2. Change in the livestock sector

Rapid growth and technological innovation have led to profound structural changes in the livestock sector, including: a move from smallholder mixed farms towards large-scale specialized industrial production systems; a shift in the geographic locus of demand and supply to the developing world; and an increasing emphasis on global sourcing and marketing. These changes have implications for the ability of the livestock sector to expand production sustainably in ways that promote food security, poverty reduction and public health. This chapter reviews trends in and the outlook for consumption, production and trade of livestock products and accompanying technological and structural changes in the sector. It discusses the structure and diversity of the livestock sector and factors that will shape the sector over the coming decades. Challenges facing efforts to improve livelihoods, alleviate poverty and food insecurity, reduce pressures on natural resources and manage human and animal diseases are highlighted.

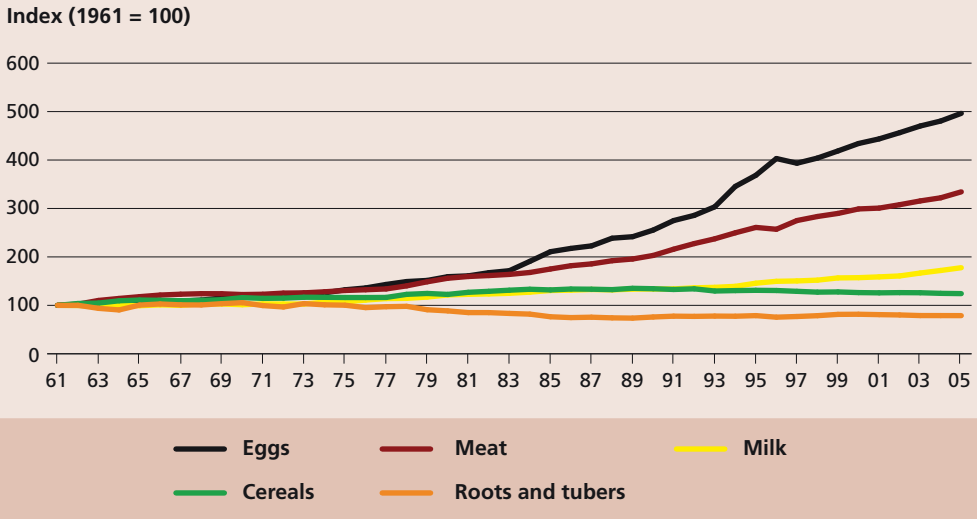
Consumption trends and drivers[1]

Trends in consumption

Consumption of livestock products has increased rapidly in developing countries over the past decades, particularly from the 1980s onwards. Growth in consumption of livestock products per capita has markedly outpaced growth in consumption of other major food commodity groups (Figure 1). Since the early 1960s, consumption of milk per capita in the developing countries has almost doubled, meat consumption more than tripled and egg consumption increased by a factor of five.

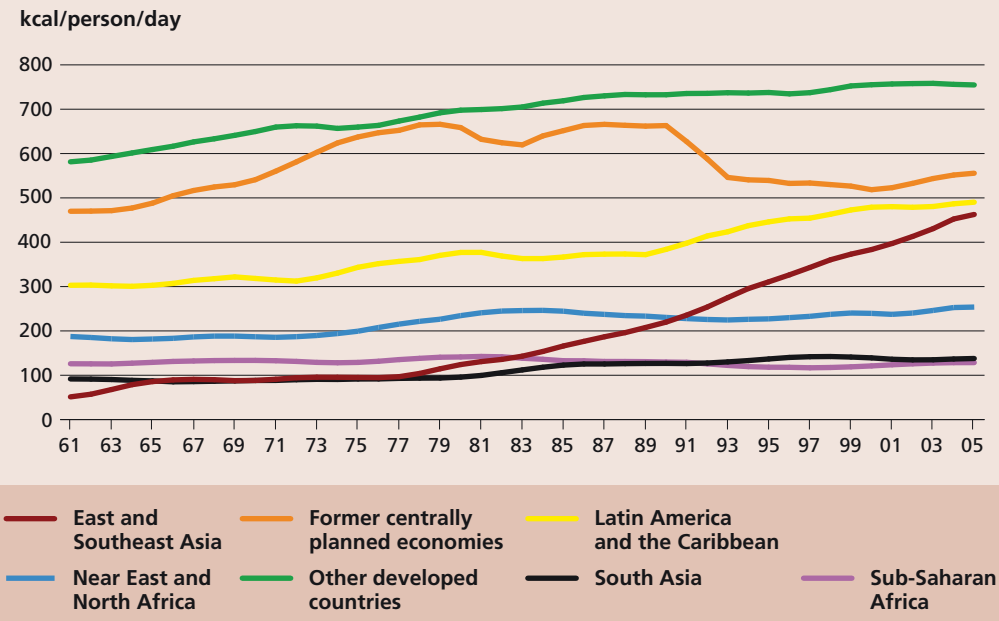
[1] More detailed information about the most recent trends in consumption, production and trade, by country, can be found in the Statistical annex at the end of this report. The analysis and data presented in this and the following sections cover consumption, production and trade of livestock products. Animal-source food of other origins – such as fish and bushmeat – are not included.

FIGURE 1
Per capita consumption of major food items in developing countries, 1961–2005



Source: FAO, 2009b.

FIGURE 2
Per capita intake of energy derived from livestock products by region, 1961–2005



Note: Livestock products include meat, eggs and milk and dairy products (excluding butter). *Source:* FAO, 2009b.

This has translated into considerable growth in global per capita intake of energy derived from livestock products, but with significant regional differences (Figure 2). Consumption has increased in all regions except sub-Saharan Africa. Also, the former centrally planned economies of Eastern Europe and Central Asia saw major declines around 1990. The greatest increases have occurred in East and Southeast Asia and in Latin America and the Caribbean.

Table 1 summarizes per capita consumption of meat, milk and eggs for the major developed- and developing-country groups since 1980. The most substantial growth in per capita consumption of livestock products has occurred in East and Southeast Asia. China, in particular, has seen per capita consumption of meat quadruple, consumption of milk increase tenfold, and egg consumption increase eightfold. Per capita consumption of livestock products in the rest of East and Southeast Asia has also grown significantly, particularly in the Democratic People's Republic of Korea, Malaysia and Viet Nam.

Brazil too has experienced a rapid expansion in the consumption of livestock products – per capita consumption of meat has almost doubled, while that of milk has increased by 40 percent. In the rest of Latin America and the Caribbean, increases in consumption have been more modest, with some exceptions. The Near East and North Africa has seen a 50 percent increase in consumption of meat and a 70 percent increase in egg consumption, although milk consumption has declined slightly. In South Asia, including India, per capita consumption of livestock products has grown steadily, although meat consumption remains low. Among the developing-country regions, only sub-Saharan Africa has seen a modest decline in per capita consumption of both meat and milk.

In the developed countries overall, growth in per capita consumption of livestock products has been much more modest. The former centrally planned economies of Eastern Europe and Central Asia suffered a sudden drop in per capita consumption of livestock products in the early 1990s and consumption has not recovered since – as a result, per capita meat consumption in 2005 was 20 percent below its 1980 level.

Consumption of livestock products per capita in developing regions is still

substantially lower than in the developed world, even though some rapidly developing countries are narrowing the gap (Table 1). There is significant potential for increasing per capita consumption of livestock products in many developing countries. The extent to which this potential will translate into increasing demand depends on future income growth and its distribution among countries and regions. Rising incomes are more likely to generate additional demand for livestock products in low-income countries than in middle- and high-income countries.

Drivers of consumption growth

The growing demand for livestock products in a number of developing countries has been driven by economic growth, rising per capita incomes and urbanization. In recent decades, the global economy has experienced an unparalleled expansion, with per capita incomes rising rapidly. The relationship between per capita income and meat consumption for 2005 is illustrated in Figure 3. The figure shows a strongly positive effect of increased incomes on livestock consumption at lower income levels but a less positive, or even negative, effect at high levels of GDP per capita.

Demographic factors also underlie changing consumption patterns of livestock products. An important factor has been urbanization. The share of total population living in urban areas is larger in the developed countries than in developing countries (73 percent compared with an average of 42 percent). However, urbanization is increasing faster in developing countries than in developed countries. In the period 1980–2003, the urban population in developing countries grew at average annual rates ranging from 4.9 percent in sub-Saharan Africa to 2.6 percent in Latin America, compared with an average of only 0.8 percent in developed countries (Table 2).

