-Saharan Africa at 2.6% (Table I).

In addition to higher incomes, increases in human populations add to the demand for animal-source food products. Most developing countries still have rapidly growing populations even though percentage growth rates are below their peak in the 1970s. Each year, the human

Table I
Economic growth rates, per capita gross domestic product (GDP) growth rates and human population growth rates (annual rates during the period 1991 to 2001)

Region	GDP growth rates (%)	Per capita GDP growth rate (%)	Population growth rate (%)
East Asia and Pacific	7.4	6.2	1.6
South Asia	5.5	3.6	2.1
Sub-Saharan Africa	2.6	0.0	2.8
Near East and North Africa	4.4	2.3	2.6
Latin America and Caribbean	2.9	1.3	2.0
OECD countries	2.5	1.9	0.7
EE and CIS	0.0	-0.1	0.7
Developing countries	3.8	1.8	0.8
Developed countries	2.5	2.3	1.8
World	2.8	1.4	1.6

Source: World Bank (14)

CIS: Commonwealth of Independent States

EE: Eastern Europe

OECD: Organization for Economic Co-operation and Development

population in developing countries grows by 72 million, adding to the demand for food products. There are wide differences among developing countries; population growth has slowed down to 1.6% in East Asia whereas it remains high in sub-Saharan Africa (2.8%) and in the Near East/North Africa region (2.6%). In addition to population growth, the population structure is also changing: urbanisation is fast increasing and it is projected that by 2007 the majority of the human population will live in cities (13). Urban people adopt new eating habits, consuming higher amounts of animal protein, and eating a higher proportion of their food away from home. Furthermore, many populations in developed and developing countries are aging, with a declining proportion of the total population younger than 15 years. This also has an impact on total food demand and on the type of food consumed.

Table II gives an overview of the important changes that have occurred in the average diets of people in various world regions. People in industrialised countries derive more than 40% of their dietary protein intake from food of livestock origin (the figures do not include fish and other seafood), and little change occurred between 1980 and 2002. Changes have been most dramatic in Asia, where total protein supply from livestock for human diets increased by 131%, followed by Latin America, where per capita animal protein intake rose by nearly a third. In contrast, there has been a decline in livestock consumption in sub-Saharan Africa, reflecting economic stagnation and a decline in available incomes.

The increasing share of livestock products in the human diet in many developing countries is part of a dietary transition that has also included a higher intake of fats, fish, vegetables and fruit, at the expense of staple foods such as cereals and tubers.

Rapidly increasing demand for animal-source food products exerts pressures on the livestock sector, which needs to adapt fast in order to cope with such demand.

Table II
Daily protein supply from livestock and from all sources in 1980 and 2002 (in grams per capita)

Region	Total protein from livestock		Total protein	
	1980	2002	1980	2002
Sub-Saharan Africa	10.4	9.3	53.9	55.1
Near East	18.2	18.1	76.3	80.5
Latin America	27.5	34.1	69.8	77.0
Developing Asia	7.0	16.2	53.4	68.9
Industrialised countries	50.8	56.1	95.8	106.4
World	20.0	24.3	66.9	75.3

Source: FAOSTAT (7; accessed June 2006)

These adjustments are based on a changing feed resource base, particularly feed concentrates. Current and projected levels of livestock production would not be possible without the expanding production and yield increase of crop agriculture. Traditionally, livestock production used to be based on locally available feed resources, including local fodder, crop residues and unconsumed parts of human food – resources that had no value as human food. Traditionally, natural pastures were the venue of livestock production. More recently, however, a growing proportion of pastureland in developing countries is in areas which are unfit or marginal for cropping, and degraded arable land is often converted into pastureland. The demand for arable land, and the fact that there is basically no additional available land that can readily be converted into pastures, except in parts of tropical Latin America, have important implications for the livestock sector. The lack of available new land prohibits a 'horizontal' expansion of existing modes of production, and forces the sector into rapid technological change and search for alternative resources.

Livestock production systems

Production environments, and the intensities and purposes of production, vary greatly within and across countries. Animal agriculture systems have been categorised on the basis of agro-ecological opportunities and demand for livestock commodities. In general, these systems are shaped by prevailing biophysical and socio-cultural environments, and without external inputs they have traditionally been mostly in sustainable equilibrium with such environments. In many of these systems, the livestock element is interwoven with crop production, as in the rice/buffalo or cereal/cattle systems of Asia. Animal manure is often essential for maintaining soil fertility, and the role of animals in nutrient cycling is often an important motivation for keeping animals, particularly where this involves a transfer of nutrients from common property resources to private land. In other cases, such as the semi-nomadic pastoral systems of the world's natural grassland regions, environmentally stable balances of human society, animal population and vegetative biomass have been maintained for centuries. Many of these systems that are the result of a long evolution are currently under pressure to adjust to rapidly evolving socio-economic conditions; large intensive livestock production units, in particular for pig and poultry production, have emerged over the last decades in many developing regions in response to the rapidly growing demand for livestock products.

To classify the resulting continuity of situations into a limited number of distinct LPS, the following criteria should ideally be considered:

- integration with crops
- relation to land

- agro-ecological zone
- intensity of production
- type of product.

The classification proposed by Seré and Steinfeld (12), which uses only the first three of these classification criteria, identifies ten broad categories of systems. In addition, the landless category defined by Seré and Steinfeld is split into landless ruminant and landless monogastric systems, bringing the total number of production system categories to eleven.

The LPS are considered a subset of farming systems. Seré and Steinfeld (12) distinguished two main groups of LPS: those solely based on animal production and those where cropping and livestock rearing are associated. The first group is defined as systems in which more than 90% of dry matter fed to animals comes from rangelands, pastures, annual forages and purchased feeds, and less than 10% of the total value of production comes from non-livestock farming activities. Mixed farming systems are livestock systems in which more than 10% of the dry matter fed to animals comes from crop by-products such as stubble, or where more than 10% of the total value of production comes from non-livestock farming activities.

Landless LPS are a subset of the pure livestock systems in which less than 10% of the dry matter fed to animals is farm produced and in which annual average stocking rates are above ten livestock units per hectare of agricultural land (on average at census unit level). Grassland-based systems are defined as systems in which more than 10% of the dry matter fed to animals is farm produced and in which annual average stocking rates are less than ten livestock units per hectare of agricultural land. A distinction is made between:

- temperate zones and tropical highland
- humid/sub-humid tropics and sub-tropics
- arid/semi-arid tropics and sub-tropics.

Rainfed mixed farming systems are mixed systems in which more than 90% of the value of non-livestock farm production comes from rainfed land use; these systems can be divided into the same agro-ecological sub-classes as given above. Irrigated mixed farming systems are systems in which more than 10% of the value of non-livestock farm production comes from irrigated land use, and again includes the same sub-classes.

The map in Figure 1 depicts the relative predominance of the broad groups of LPS around the world. The presence of industrial systems is connected to both demand factors and supply determinants; areas with high population density and purchasing power, in particular coastal areas in