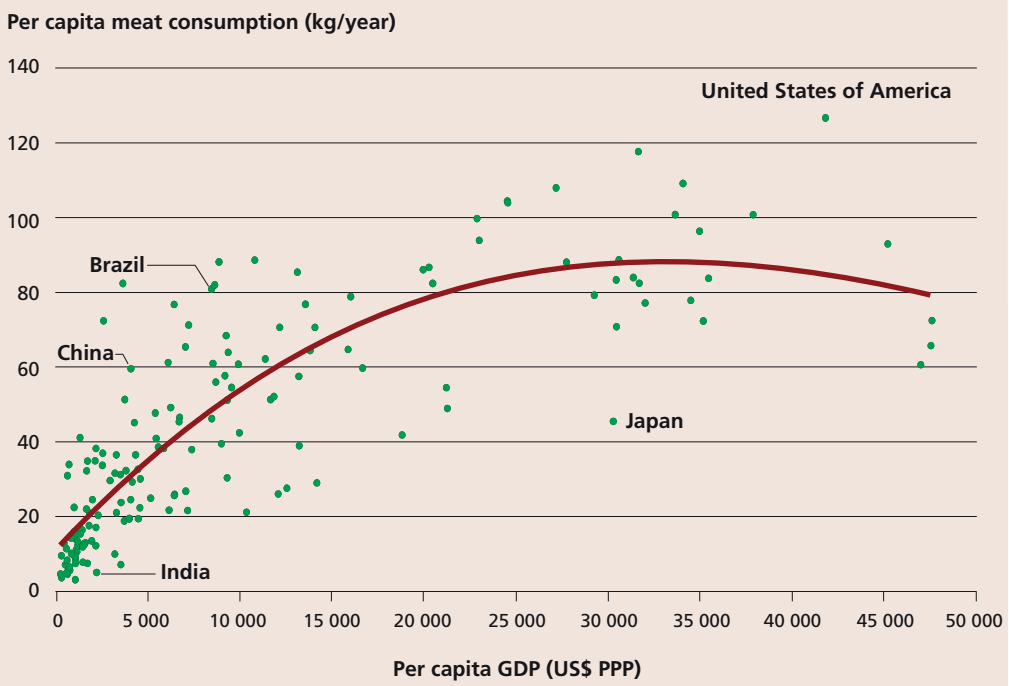
TABLE 1

Per capita consumption of livestock products by region, country group and country, 1980 and 2005

REGION/COUNTRY GROUP/ COUNTRY	MEAT		MILK		EGGS	
	1980	2005	1980	2005	1980	2005
	(kg/capita/year)		*(kg/capita/year)*		*(kg/capita/year)*	
DEVELOPED COUNTRIES	**76.3**	**82.1**	**197.6**	**207.7**	**14.3**	**13.0**
Former centrally planned economies	63.1	51.5	181.2	176.0	13.2	11.4
Other developed countries	82.4	95.8	205.3	221.8	14.8	13.8
DEVELOPING COUNTRIES	**14.1**	**30.9**	**33.9**	**50.5**	**2.5**	**8.0**
East and Southeast Asia	12.8	48.2	4.5	21.0	2.7	15.4
China	13.7	59.5	2.3	23.2	2.5	20.2
Rest of East and Southeast Asia	10.7	24.1	9.9	16.4	3.3	5.1
Latin America and the Caribbean	41.1	61.9	101.1	109.7	6.2	8.6
Brazil	41.0	80.8	85.9	120.8	5.6	6.8
Rest of Latin America and the Caribbean	41.1	52.4	109.0	104.1	6.5	9.4
South Asia	4.2	5.8	41.5	69.5	0.8	1.7
India	3.7	5.1	38.5	65.2	0.7	1.8
Rest of South Asia	5.7	8.0	52.0	83.1	0.9	1.5
Near East and North Africa	17.9	27.3	86.1	81.6	3.7	6.3
Sub-Saharan Africa	14.4	13.3	33.6	30.1	1.6	1.6
WORLD	**30.0**	**41.2**	**75.7**	**82.1**	**5.5**	**9.0**

Source: FAO, 2009b.

FIGURE 3
Per capita GDP and meat consumption by country, 2005



Note: GDP per capita is measured at purchasing power parity (PPP) in constant 2005 international US dollars.
Source: Based on data from FAOSTAT (FAO, 2009b) for per capita meat consumption and the World Bank for per capita GDP.

Urbanization alters patterns of food consumption, which may influence demand for livestock products. People in cities typically consume more food away from home and larger amounts of pre-cooked, fast and convenience foods than do people in rural areas (Schmidhuber and Shetty, 2005; King, Tietyen and Vickner, 2000; Rae, 1998). Urbanization influences the position and the shape of consumption functions – the relationship between income and consumption – for food products. Estimating consumption functions for total animal-derived products in a sample of East Asian economies, Rae (1998) found urbanization to have a significant effect on the consumption of animal products, independently of income levels. Another implication of urbanization in many parts of the world is the growing concentration of animals in cities, in close proximity to humans, as people tend to move livestock activities to urban areas.

Social and cultural factors and natural-resource endowments can also significantly influence local demand and shape future demand trends. For example, Brazil and Thailand have similar levels of income per capita and urbanization, but livestock product consumption is roughly twice as high in Brazil as in Thailand. The influence of natural-resource endowments can be seen in the case of Japan, which has considerably lower levels of consumption of livestock products than other countries with comparable income levels, but compensates with higher levels of fish consumption. Natural-resource endowment affects the relative costs of different food commodities. Access to marine resources favours consumption of fish while access to natural resources for livestock production favours consumption of livestock products. Cultural reasons further influence consumption habits. In South Asia, for example, consumption of meat per capita is lower than income alone would seem to explain.

TABLE 2
Urbanization: levels and growth rates

REGION/COUNTRY GROUP/ COUNTRY	URBAN SHARE OF TOTAL POPULATION	GROWTH IN TOTAL POPULATION	GROWTH IN URBAN POPULATION
	2003	1980–2003	1980–2003
	(Percentage)	*(Annual percentage growth)*	
DEVELOPED COUNTRIES	**73**	**0.5**	**0.8**
Former centrally planned economies	63	0.3	0.6
Other developed countries	77	0.6	0.9
DEVELOPING COUNTRIES	**42**	**1.9**	**3.7**
East and Southeast Asia	41	1.3	4.0
China	39	1.1	4.1
Latin America and the Caribbean	77	1.8	2.6
Brazil	83	1.7	2.7
Near East and North Africa	60	2.4	3.4
South Asia	28	2.0	3.1
India	28	1.9	2.8
Sub-Saharan Africa	35	2.7	4.9
WORLD	**48**	**1.5**	**3.0**

Source: FAO, 2009b.

Production trends and drivers

Trends in production

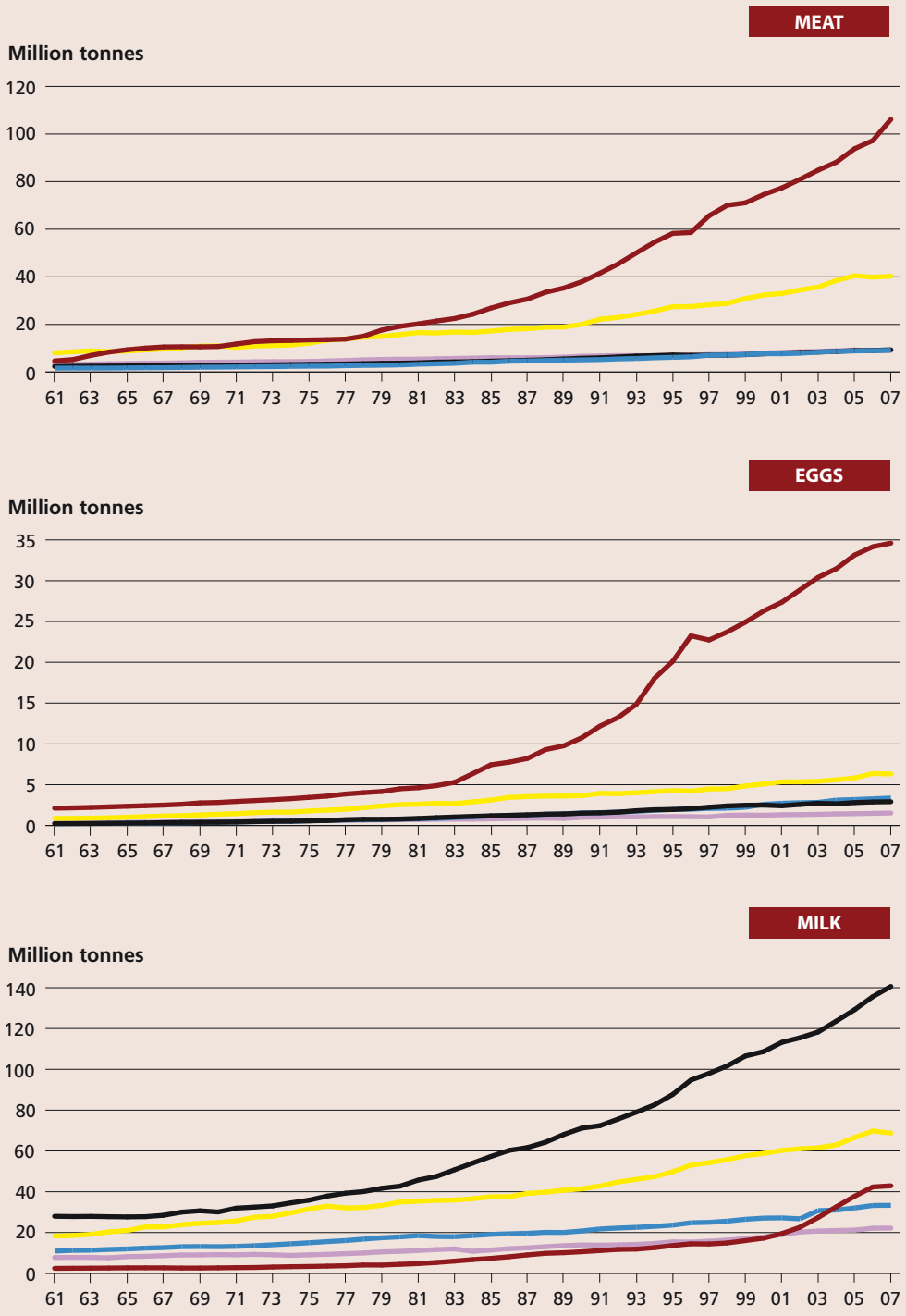
Developing countries have responded to growing demand for livestock products by rapidly increasing production (Figure 4). Between 1961 and 2007, the greatest growth in meat production occurred in East and Southeast Asia, followed by Latin America and the Caribbean. Most of the expansion in egg production was in East and Southeast Asia, while South Asia dominated milk production.

By 2007, developing countries had overtaken developed countries in terms of production of meat and eggs and were closing the gap for milk production (Table 3). Trends in production growth largely mirror those for consumption. China and Brazil show the greatest growth, especially for meat. Between 1980 and 2007, China increased its production of meat more than sixfold; today, it accounts for nearly 50 percent of meat production in developing countries and 31 percent of world production. Brazil expanded meat production by a factor of almost four and now contributes 11 percent of developing-country meat production and 7 percent of global production.

In the remaining parts of the developing world, growth in meat output – as well as production levels – was lower, with the highest growth rates being in the rest of East and Southeast Asia and the Near East and North Africa. In spite of more than doubling meat production between 1980 and 2007, India's overall meat production levels remain low in a global context. However, after more than tripling milk production between 1980 and 2007, India now produces some 15 percent of the world's milk. Production of meat, milk and eggs also increased in sub-Saharan Africa but more slowly than in other regions.

Most of the increase in meat production has been from monogastrics; poultry meat production has been the fastest-growing subsector, followed by pig meat production. Increases from large and small ruminants have been much more modest (Figure 5). The result has been major changes in the composition of meat output globally, with

FIGURE 4
Production of meat, eggs and milk by developing country region, 1961–2007



Source: FAO, 2009b.

TABLE 3
Production of livestock products by region, 1980 and 2007

REGION/COUNTRY GROUP/ COUNTRY	MEAT		MILK		EGGS	
	1980	2007	1980	2007	1980	2007
	(Million tonnes)		*(Million tonnes)*		*(Million tonnes)*	
DEVELOPED COUNTRIES	**88.6**	**110.2**	**350.6**	**357.8**	**17.9**	**18.9**
Former centrally planned economies	24.6	19.0	127.3	101.5	5.6	5.1
Other developed countries	64.0	91.3	223.3	256.3	12.4	13.8
DEVELOPING COUNTRIES	**48.1**	**175.5**	**114.9**	**313.5**	**9.5**	**48.9**
East and Southeast Asia	19.4	106.2	4.4	42.9	4.5	34.6
China	13.6	88.7	2.9	36.8	2.8	30.1
Rest of East and Southeast Asia	5.6	17.5	1.5	6.1	1.7	4.5
Latin America and the Caribbean	15.7	40.3	35.0	68.7	2.6	6.3
Brazil	5.3	20.1	12.1	25.5	0.8	1.8
Rest of Latin America and the Caribbean	10.4	20.2	22.9	43.3	1.8	4.6
South Asia	3.7	9.4	42.7	140.6	0.8	3.4
India	2.6	6.3	31.6	102.9	0.6	2.7
Rest of South Asia	1.1	3.0	11.2	37.7	0.2	0.7
Near East and North Africa	3.4	9.7	19.3	36.4	0.9	3.0
Sub-Saharan Africa	5.5	9.3	12.9	24.3	0.7	1.5
WORLD	**136.7**	**285.7**	**465.5**	**671.3**	**27.4**	**67.8**

Note: Totals for developing countries and the world include a few countries not included in the regional aggregates.
Source: FAO, 2009b.

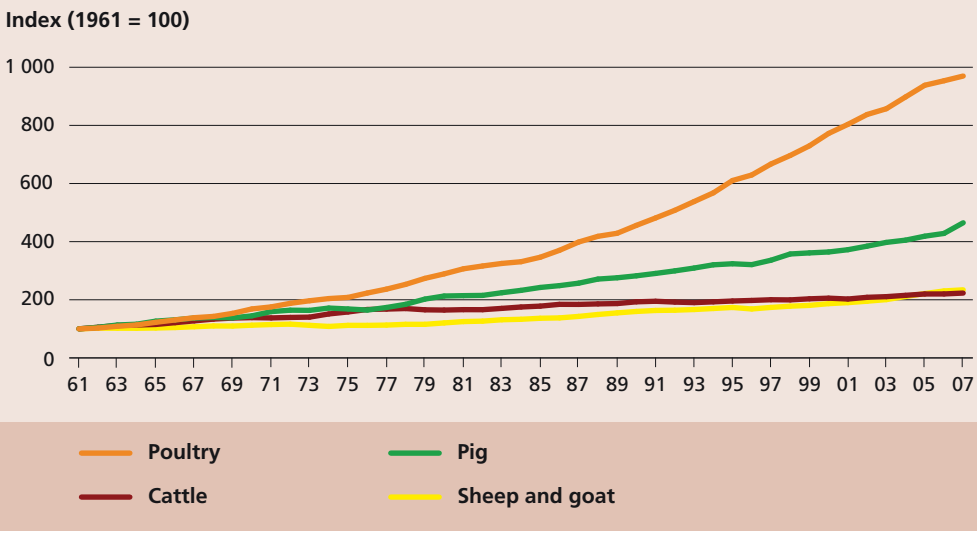
significant differences between regions and countries (Table 4).

Pig meat accounts for over 40 percent of global meat supplies, in part because of high levels of production and rapid growth in China, where more than half of world production takes place. The expansion of poultry meat production, which in 2007 accounted for 26 percent of global meat supplies, has been more widely distributed among both developed and developing countries, but again with China experiencing very high rates of growth. Globally, cattle production has increased much less and only in the developing countries. China and Brazil, in particular, have expanded production considerably and are each now responsible for around 12–13 percent of global cattle meat production. Meat from small ruminants remains of minor importance at the global level, but accounts for a significant portion of meat produced in the Near East and North Africa, sub-Saharan Africa and South Asia.

Drivers of production growth

Supply-side factors have enabled expansion in livestock production. Cheap inputs, technological change and scale efficiency gains in recent decades have resulted in declining prices for livestock products. This has improved access to animal-based foods even for those consumers whose incomes have not risen. Favourable long-run trends in input prices (e.g. feedgrain and fuel) have played an important role. Declining grain prices have contributed to increased use of grains as feed and downward trends in transportation costs have facilitated the movement not only of livestock products but also of feed. Recent increases in grain and energy prices may signal the end of the era of cheap inputs.

FIGURE 5
World production of main categories of meat, 1961–2007



Source: FAO, 2009b.