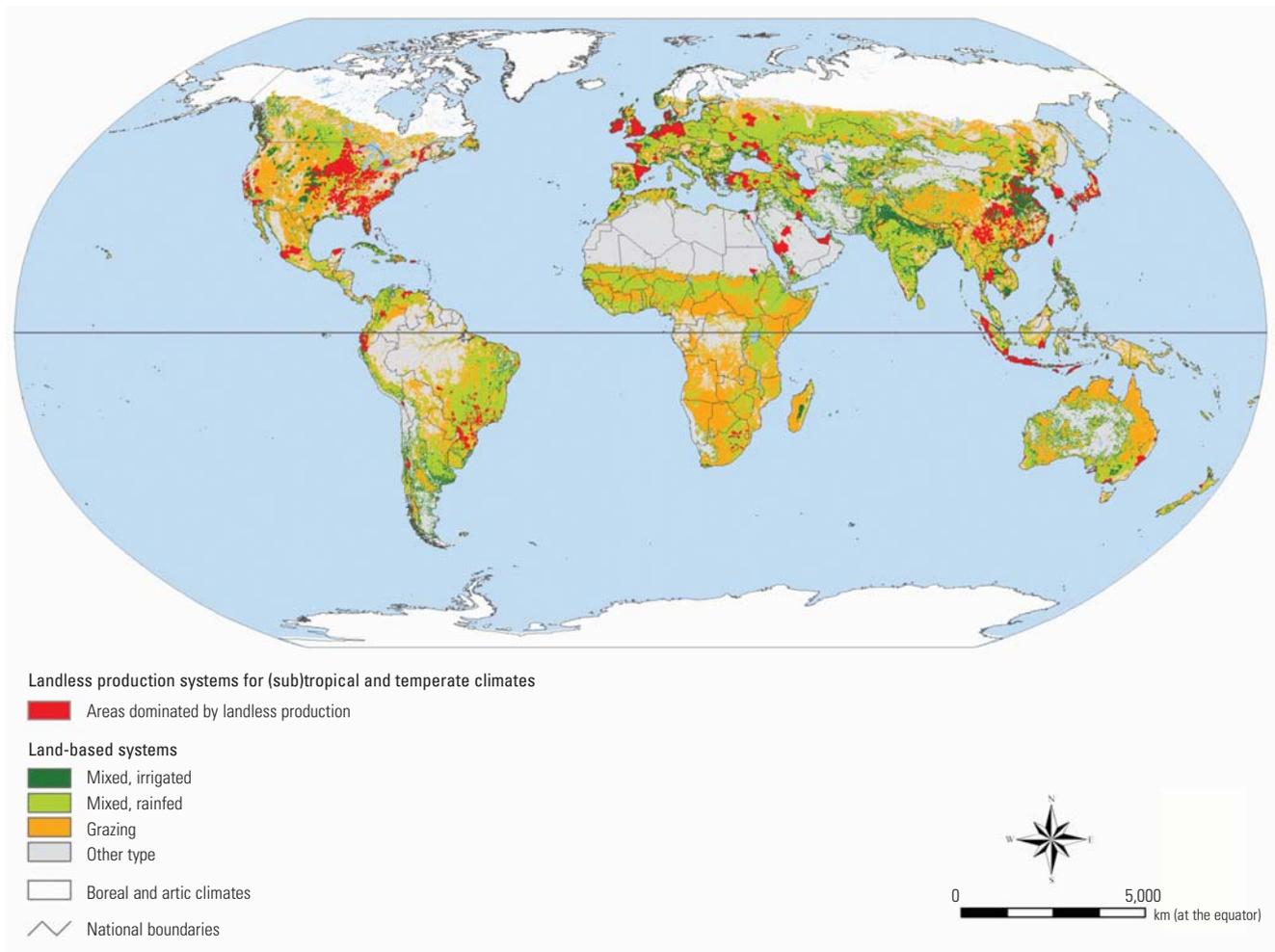


Fig. 1
Map of world livestock production systems

East Asia, Europe and North America, which also have access to ocean ports, show a high prevalence of industrial systems and import much of the necessary feed. In contrast, there are areas with ample feed supplies such as the mid-western United States of America (USA) and interior parts of Brazil and Argentina, where industrial systems rely mainly on local feed surpluses. East and Southeast Asia strongly dominate industrial monogastrics' production in the developing regions. Southern Brazil is another industrial production hot spot at world level, while important regional centres of industrial production are found, for example in Mexico, Colombia, Venezuela and Chile. Similarly there are major regional centres for the industrial production of chicken in Nigeria, South Africa and the Middle East.

Of the land-based system group, grazing systems cover the largest area and are currently estimated to occupy some

26% of the earth's ice-free land surface. This figure obviously includes a large variety of agro-ecological contexts with very different levels of biomass productivity. Grazing systems are primarily found in the more marginal areas which are unfit for cropping because of topography, low temperature or low rainfall. Mixed farming systems are prevalent in bio-climatically more favoured ecosystems. Most mixed farming systems are rain-fed, and they are particularly widespread in semi-arid and sub-humid areas of the tropics and in temperate zones. Mixed irrigated systems are found throughout the world, but in most cases are relatively small. Exceptions are the eastern parts of the People's Republic of China, northern India and Pakistan, where mixed irrigated systems extend over large areas.

Tables III and IV show the kinds of ruminant populations and animal production in the different production system groups, both globally and for the developing regions. The

Table III
Global livestock population and production in different production systems (averages 2001 to 2003)

Type of animal/ animal product	Livestock population (10 ⁶ heads) and production (10 ⁶ tonnes)			
	Grazing	Rainfed mixed	Irrigated mixed	Industrial
Animal				
Cattle and buffaloes	406	641	450	29
Sheep and goats	590	632	546	9
Animal product				
Total beef	14.6	29.3	12.9	3.9
Total mutton	3.8	4.0	4.0	0.1
Total pork	0.8	12.5	29.1	52.8
Total poultry meat	1.2	8.0	11.7	52.8
Total milk	71.5	319.2	203.7	–
Total eggs	0.5	5.6	17.1	35.7

Source: based on FAOSTAT data and calculations by J. Groenewold ('Classification and characterization of world livestock production systems'; unpublished report for the Food and Agriculture Organization, 2005)

Table IV
Livestock population and production in different production systems of the developing world (averages, 2001 to 2003)

Type of animal/ animal product	Livestock population (10 ⁶ heads) and production (10 ⁶ tonnes)			
	Grazing	Rainfed mixed	Irrigated mixed	Industrial
Animal				
Cattle and buffaloes	342	444	416	1
Sheep and goats	405	500	474	9
Animal product				
Total beef	9.8	11.5	9.4	0.2
Total mutton	2.3	2.7	3.4	0.1
Total pork	0.6	3.2	26.6	26.6
Total poultry meat	0.8	3.6	9.7	25.2
Total milk	43.8	69.2	130.8	0.0
Total eggs	0.4	2.4	15.6	21.6

Source: based on FAOSTAT data and calculations by J. Groenewold ('Classification and characterization of world livestock production systems'; unpublished report for the Food and Agriculture Organization, 2005)

1.5 billion head of cattle and buffaloes, and the 1.7 billion sheep and goats are fairly evenly distributed across the land-based systems, but average densities increase sharply from grazing systems to mixed irrigated systems; the latter have far greater livestock supporting capacities per unit area. Only a small fraction of the world's ruminant population is found in industrial feedlots, partly because this corresponds to only the final stage of the animal's life cycle, even in regions where intensive production is

common. Ruminant feedlots are predominantly a North American phenomenon, though they are used to a lesser extent in parts of Europe and the Near East. The vast majority of large and small ruminant populations are found in the developing regions: some 70% of small ruminants in grazing systems and over 80% of large ruminants in grazing systems are located in developing regions. These shares are respectively about 80% and 70% in rainfed mixed systems and 87% and 92% in irrigated mixed systems.