TABLE 4
Production of main categories of meat by region, 1987 and 2007

REGION/COUNTRY GROUP/ COUNTRY	PIG		POULTRY		CATTLE		SHEEP AND GOAT	
	1987	2007	1987	2007	1987	2007	1987	2007
	(Million tonnes)		*(Million tonnes)*		*(Million tonnes)*		*(Million tonnes)*	
DEVELOPED COUNTRIES	**37.1**	**39.5**	**22.9**	**37.0**	**34.1**	**29.4**	**3.7**	**3.2**
Former centrally planned economies	12.0	7.7	5.1	5.1	10.2	5.1	1.2	0.8
Other developed countries	25.0	31.7	17.8	31.8	23.8	24.3	2.5	2.5
DEVELOPING COUNTRIES	**26.6**	**76.0**	**13.0**	**49.8**	**16.9**	**32.5**	**5.0**	**10.8**
East and Southeast Asia	22.4	68.4	4.8	22.2	1.7	8.8	1.0	5.2
China	18.3	60.0	2.2	15.3	0.6	7.3	0.7	4.9
Rest of East and Southeast Asia	4.0	8.3	2.5	6.8	1.0	1.5	0.2	0.4
Latin America and the Caribbean	3.2	6.1	4.5	17.2	9.8	15.8	0.4	0.5
Brazil	1.2	3.1	1.9	8.9	3.7	7.9	0.1	0.1
Rest of Latin America and the Caribbean	2.0	3.0	2.7	8.3	6.1	7.9	0.3	0.3
South Asia	0.4	0.5	0.5	3.0	1.5	2.1	1.1	1.5
India	0.4	0.5	0.2	2.3	1.0	1.3	0.6	0.8
Rest of South Asia	0.0	0.0	0.2	0.7	0.5	0.8	0.5	0.8
Near East and North Africa	0.0	0.1	2.1	5.3	1.1	1.8	1.5	2.0
Sub-Saharan Africa	0.5	0.8	1.0	2.0	2.7	4.0	1.0	1.6
WORLD	**63.6**	**115.5**	**35.9**	**86.8**	**50.9**	**61.9**	**8.6**	**14.0**

Note: Totals for developing countries and the world include a few countries not included in the regional aggregates.
Source: FAO, 2009b.

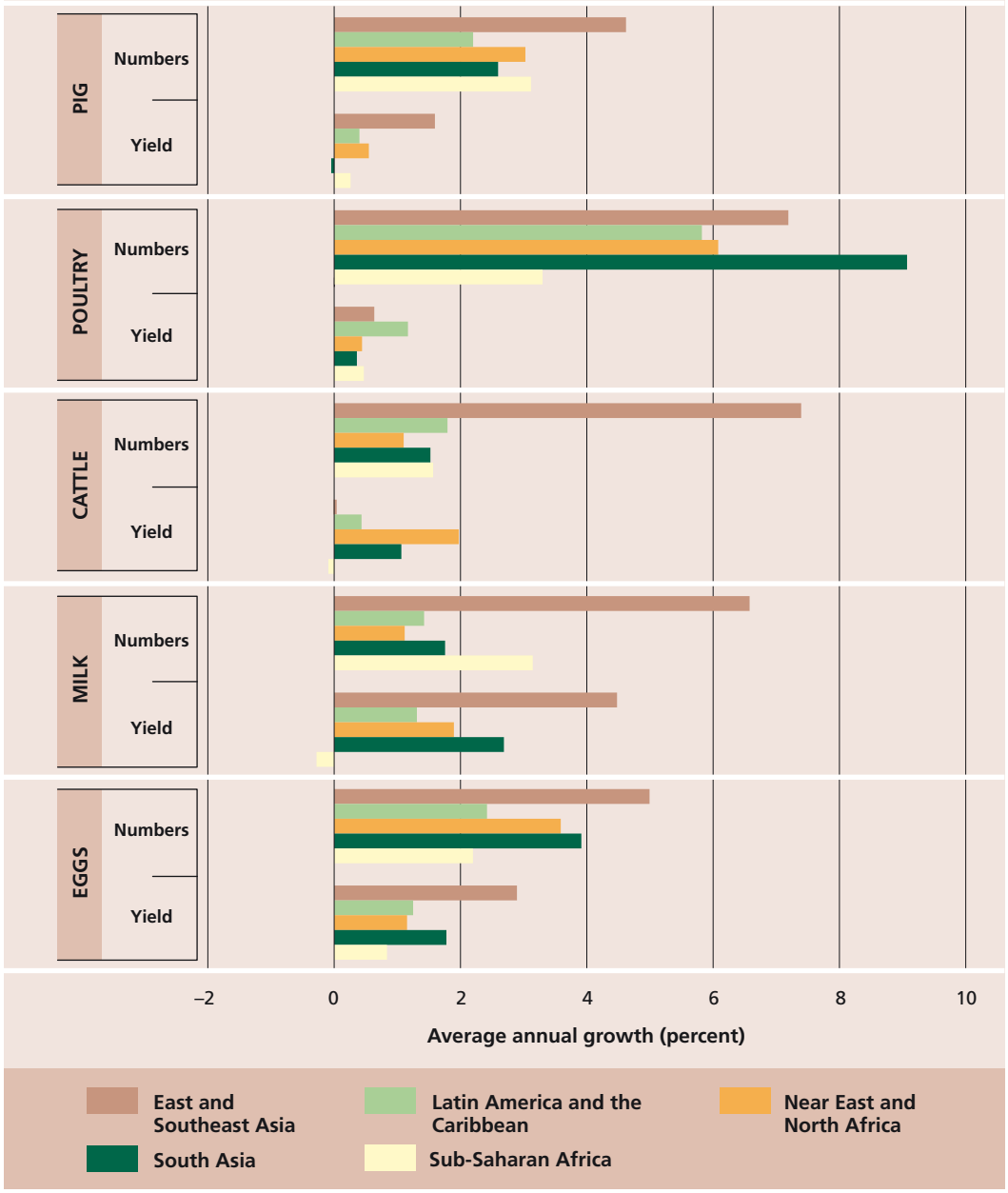
Increases in livestock production occur in two ways, or in a combination of the two:

- an increase in the number of animals slaughtered (in the case of meat) or producing (in the case of milk and eggs);
- increased output per animal (or yield).

Between 1980 and 2007, livestock numbers generally increased faster than yields (Figure 6). However, there are differences across regions and species.

Change in yield per animal is an important productivity indicator but it provides only a partial measure of productivity increases. It does not account for gains in terms of

FIGURE 6
Sources of growth in livestock production: average annual growth in number of animals and in output per animal, 1980–2007



Source: Calculations based on data from FAO (2009b).

the rate at which animals grow and gain weight or any improved efficiency in input use or production factors. Other productivity indicators, although still imperfect, may contribute to providing a more complete picture of trends in livestock productivity (see Box 1).

Technological change in livestock production

Technological change is the single most important factor in expanding supply of cheap livestock products. At the same time, it has affected the structure of the sector in many parts of the world.

Technological change refers to developments and innovations in all aspects of livestock production from breeding, feeding and housing to disease control, processing, transportation and marketing. Technological change in the livestock sector has mostly been the result of private research and development efforts aimed at commercial producers, in contrast with the publicly funded efforts aimed specifically

BOX 1
Measuring productivity growth in the livestock sector

Measures of productivity per animal have their uses, but provide only a partial indicator of livestock productivity. To address this, Steinfeld and Opio (2009) developed a new partial productivity measure, termed biomass–food productivity (BFP). BFP considers the entire herd or flock as an input into the production process and takes account of multiple outputs, e.g. meat, milk and eggs. BFP for a herd or flock is given by the annual output in protein divided by total biomass in the herd or flock, expressed in kilograms. Total BFP for the whole livestock sector of a country is obtained by aggregating protein output for the subsectors assessed (e.g. cattle, pig and chicken) and dividing by total biomass of the subsectors.

Changes in BFP have been estimated for three major livestock-producing developing countries, Brazil, China and India, over the period 1965–2005. The table separates average annual growth rates in total output of the livestock sector into two key components: growth in biomass and growth in productivity as measured by BFP.

In Brazil, about two-thirds of the aggregate growth was due to increased input (biomass) and about one-third to productivity gains. Similarly, in China more than half of the growth in output can be attributed to increases in biomass. In India, on the other hand, improved BFP accounted for over 80 percent of output growth.

Sources of growth in the livestock sectors of Brazil, China and India, 1965–2005

	BRAZIL	CHINA	INDIA
	Average annual growth (percent)		
BFP growth	1.6	2.8	3.7
Biomass growth	3.2	3.8	0.8
Output growth	4.8	6.5	4.5

Although BFP is an improvement over the more traditional productivity indicators based on output per single animal, it still has limitations. These include the fact that it considers only food outputs from a herd and disregards non-food outputs, such as draught power and manure. It may thus underestimate productivity in some traditional production systems where such outputs are important.

Source: Steinfeld and Opio, 2009.

at developing technological innovations that could be applied by smallholders that led to the green revolution in wheat and rice. As a result, technological innovations in the livestock sector have been relatively less widely available and applicable to smallholders. Little emphasis has been given to research on the public goods aspects of technology development for livestock, such as impacts on poor people or externalities related to the environment or public health.

The application of advanced breeding and feeding technology has spurred significant productivity growth, especially in broiler and egg production and the pork and dairy sectors. Technological advances, and thus productivity growth, have been less pronounced for beef and meat from small ruminants. The use of hybridization and artificial insemination has accelerated the process of genetic improvement. The speed and precision with which breeding goals can be achieved has increased considerably over recent decades. Genetic advances are much faster in short-cycle animals, such as poultry and pigs, than in species with a longer generation interval, such as cattle. In all species, feed conversion and related parameters, such as growth rate, milk yield and reproductive efficiency, have been major targets for breeding efforts, while features corresponding to consumer demands, such as fat content, are increasing in importance. While impressive advances have been made in breeds developed for temperate regions, results have been limited in development of breeds of dairy cows, pigs and poultry that perform well in tropical low-input environments.

Improvements in feed technology include balanced feeding, precision feeding, optimal addition of amino acids and mineral micronutrients, and development of improved pasture species and animal husbandry systems such as zero-grazing.

Animal-health improvements, including the increasing use of vaccines and antibiotics, have also contributed to raising productivity. These technologies have spread widely in recent years in a number of developing countries, particularly in industrial production systems close to major consumption centres.

Technological innovations in processing, transportation, distribution and marketing of livestock products have also significantly altered the way food is delivered to consumers (cold chains, longer shelf-life, etc.).

Box 2 shows how all these different technological advances have contributed to increased production in the commercial poultry industry.

Trade trends and drivers

Growth in livestock trade has been facilitated by increasing consumption of livestock products and economic liberalization. Developments in transportation, such as long-distance cold-chain shipments (refrigerated transport) and large-scale and faster shipments, have made it possible to trade and transport animals, products and feedstuffs over long distances. This has allowed production to move away from the loci of both consumption and production of feed resources. Increasing trade flows also have implications for the management of animal diseases and a number of food-safety issues.

Livestock products represent a growing proportion of agricultural exports. Their share of agricultural export value globally rose from 11 percent to 17 percent between 1961 and 2006 (Figure 7). However, trade in crops – including feed crops – still dwarfs that of livestock products.

Between 1980 and 2006, the volume of total meat exports increased more than threefold. Exports of dairy more than doubled and exports of eggs almost doubled (Table 5). The share of production entering international trade increased, except for sheep meat and eggs, reflecting the sector's increasing degree of openness to trade. The degree of trade openness has been particularly high for monogastrics.

Although the bulk of livestock produce is consumed within the country of production and does not enter international trade, livestock exports are important for a few countries. Since mid-2002, developing countries as a whole have been net exporters of meat (Figure 8). However, this masks large disparities between countries. Developing-country meat exports are dominated by the

contribution of Brazil, the world's largest meat exporter. If exports from Brazil, China, India and Thailand are excluded, all developing regions are net importers of meat. Thailand has emerged as a major force in the global market for poultry, with net exports of almost half a million tonnes in 2006. All developing regions are increasingly dependent on imports of dairy products (Figure 8).

Brazil's performance in export for livestock products is particularly noteworthy. Over the

BOX 2
Technological progress in the poultry industry

No other livestock industry has applied technological improvements as rapidly or effectively as the commercial poultry industry. Poultry respond well to technological change because of their high reproductive rates and short generation intervals. Moreover, the vertically integrated structure of commercial poultry production has permitted widespread application of new technologies to large numbers of birds, often across thousands of farms.

Since the early 1960s, broiler growth rates have doubled and feed conversion ratios have halved. Modern commercial layers typically produce about 330 eggs per year with a feed conversion ratio of 2 kg of feed per kilogram of eggs produced. Modern broilers weigh about 2.5 kg at 39 days, with a feed conversion ratio of 1.6 kg of feed per kilogram of body-weight gain.

The gains in the production of poultry meat and eggs from individual birds in commercial flocks are largely due to genetic selection in the nucleus breeding flocks and the rapid transfer of these gains to the commercial crossbred progeny (McKay, 2008; Hunton, 1990). Breeding advances have largely been based on the application of quantitative genetic selection, without recourse to molecular technologies. The impressive annual gain in the productivity of commercial broiler flocks is a reflection of a complex and coordinated approach by the breeders to maximize performance (McKay, 2008; Pym, 1993).

Bird health, robustness and product quality and safety have improved commensurately with gains in productivity as a result of the application of breeding, feeding, disease control, housing and processing technologies.

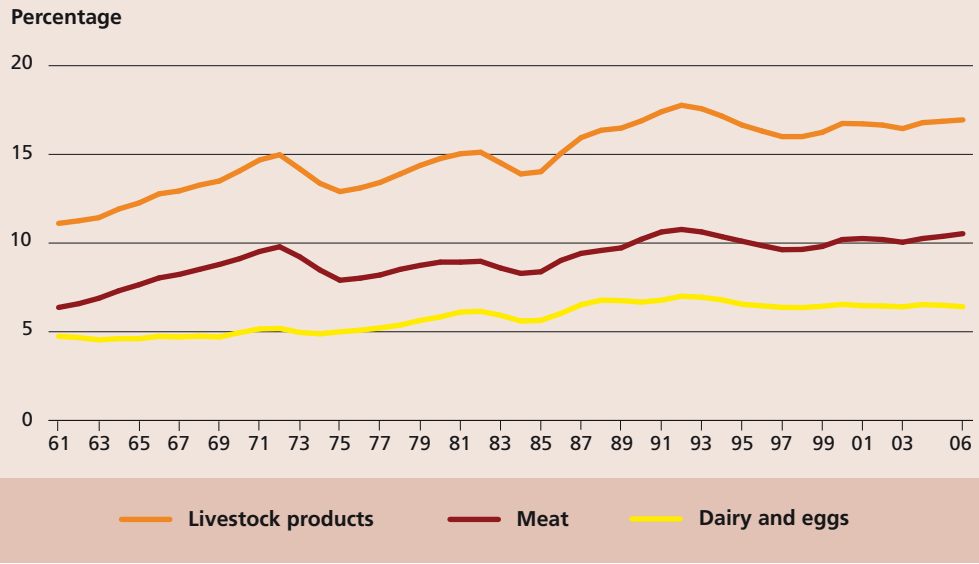
Disease challenges can have a major impact on efficiency, but improvements in vaccination, nutrition and biosecurity have contributed to reducing their impact. Breeding for improved disease resistance, particularly through the adoption of molecular technologies, will be an important component of future genetic programmes. Future advances in the industry depend upon the application of new molecular tools to the development of improved diagnostic techniques for poultry disease surveillance programmes and surveillance for food-borne pathogens. Past experience has demonstrated the need for rapidly addressing problems of food-borne pathogens in poultry meat and eggs, if consumer confidence in the safety of poultry products is to be maintained.

Unfortunately, technologies developed for industrial production systems with strict biosecurity controls have little applicability in small-scale mixed farming systems. The poorest farmers tend to be the least technologically advanced, operating with indigenous birds, semi-scavenging feeding systems, minimal disease control and basic housing. However, the application of some relatively simple technologies (e.g. short-term confinement rearing and creep-feeding of chicks with suitable diets, vaccination against Newcastle disease, and overnight secure housing of all birds) can yield profound improvements in smallholder profitability, household food security and the empowerment of women as poultry keepers.

Source: Pym *et al.*, 2008.

last decade, the country has increased the quantity of poultry meat exports fivefold, and exports of pig and bovine meat have risen by a factor of 8 and 10, respectively. In nominal value, Brazil's net exports of livestock products went from US$435 million in 1995 to US$7 280 million in 2006. In 2006, Brazil's net exports accounted for 6 percent of global exports of pig meat, 20 percent of bovine meat and 28 percent of poultry meat. Brazil has increasingly taken advantage of low feed production costs for its livestock industry and is poised to remain an important producer of feedstuffs. The combination of abundant land and recent infrastructure developments has turned previously remote areas, such as Mato Grosso and the Cerrado region of central Brazil, into feed baskets. These two regions have the lowest production costs for maize

FIGURE 7
Value of livestock products as a share of global agricultural export value, 1961–2006