Ruminant productivity varies considerably within each system, but in grazing and mixed systems overall productivity is lower in developing countries than in developed ones: in grazing systems, for example, worldwide beef production per head averages 36 kg/head/year, but the average for developing countries is only 29 kg/head/year. In the mixed rainfed system, the difference between developed and developing regions is even more marked. By far the largest variation in intensity of production is found within this system, which is the largest producer of ruminant products. Even though the developing regions host the vast majority of the mixed rainfed ruminant population, they account for less than half of the system's production worldwide. In fact beef productivity in these regions averages 26 kg/head, as opposed to 46 kg/head at world level, and their milk production represents only 22% of the world total. Across all systems, developing regions account for half of the world's beef production, some 70% of mutton production and about 40% of milk production.

A sharply contrasting situation is found in the monogastric sector. More than half of the world's pork production currently originates from industrial systems, and over 70% of poultry meat. About half of this production originates from developing countries and, though reliable population figures are not available, variation in productivity between regions is probably much lower than for ruminants. Including the substantial monogastric production from irrigated mixed systems in developing regions, these regions account for the majority of the world's pork, poultry and egg production. Huge differences are found between the developing regions: although substantial, total production in Latin America is less than one tenth of that in Asia, and production in Africa and the Near East is almost non-existent. The developed countries and Asia together account for over 95% of the world's industrial pork production.

Table V shows the breakdown by agro-ecological zones. There has recently been a rapid growth in industrial production of monogastrics in the tropics and sub-tropics, leading to production levels that are similar to those of temperate regions. However, the situation is very different for ruminant production, partly because of its land-based nature; production and productivity are much higher in

Table V
Livestock population and production in different
agro-ecological zones (global averages, 2001 to 2003)

Type of animal / animal product	Livestock population (10 ⁶ heads) and production (10 ⁶ tonnes)		
	Arid and semi-arid tropics and sub-tropics	Humid and sub-humid tropics and sub-tropics	Temperate and tropical highlands
Animal			
Cattle and buffaloes	515	603	381
Sheep and goats	810	405	552
Animal product			
Total beef	11.7	18.1	27.1
Total mutton	4.5	2.3	5.1
Total pork	4.7	19.4	18.4
Total poultry meat	4.2	8.1	8.6
Total milk	177.2	73.6	343.5
Total eggs	4.65	10.2	8.3

Source: based on FAOSTAT data and calculations by J. Groenewold ('Classification and characterization of world livestock production systems'; unpublished report for the Food and Agriculture Organization, 2005)

the cooler climates. Small ruminant production in the (semi-)arid (sub-)tropics is a notable exception, explained by the large population and the relatively high rates of breeding, the latter being due to the fitness of these species, which are well adapted to harsh and marginal conditions. The relatively low productivity for milk in the more humid tropics relates to the strong dominance of mixed systems in these regions, where substantial use is still made of animals for draught power and other non-productive uses.

System dynamics

Intensification

Intensification of livestock production is taking place with regard to the use of most of the production inputs. In particular, the intensity of feed use has greatly increased over recent decades. While a growing number of people in the developing world are moving up the food chain, enjoying a richer and more diverse diet, so too are livestock; traditional fibrous and energy-rich feed stuffs are in relative decline, and protein-rich feeds together with sophisticated additives that enhance feed conversion are on the rise.

On balance, pastureland productivity has lagged far behind that of cultivated areas, although detailed estimates are difficult to make. A number of factors contribute to this trend. First, making more intensive use of the areas classified as pastures is often technically difficult and unprofitable. Constraints on the productivity of pastures most commonly relate to climatic features, topography,

shallowness and/or acidity of the soils, and disease pressure, among other factors. These constraints can be overcome only with massive investments to address them on various fronts. Additionally, in much of Africa and Asia, most pastures are used as common property, which further complicates attempts to intensify production. Without firm institutional arrangements, private investments in these areas are difficult to organise as returns accrue to individuals in proportion to the number of livestock they graze on communal land. Limited market access due to lack of infrastructure in these remote areas further contributes to the difficulty in achieving productivity improvements through individual investments. The harsh conditions of these pasturelands are exemplified by the pastoralist and agro-pastoralist areas in arid and semi-arid lands in sub-Saharan Africa.

As livestock production grows and intensifies, it depends less and less on locally available feed resources but increasingly on feed concentrates that are traded domestically and internationally. In 2004, a total of 690 million tonnes of cereals were fed to livestock (34% of the global cereal harvest) and another 18 million tonnes of oilseeds (mainly soya). In addition, 295 million tonnes of protein-rich processing by-products were used as feed (mainly bran, oilcakes and fish meal).

Species that can profitably make use of such feed concentrates (pigs and poultry) have an advantage over those that cannot do this to the same extent (cattle, sheep, goats). Among the monogastrics, it is poultry that shows the highest growth rates and lowest costs per unit of output, mainly because of efficient feed conversion. The use of feed concentrates for ruminants is limited to countries with low grain–meat price ratios. Where these ratios are high, typically in grain- or cereal-deficit developing countries, grain feeding to ruminants is usually not profitable.