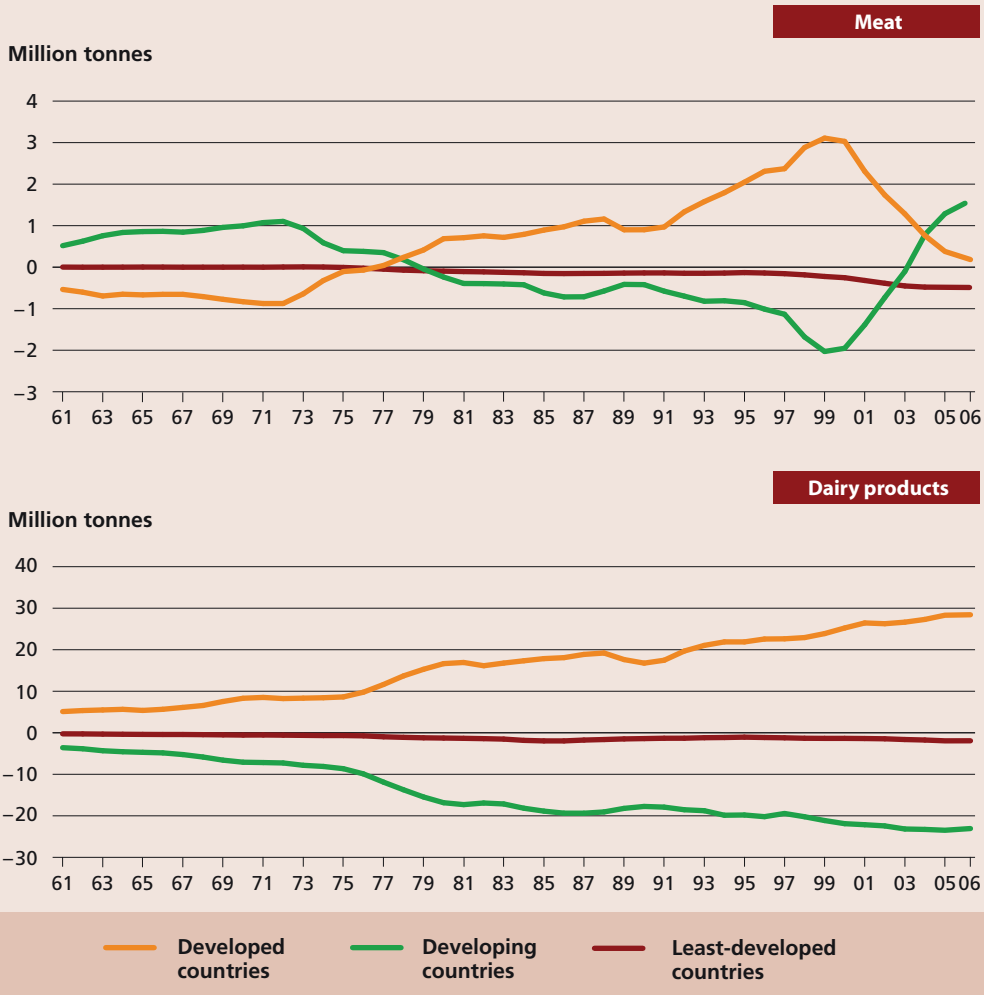
Source: FAO, 2009b.

TABLE 5
Global trade in livestock products, 1980 and 2006

PRODUCT	WORLD EXPORTS		SHARE OF TOTAL PRODUCTION	
	1980	2006	1980	2006
	(Million tonnes)		*(Percentage)*	
Total meat[1]	**9.6**	**32.1**	**7.0**	**11.7**
Pig	2.6	10.4	4.9	9.8
Poultry	1.5	11.1	5.9	13.0
Bovine	4.3	9.2	9.1	14.2
Ovine	0.8	1.1	10.6	7.7
Dairy[2]	**42.8**	**90.2**	**8.7**	**12.7**
Eggs	**0.8**	**1.5**	**3.1**	**2.2**

[1] Includes other types of meat than those listed below.
[2] Milk equivalent.
Source: FAO, 2009b.

FIGURE 8
Net exports of meat and dairy products from developed and developing countries, 1961–2006



Source: FAO, 2009b.

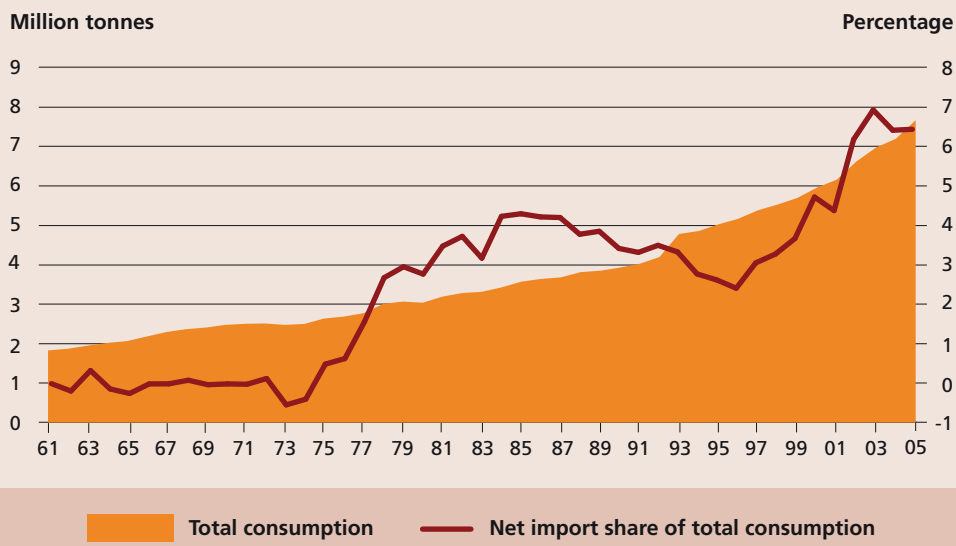
and soybeans anywhere in the world. Since the early 1990s, Brazilian producers have actively taken strategic advantage of their position and have started to convert their feed into exportable surpluses of livestock commodities (FAO, 2006).

A particular source of concern is the net trade position in livestock products of the least-developed countries (LDCs). These countries are increasingly dependent on imports of livestock products – indeed, food commodities in general – to meet growing demand (Figure 9). The proportion of consumption met by imports has increased rapidly since 1996. As part of wider efforts to boost agricultural growth, expanding domestic supply could potentially contribute to economic growth, rural development and an improved external trade position.

Outlook for consumption, production and trade

The factors that have encouraged growth in demand in developing countries – rising incomes, population growth and urbanization – will continue to be important over the coming decades, although the effects of some may weaken. Population growth, although slowing, will continue.

FIGURE 9
Meat consumption and share of net imports in consumption, least-developed countries, 1961–2005



Source: FAO, 2009b.

While projections of the future growth in the world's population vary, a recent estimate suggests the world's population will exceed 9 billion in 2050 (UN, 2008).

Trends towards increasing urbanization are considered unstoppable. By the end of 2008, it is believed that, for the first time, more than half the world's population was living in towns and cities. By 2050, around seven out of every ten people are expected to be urban dwellers; by then, there will be 600 million fewer rural residents than now (UN, 2007).

Income growth is generally considered to be the strongest driver of increased consumption of livestock products. Although short-term prospects are poor, with the global economy in a severe recession, medium-term prospects do suggest a recovery, albeit slow. In April 2009, the International Monetary Fund (IMF) projected a decline in global GDP of 1.3 percent in 2009, followed by growth of 1.9 percent in 2010, rising to 4.8 percent by 2014 (IMF, 2009). According to the IMF, the exceptional uncertainty of the growth outlook means that the transition period will be characterized by slower growth than seen in the recent past.

The effect of economic growth on demand for livestock products depends on the rate of growth and where it occurs. Demand for livestock products is more responsive to income growth in low-income countries than in higher-income countries. Increasing saturation in per capita consumption in countries that have reached relatively high levels of consumption, notably Brazil and China, could lead to some slowing in demand. An important question is whether other major developing countries with low current levels of meat consumption will emerge as new growth poles, thus sustaining large increases in global demand. India, with its large population and low levels of per capita consumption of livestock products, has the potential to be a major source of new demand. However, opinions differ on the likely future contribution of India to global demand for livestock products (see Bruinsma, 2003).

A further question is to what extent continuing high food prices will dampen consumer demand, as consumers across the globe alter their eating habits. While it is difficult to forecast future feed and food price trends accurately, most analysts and observers agree that in the short to medium term, prices will remain higher than in the recent past, but that increased volatility of prices will become the norm (IFPRI, 2008; OECD–FAO, 2008; World Bank, 2008a).

Overall, the potential for expanding per capita consumption of livestock products remains vast in large parts of the developing world as rising incomes translate into growing purchasing power.

All indications are for continued growth in global demand for livestock products. In 2007, the "IMPACT" model developed by the International Food Policy Research Institute (IFPRI) projected an increase in global per capita demand for meat ranging from 6 to 23 kg, according to the region, under a "business-as-usual scenario" (Rosegrant and Thornton, 2008) (Table 6). The bulk of the increase is projected to be in developing countries. The largest numerical increases are projected for Latin America and the Caribbean and the East and South Asia and the Pacific regions, but a doubling – albeit from a low level – is foreseen for sub-Saharan Africa.

The model projects that growing demand will lead to increasing livestock populations, with the global population of cattle increasing from 1.5 billion to 2.6 billion and that of goats and sheep from 1.7 billion to 2.7 billion between 2000 and 2050. Demand for coarse grains for animal feed is also projected to increase over the period by 553 million tonnes, corresponding to approximately half of the total increase in demand.

The *OECD–FAO Agricultural Outlook, 2009–2018* (OECD–FAO, 2009) presents projections for the coming decade. Although methodological and measurement differences between the two prevent direct comparison of precise figures, the OECD–FAO projections nevertheless confirm the trends indicated by the longer-term IFPRI projections. In spite of low economic growth in the first part of the projection period, OECD–FAO expect demand to continue growing, especially in the developing countries, driven by increasing purchasing power, population growth and urbanization. However, global meat consumption is expected to expand by an overall 19 percent compared with the base period, a slightly lower rate than over the previous decade (22 percent). Most of the increase is projected to occur in developing countries, with meat intake growing by 28 percent, compared with 10 percent at most in the developed and OECD countries. The increase is explained in part by population growth, but mostly reflects an increase in per capita consumption in developing countries of 14 percent – from 24 kg per person per year to more than 27 kg per person per year. Per capita consumption in developed countries is projected to increase by only 7 percent, from 65 kg to 69 kg. The smallest increase, of only around 3.5 percent, is projected for the OECD countries. Globally, demand for poultry is expected to continue to show the strongest growth.

According to the OECD–FAO projections from 2009 to 2018, 87 percent of global growth in meat production will occur outside the OECD area. For the developing countries, an overall increase in meat production of 32 percent is foreseen over the projection period.

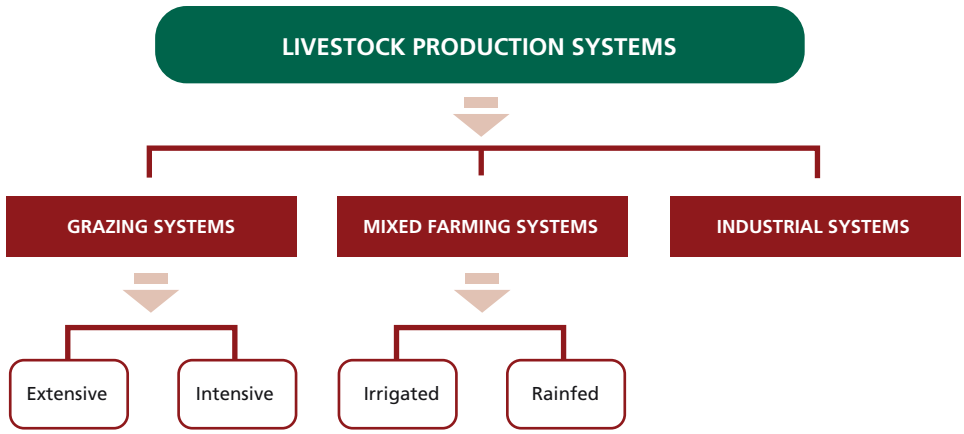
The OECD–FAO projections for dairy suggest that demand, both per capita and overall, will continue to grow. The most rapid growth will occur in developing countries, where per capita demand is expected to

TABLE 6
Meat consumption by region, 2000 and 2050 (projected)

	PER CAPITA CONSUMPTION OF MEAT	
	2000	2050
	(kg/person/year)	
Central and West Asia and North Africa	20	33
East and South Asia and the Pacific	28	51
Latin America and the Caribbean	58	77
North America and Europe	83	89
Sub-Saharan Africa	11	22

Source: Rosegrant and Thornton, 2008.

FIGURE 10
Classification of livestock production systems



Source: FAO.

increase at an annual rate of 1.2 percent. Overall production growth is projected at 1.7 percent per year from 2009 to 2018, with much of the increase coming from developing countries.

Feed demand is also projected to continue increasing. Use of coarse grains as feed is expected to grow by 1.2 percent a year. The total increase will amount to 79 million tonnes, to a total of 716 million tonnes, with most of the increase in developing countries. The projection excludes distiller dried grain (DDG), a by-product from ethanol production (see Box 10, page 54). Higher feed prices may lead to slower demand growth in the developing countries. Use of wheat as feed is also projected to increase slightly. Demand for oilseed meal is projected to grow by an annual rate of 3.8 percent in the non-OECD countries and 0.7 percent in the OECD countries. This, however, is only half the rate of growth seen in the previous decade.

Livestock sector diversity

The rapid growth of the livestock sector and projections for continued expansion are affecting the sector's structure. The livestock sector is characterized by large variations in the scale and intensity of production and in the nature and degree of linkages with the broader agricultural and rural economy. Further variation is found by species, location, agro-ecological conditions, technology and level of economic development. No single classification system can capture all of this diversity. This report uses a simplified classification that distinguishes between grazing, mixed farming and industrial production systems (Figure 10). Estimates of livestock numbers and production from different production systems are given in Table 7.

Looser terms such as "modern" and "traditional" are also used in this report to distinguish between parts of the livestock sector that have undergone greater or lesser degrees of economic and technological transformation in recent decades. Industrial systems are generally described as modern, although some grazing and mixed systems also use modern techniques such as breed selection and herd management. These terms are used to facilitate a comparative discussion of the costs, benefits and trade-offs implied by different systems for food security and livelihoods, environmental sustainability and human health, not to suggest that one is preferable to the other.

Grazing systems

Grazing systems cover the largest land area and are currently estimated to occupy some 26 percent of the earth's ice-free land surface (Steinfeld *et al.*, 2006).

TABLE 7
Global livestock population and production, by production system, average 2001–2003

	LIVESTOCK PRODUCTION SYSTEM				
	Grazing	Rainfed mixed	Irrigated mixed	Landless/ industrial	Total
			(Million head)		
POPULATION					
Cattle and buffaloes	406	641	450	29	1 526
Sheep and goats	590	632	546	9	1 777
			(Million tonnes)		
PRODUCTION					
Beef	14.6	29.3	12.9	3.9	60.7
Mutton	3.8	4.0	4.0	0.1	11.9
Pork	0.8	12.5	29.1	52.8	95.2
Poultry meat	1.2	8.0	11.7	52.8	73.7
Milk	71.5	319.2	203.7	–	594.4
Eggs	0.5	5.6	17.1	35.7	58.9

Source: Steinfeld *et al.*, 2006, p. 53.

- *Extensive grazing systems* cover most of the dry areas of the world that are marginal for crop production. Such areas tend to be sparsely populated and include, for example, the dry tropics and continental climates of southern Africa, central, eastern and western Asia, Australia and western North America. These systems are characterized by ruminants (e.g. cattle, sheep, goats and camels) grazing mainly grasses and other herbaceous plants, often on communal or open-access areas and often in a mobile fashion. The main products of these systems include about 7 percent of global beef production, about 12 percent of sheep and goat meat production and 5 percent of global milk supply.
- *Intensive grazing systems* are found in temperate zones where high-quality grassland and fodder production can support larger numbers of animals. These areas tend to have medium to high human population density and include most of Europe, North America, South America, parts of Oceania and some parts of the humid tropics. These systems are characterized by cattle (dairy and beef) and are based mostly on individual landownership. They contribute about 17 percent of global beef and veal supply, about the same share of the sheep and goat meat supply and 7 percent of global milk supply as their main outputs.

Mixed farming systems

In mixed farming systems, cropping and livestock rearing are linked activities. Mixed farming systems are defined as those systems in which more than 10 percent of the dry matter fed to animals comes from crop by-products or stubble or where more than 10 percent of the total value of production comes from non-livestock farming activities.

- *Rainfed mixed farming systems* are found in temperate regions of Europe and the Americas and subhumid regions of tropical Africa and Latin America. They are characterized by individual ownership, often with more than one species of livestock. Globally, around 48 percent of global beef production, 53 percent of milk production and 33 percent of mutton production

originates from this type of production system.

- *Irrigated mixed farming systems* prevail in East and South Asia, mostly in areas with high population density. They are an important contributor to most animal products, providing about one-third of the world's pork, mutton and milk and one-fifth of its beef.

Industrial production systems

Industrial systems are defined as those systems that purchase at least 90 percent of their feed from other enterprises. Such systems are mostly intensive and are often found near large urban centres. Industrial systems are common in Europe and North America and in parts of East and Southeast Asia, Latin America and the Near East. They often consist of a single species (beef cattle, pigs or poultry) fed on feed (grain and industrial by-products purchased from outside the farm). They contribute slightly more than two-thirds of global production of poultry meat, slightly less than two-thirds of egg production and more than half of world output of pork, but are less significant in terms of ruminant production. These systems are sometimes described as "landless" because the animals are physically separated from the land that supports them. However, about 33 percent of global agricultural cropland is used to produce animal feed (Steinfeld *et al*., 2006), so the term "landless" is somewhat misleading.