What is driving the increasing use of feed grains? First, there is a decline in grain prices, a trend that is basically unchanged since the 1950s – which implies that global agriculture has been in a position to easily meet the growing demand over that period. The total supply of cereals increased by 46% over the 24 years from 1980 to 2004. In real terms (constant US dollars), international prices for grains are now half those in 1961. Expanding supply at declining prices has been brought about by intensification of existing crop-land use (not by expanding the crop area: globally, cereal crop-land declined by 5.2% between 1980 and 2004).

Intensification is a result of technological advances and greater use of inputs in crop production, notably in the areas of plant breeding, irrigation and water management, application of fertilisers and mechanisation. In contrast to developed countries, the expansion of the area dedicated

to cereals has been an important contributor to increasing supplies in the developing countries, with rates highest in sub-Saharan Africa (64%) and East and Southeast Asia (15.2%) over the period 1980 to 2004. However, the vast majority of the additional supplies in these regions are used for food and not for feed. In Latin America, expansion of the area dedicated to cereal production has been slower (3.9%), but there was a 97% increase in the area under oil crops, notably soya. Here, however, the demand for feed crops has been a major determining factor in the expansion of arable land. Some countries have seen a particularly strong expansion of cropped area, most of it at the expense of the forests (Brazil and other Latin America countries). Large parts of this expansion are devoted to production of feed concentrates, notably soya and maize (8).

Intensification also draws on technical improvements in livestock production, such as genetics, health and farm management, which have contributed to raising resource-use efficiency and higher output per animal. Over the 24 years from 1980 to 2004, the pork, chicken and milk offtake per unit of stock increased by 61%, 32% and 21% respectively (7). Such biological and technical advances must be adapted to local conditions if they are to be profitably introduced. These advances are supported by increasing use of external services and by the specialisation of production, with a substantial shift from backyard and mixed systems to commercial, specialised, single-product operations.

Geographic concentration

Driven by growing demand and market opportunities, and supported by technological change, the distribution of production is no longer determined by the agro-ecological potential of a given location but by a variety of interacting factors. As well as local supply of feed and demand for livestock products, driving factors include transport costs, disease concerns, environmental regulations and a whole set of other policy factors.

As countries industrialise, they follow a pattern in relocating livestock production. Livestock production has traditionally been based on locally available feed resources, particularly those that have no other use or are of limited value, such as natural pasture and crop residues. In pre-industrialised contexts, the distribution of ruminant livestock can be explained by the availability of such resources, while the distribution of pigs and poultry closely matches that of humans, because of these animals' role as waste converters. For example, in Vietnam, a country that can be considered to be in the early stages of industrialisation, in 1991 90% of the poultry distribution pattern could be explained by the distribution of the human population ('Geographical shifts of livestock production: landuse and environmental impact

implications'; unpublished report for the Food and Agriculture Organization by P. Gerber and T. Wassenaar, 2005). As soon as urbanisation and economic growth translate rising incomes into 'bulk' demand for animal food products, large-scale operators emerge that are initially located close to towns and cities. Livestock products are among the most perishable products, and their conservation without chilling or processing poses serious problems. Therefore, food items from livestock have to be produced in the vicinity of demand – with concomitant human health and environmental problems stemming from the rapid urbanisation of both humans and animals in the same places.

In a subsequent phase, infrastructure and technology develop sufficiently to enable the production of livestock farther away from human populations, and livestock production shifts further away from demand centres, driven by a series of factors such as lower land and labour prices, access to feed, lower environmental standards in rural areas, tax incentives, and fewer disease problems. Figure 2 shows an example of this geographic shift that occurred around Bangkok between 1992 and 2000.

Vertical integration

There is rapid change also in the way value or food chains are organised in the livestock sector. Vertical integration provides economies of scope, ensures reliability of supply, and facilitates quality management and homogeneity of products. Importantly, it also allows producers to mitigate the wide host of pathogen threats to which the livestock sector and associated food chains are subject. At the same time, and in line with previous observations on dietary

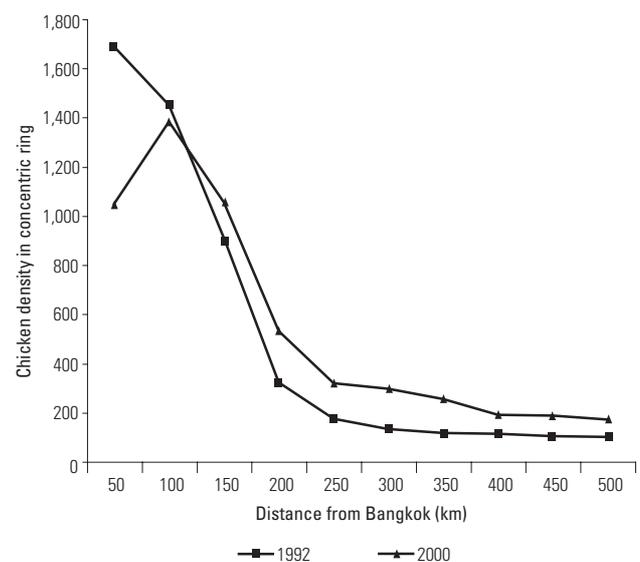


Fig. 2
The evolution of the geographical concentration of poultry around Bangkok from 1992 to 2000

changes, vertical integration accompanies the global sourcing of both livestock production inputs and outputs, and the important moves in trade liberalisation that have occurred over the last decade.

In many developing countries, particularly in rapidly developing countries in Asia and Latin America, the continued rise in per capita incomes together with the increasing urbanisation of populations has led to the westernisation of diets and transformation of food systems (9). The increasing affluence of urban consumers in developing countries is associated with an increase in the predominance and reach of large-scale retail stores, in particular supermarkets, responding to and also shaping the increasing demand for convenience, variety and quality assurance by individuals and households with more disposable income and increased opportunity-costs of time (4). While the main customer of the supermarkets in developing countries is the urban middle class, the competition among rival chains brings the prices of similar products down, thus also accommodating lower-income households seeking to stretch the purchasing power of their food budgets. The rapid expansion in supermarket penetration in developing countries is a fairly recent phenomenon, notable only over the last five to ten years, that is proceeding at different rates and depths in the various regions of the developing world (11).

The emergence of supermarkets in developing countries reflects a structural change in the way that meat, dairy products and eggs are collected, inspected, processed, packaged and supplied to consumers. It is a change that has deep impacts on livestock producers, particularly in determining who can and who cannot participate in the mainstream supply chains. A segmentation of markets can be observed, between the rapidly growing formal and the stagnating or declining informal supply chains, and between the 'wet' markets for fresh meat and the supermarket outlets of processed, frozen, packaged and branded meat. The relative significance of each market segment is tied to the level of economic development. It is closely linked to the purchasing power of households and individuals, their demand for leisure, their preferences with respect to the form and texture of meat upon purchase, and the relative value they give to notions of food that are considered 'safe'.

At the same time large-scale retailers compete in delivering consistent product quality that is demanded by their main market. The concept of 'quality' from the producers' perspective is complex, and its attributes evolve over time. The definition of quality varies according to suppliers' strategies on the one hand, and to cultural influences on the other. It includes food safety, nutrition and attributes related to the commercial differentiation of the products (11). Large retailers require a reliable supply of agricultural

products from their suppliers (producers) with consistency in volume and in quality.

Vertical coordination presents the opportunity to keep control of operating and transaction costs while at the same time meeting high standards of food safety. It demands organisational and institutional changes in the relationship between the primary producer and the agri-food processor or supermarket distributor, giving rise either to various forms of vertically coordinated transactions (the retailer contracts suppliers and/or processors), or in the extreme form, to fully integrated systems (all units in the food chain owned by one company). Large retailers in developing countries are increasingly tending towards vertical coordination, although vertically coordinated chains may interact with informal markets that supply inputs of live animals or products.

Increasing scales of production

Throughout developed and rapidly developing countries, there is a continuing tendency for production scales to grow. This is particularly pronounced for the production of monogastrics, and less so for ruminants. In contrast, certain areas with low economic growth, like parts of South Asia and sub-Saharan Africa, have not yet experienced an increase in average scale of production.

The process of ever-growing scales is triggered by economies of scale: average production costs decline with an expanding scale of operations at various stages of the production process. As a result, the number of producers rapidly diminishes even though the sector as a whole may expand. In emerging economies, the average size of operations is rapidly increasing and the numbers of livestock producers are in sharp decline. For chicken in Brazil, between 1985 and 1996, most of the growth occurred in the larger farms of the central western part of the country: farms with more than 10,000 head increased their proportion of the total population from 42% to 78% (1).

Similarly in Thailand, only the largest category of pig farms grew in number (Fig. 3) (10). However, in the Southern Luzon region of the Philippines, one of the main pig producing regions of the country, the pig numbers in commercial farms exhibited phenomenal growth between 1980 and 2000, while the number of pigs produced by smallholders as a whole also increased (3).

Smallholders can stay in business by providing their labour input to their own farms at below market price, which works well in countries where there are limited employment opportunities in other sectors (5). But as soon as employment opportunities in other sectors rise, many smallholder producers opt out of livestock production.

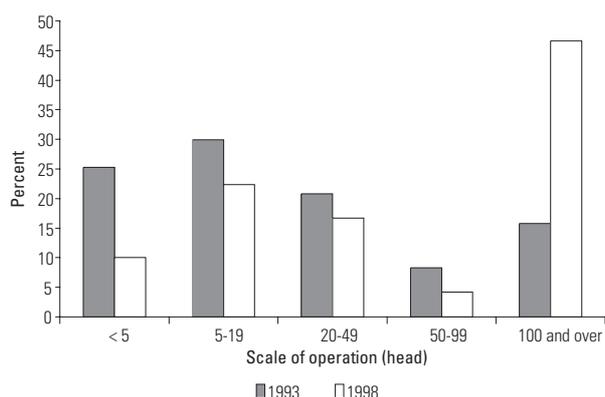


Fig. 3
Changes in the proportion of large and small-scale pig holdings in Thailand from 1993 to 1998

Different commodities and different stages in the production process reveal different potential for economies of scale. This potential tends to be high in the post-harvest sectors (e.g. slaughterhouses, dairy plants). In commodity production, poultry is most easily mechanised and shows a trend towards industrial forms of production even in the least-developed countries.

Livestock production system growth rates

The Livestock, Environment and Development Initiative has recently conducted an update ('Classification and characterization of world livestock production systems'; unpublished report for the Food and Agriculture Organization by J. Groenewold, 2005) of the world livestock production systems study by Seré and Steinfeld (12). The ten-year period between the two quantifications (which took averages of the periods 1991 to 1993 and 2001 to 2003) allows for a number of observations that among others confirm the importance of the above processes. Significant changes in resource endowment have brought about changes in the nature and extent of certain production systems. Permanent pastures show an increase at world level of about 3% in that period, particularly in Central/South America and western Asia/North Africa, while slight drops are observed in sub-Saharan Africa and in the countries of the Organization for Economic Co-operation and Development (OECD). Total arable land increased by about 5%, with almost all of this growth occurring in the developing regions. Major increases are observed in tropical highland grazing systems as well as in humid mixed irrigated systems. The irrigated area expanded by some 20% in ten years. This expansion has been particularly large in the arid and tropical highland grazing systems, as well as in the arid mixed rainfed systems.

As a consequence of the agricultural expansion, global cattle stocks are slightly up (5%), with considerable increases in stock numbers for sub-Saharan Africa, Asia

and Latin America. A sharp drop (almost 50%) in animal numbers occurred in Eastern Europe and the Commonwealth of Independent States (CIS, the former Soviet Union) following the collapse of the Soviet Union and political change in other countries. World output rose by about 10% in the period of observation, with very sharp differences at regional level; Asia almost doubled cattle meat output, sub-Saharan Africa increased by 30%, Latin America by 40%, and West Asia and North Africa (WANA), albeit from a lower absolute level, by about 20%. The strongest cattle output increases occurred in the mixed systems in the humid zones.

Total meat production from small ruminants increased by about 10%, while the overall stock numbers for small ruminants remained fairly constant for the two reference periods. There have been inter-regional shifts in distribution: stock numbers increased considerably in sub-Saharan Africa and Asia, and declined sharply in Latin America and the OECD, and in particular in Eastern Europe and the CIS. The increases occurred mainly in the mixed humid systems.

The changes in monogastric animal production are more notable. Total pig meat output rose by 30% at the world level, and this increase is accounted for almost entirely by the increased output in Asia. Most regional groupings show increases in pig meat production, while for Eastern Europe and the CIS there is a drop of about 30%. Industrial pig meat production grew at a pace of about 3% per annum. Major increases also occurred in the humid and temperate mixed irrigated systems.

The total production of poultry meat grew by about 75%, the greatest expansion of all livestock products. Regional differences are pronounced, with an extremely strong expansion in Asia (about 150% of added production, representing 9% yearly growth). The growth rates are generally positive, ranging between 2% and 10% across regions, the majority originating from the expansion of industrial systems. The global production of table eggs grew by about 40%. Asia more than doubled its egg production in the period and attained a share of about 50% of world production. The landless system grew by about 4% per year.

Implications for food safety

On a global average for 1997, animal products provided about 16% of the calories in the diet (6), representing around 25% in developed countries and around 12% in developing countries. For proteins over the same period the proportion was about 37%, being about 56% in developed countries and 29% in developing countries. Meat and other animal products also provide essential fatty

acids, vitamins and minerals. The iron in meat and meat products is easily assimilated by humans and is a key to preventing iron deficiency anaemia, a high prevalence of which has been reported in, for example, Eastern Europe. The livestock industry therefore has great global economic and nutritional significance. While the global importance of animal food increases, the related changes in the livestock sector affect the security of the food provided in many ways. While being far from exhaustive, a few salient aspects of these consequences are highlighted below.

The production/demand trends described above have led to an increase in white meat consumption and a decline in red meat. This has important implications because it is the poultry, pig (requiring protein supplementation) and dairy industries that are the principal users of processed animal feeds. This feed must be of high quality to sustain efficient growth and feed conversion. It is important to realise, however, that the large and increasing volume of international trade in foods of animal origin as well as in feedstuffs adds an important international dimension to the control of animal feedstuffs. Given the direct links between feed safety and the safety of foods of animal origin, it is essential that feed production and manufacture be considered as an integral part of the food production chain. Feed production must therefore be subject, in the same way as food production, to quality assurance, including food safety systems based preferably on hazard analysis and critical control points. The Codex Alimentarius Commission has negotiated a *Code of Conduct on Safe Animal Feeding*, adopted in 2004, to help meet such requirements (2).

While in many developing countries LPS are subject to strong external forces and are in the process of rapid adjustment, little change is occurring in other countries. In a number of ways, it is the dichotomy that characterises livestock production in developing countries that poses the greatest challenge to food safety. Where traditional and modern forms of livestock production co-exist, with parallel market channels and outlets, uniform standards are difficult to enforce because of equity concerns, disease concerns, certification problems and other issues. This poses a formidable challenge to regulating and upgrading food safety in developing countries, particularly also because the two segments interact.

A recent Food and Agriculture Organization expert consultation on the dynamics of sanitary and technical requirements analysed the trends in food safety (8). Standards and regulations for animal health, food safety and food quality affect and are affected by the structure of livestock food chains. These standards are increasing in stringency, complexity and cost implications. They are

variable in nature and driven by multiple forces, which include international agreements and bodies, national policies and laws, and the requirements of large-scale retailers. Consumers in affluent countries have a major impact on standard setting, yet the results may affect poor and marginal producers, processors and consumers who do not directly trade in the global market and have very little voice in the standard-setting process. The private sector has an increasing influence, while the impact of the public sector is limited and policies do not always reflect the needs of the various stakeholders in livestock food chains.

Food safety requirements are a major determinant shaping the structure of the livestock sector and associated food chains. One of the main aspects of the structural change process described above is the decoupling of production locations from consumption, and this has resulted in the risk through the food chain becoming an issue. Vertical integration, one of the other characteristics of structural change, also may affect food safety. The emergence of multinational food chains and a dramatic rise in the market share of supermarkets and the modern retail sector in many countries have created a number of effects, some of which may affect food safety:

- a shift toward cross-border systems, with corporations procuring goods in their different countries of operation
- a shift toward preferred-supplier systems to select producers who meet specific quality and safety standards and lower transaction costs
- a consolidation of production and processing which may have unexpected impacts on safety
- a shift toward safety and quality standards driven by the private sector.

While the speed and intensity of such effects vary by region – rapid in Eastern Europe, Latin America and the People's Republic of China, much slower in Africa – they suggest a trend that will continue. Other sectoral changes may take place in response to food safety concerns or in response to a crisis. In Thailand, for example, following the highly pathogenic avian influenza crisis, the poultry sector – and particularly the layer industry – showed signs of becoming more concentrated. Factors affecting this included producer liquidity, government policy and consumer risk perception towards food safety. The trend was already in evidence as a result of the export-oriented policy of one large company, but has been hastened by the avian influenza epidemic.



Les systèmes de production animale dans les pays en développement : statuts, moteurs, tendances

H. Steinfeld, T. Wassenaar & S. Jutzi

Résumé

Les auteurs décrivent et évaluent le statut actuel des systèmes de production animale ainsi que les moteurs de cette production au niveau mondial et les tendances dominantes dans ce secteur. L'analyse porte sur les six principales espèces d'élevage : les bœufs, les buffles, les chèvres, les moutons, les porcs et les poulets. Les moteurs impulsant le secteur de l'élevage au niveau mondial sont la croissance et les revenus économiques, l'évolution démographique et l'utilisation des sols, les changements d'habitudes alimentaires et les mutations technologiques. Le niveau de changement et les orientations prises pour développer le secteur de l'élevage sont très variables d'une région à l'autre. C'est en Asie que la croissance et le changement structurel sont les plus rapides. L'article aborde également la dynamique des systèmes en analysant la manière dont les systèmes de production animale se sont adaptés aux contraintes extérieures. L'article s'achève sur un bref examen des relations entre ces tendances et la sécurité sanitaire des aliments.

Mots-clés

Changement structurel – Moteur – Système de production animale.



Situación, fuerzas motrices y tendencias de los sistemas de producción agropecuaria en los países en desarrollo

H. Steinfeld, T. Wassenaar & S. Jutzi

Resumen

Los autores describen y evalúan la actual situación de los sistemas de producción agropecuaria, los factores que impulsan la producción a escala mundial y las tendencias básicas en este terreno. En su análisis estudian las seis principales especies que son objeto de producción industrial: vacas y búfalos, caprinos y ovinos, porcinos y pollos. Los factores que en el plano mundial ejercen de fuerza motriz del sector agropecuario son: el crecimiento económico y el nivel de renta, los cambios demográficos y de usos del suelo, la evolución de los regímenes alimentarios y los cambios tecnológicos. El ritmo y las orientaciones de la producción agropecuaria varían sobremanera según la región del mundo de que se trate. Asia, en este sentido, exhibe la mayor velocidad de crecimiento y el mayor nivel de cambios estructurales. Los autores se detienen también en la dinámica de los sistemas, analizando el modo en que la producción agropecuaria se ha adaptado a fuerzas externas. Para concluir, examinan brevemente la relación entre esas tendencias y la cuestión de la inocuidad de los alimentos.

Palabras clave

Cambio estructural – Fuerza motriz – Sistema de producción agropecuaria.



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