Transformation of livestock systems

Growing demand for livestock products and technological change have led to widespread changes in livestock production systems. This has radically affected the structure of the most advanced parts of the livestock production sector in both developed countries and parts of the developing world. There has been a rapid growth in the average size of primary production units and a shift towards fewer and larger firms in many parts of the world. One major reason for this is that larger operations are better placed to benefit from technical advances and economies of scale, such as those embodied in improved genetics, compound feeds or greater organization, especially in poultry and pig production.

Worldwide, much of the response to growing livestock demand has been through industrialized production. Large production units have a clear comparative advantage over smaller units in moving towards a global commercial market. There are a number of reasons for this. Concentration in the input and processing sector combined with vertical integration leads to increasing farm size because larger integrators prefer to deal with larger production units. In the short term, contract farming may benefit smallholders, but over the long term, integrators prefer to deal with a few large producers rather than a large number of small producers. This is most evident in pig and poultry production, where processors demand large quantities of supply at a consistent standard (Sones and Dijkman, 2008). Box 3 discusses the impact of coordination in value chains on livestock production systems.

Different commodities and different steps in the production process offer different potential for economies of scale. The potential tends to be high in post-harvest sectors, e.g. for facilities such as slaughterhouses and dairy processing plants. Poultry production is the most easily mechanized livestock production enterprise, and industrial forms of poultry production have emerged in even the LDCs. In contrast, dairy production offers fewer economies of scale because of its typically high labour requirement. For dairy and small ruminant production, farm-level production costs at the smallholder level are often comparable with those of large-scale enterprises, usually because of the cost advantages of providing family labour at well below the minimum wage.

The organization of livestock production has implications for the way the sector interacts with the natural-resource base and for the management of animal diseases and human-health risks. Structural transformation of the sector can have an impact on livelihoods, especially in rural areas. The degree to which smallholders can take advantage of the growing demand for livestock products, and the extent to which they have done so, is an important factor that must be taken into account in livestock development efforts.

BOX 3
Coordination in livestock value chains

Value chains for livestock products, especially meat, are very complex. This complexity begins at the production level, which depends on a feed supply chain that must ensure a timely supply of safe inputs. It continues through processing and retailing; these involve many steps and food items of animal origin are often more perishable than crop-based foods. The resulting interdependence among the companies in the food supply chain for animal products exerts substantial pressure for coordination beyond that provided by cash market transactions.

Companies in a food supply chain may put in place vertical coordinating mechanisms such as contracts, licences and strategic alliances to manage relationships with suppliers and customers. Firms operating at the same stage within the value chain may establish horizontal relationships in the form of cooperative groups for dealing with down- and up-stream business partners and for ensuring product quality.

Contracts are the most common mechanism for vertical coordination. For primary producers, contracts allow the establishment of more secure relationships with business partners, both to guarantee a price prior to selling or buying, thereby reducing market risks regarding price, and to specify quantity and quality. From the point of view of the contractor/buyer, contracts provide for much closer linkages with farmers and may offer them greater control over production decisions of the farmers. Selling contracts may be entered into with down-stream processors such as packing companies, while up-stream agreements may be in place between, for instance, the feed industry and animal producers.

Vertical integration entails a closer degree of coordination and occurs when two or more successive stages of the food supply chain are controlled and carried out by a single firm. In the extreme, the entire chain can be integrated. Examples of such vertical integration include companies that link farms and buying entities. Meat packers often own pig farms and cattle feedlots and dairy farmers may produce their own feed instead of buying it. In the case of vertically integrated firms, product transfers are determined by internal decisions rather than through market prices.

Horizontal coordination may also be necessary for a well-functioning supply chain. Processors can reduce transaction costs by dealing with one farm organization, such as a cooperative, instead of many small-scale farms. Cooperative organization can bring three main types of benefits to farmers: arranging for the selling of farmers' produce to down-stream business; exchange of information with partners in the food supply chain and its dissemination among the farmers; and providing advice to farmers on how to achieve the required levels of quality of the raw product. In many of the least-developed countries, cooperatives are crucial for small-scale farms to remain in business and, perhaps, to keep farmers out of poverty.

Source: Based on Frohberg, 2009.

From smallholder mixed systems to large-scale commodity-specific systems

The modern livestock sector is characterized by large-scale operations with intensive use of inputs, technology and capital and increased specialization of production units focusing on single-product operations. This is accompanied by the progressive substitution of non-traded inputs in favour of purchased inputs. Feed inputs are sourced off-farm, either domestically or internationally. Mechanical technologies substitute for human labour, with labour being used as a source of technical knowledge and for management. The move towards modern production systems has implied a decline in

TABLE 8
Use of feed concentrate by region, 1980 and 2005

REGION/COUNTRY GROUP/COUNTRY	TOTAL FEED CONCENTRATE	
	1980	2005
	(Million tonnes)	
DEVELOPED COUNTRIES	**668.7**	**647.4**
Former centrally planned economies	296.5	171.9
Other developed countries	372.2	475.4
DEVELOPING COUNTRIES	**239.6**	**602.7**
East and Southeast Asia	113.7	321.0
China	86.0	241.4
Rest of East and Southeast Asia	27.7	79.6
Latin America and the Caribbean	64.3	114.1
Brazil	33.4	54.9
Rest of Latin America and the Caribbean	30.9	59.3
South Asia	20.9	49.7
India	15.5	37.1
Rest of South Asia	5.4	12.6
Near East and North Africa	25.8	70.1
Sub-Saharan Africa	15.0	47.6
WORLD	**908.4**	**1 250.1**

Source: FAO, 2009b.

integrated mixed farming systems and their replacement by specialized enterprises. In this process, the livestock sector changes from being multifunctional to commodity-specific. There is a decline in the importance of traditionally important livestock functions, such as provision of draught power and manure, acting as assets and insurance, and serving sociocultural functions. Livestock production is thus no longer part of integrated production systems, based on local resources with non-food outputs serving as inputs in other production activities within the system.

From roughages to concentrate feeds

As livestock production grows and intensifies, it depends less and less on locally available feed and increasingly on feed concentrates that are traded domestically and internationally. There is a shift from the use of low-quality roughages (crop residues and natural pasture) towards high-quality agro-industrial by-products and concentrates. Use of feed concentrate in developing countries more than doubled between 1980 and 2005 (Table 8). In 2005, a total of 742 million tonnes of cereals were fed to livestock, representing roughly one-third of the global cereal harvest and an even larger share of coarse grains (Table 9).

The dominance of concentrate feeds has meant that livestock production is no longer constrained by local availability of feed and the natural resources needed to provide it. As a result, the impact of production on natural resources is partly removed from the location of livestock production and transferred to where the feed is produced.

Increased use of concentrate feed explains the rapid growth in production of monogastrics, especially poultry. When livestock are no longer reliant on local resources or waste from other activities as feed, the rate at which feed is converted into livestock outputs becomes a critical factor in the economic efficiency of production. In this respect, monogastrics, with their better feed conversion ratios, have a distinct advantage over ruminants.

TABLE 9
Use of feed concentrate by commodity group, 2005

COMMODITY GROUP	FEED CONCENTRATE USE IN 2005		
	Developing countries	Developed countries	World
	(Million tonnes)		
Cereals	284.2	457.7	741.9
Brans	71.2	34.5	105.7
Pulses	6.8	7.3	14.2
Oilcrops	13.4	14.3	27.6
Oilcake	113.2	101.7	214.9
Roots and tubers	111.2	30.8	142.0
Fishmeal	2.7	1.1	3.8
Total	**602.7**	**647.4**	**1 250.1**

Source: FAO, 2009b.

From dispersed to concentrated production

The consolidation of livestock production activities, principally those associated with monogastrics, has affected the geography of animal populations and production.

When livestock production was based on locally available feed resources, such as natural pasture and crop residues, the distribution of ruminants was almost completely determined by the availability of such resources. The distribution of pigs and poultry followed closely that of humans, because of their role in converting agricultural and household wastes. With the increasing use of bought-in feed, especially concentrates, the importance of agro-ecological conditions as a determinant of location is replaced by factors such as opportunity cost of land and access to output and input markets.

Large-scale operators emerge as soon as urbanization, economic growth and rising incomes translate into "bulk" demand for foods of animal origin. Initially, these are located close to towns and cities. Livestock products are among the most perishable foods, and their conservation without chilling and processing poses serious quality and human-health risks. Therefore, livestock have to be kept close to the location of demand. At a later stage, following development of infrastructure and technology for transporting inputs and products and for processing and preserving outputs, livestock production may shift away from demand centres. Factors such as lower land and labour prices, easier access to feed sources, lower environmental standards, fewer disease problems and tax incentives facilitate this shift.

As a result of such processes, livestock production has become more geographically clustered, with production units and associated processing centres and supporting infrastructure located close together. In parallel with changes in the structure of production, slaughterhouses and processing plants have increased in size and are increasingly located in the area of production.

In traditional mixed or pastoral production systems, non-food outputs such as manure are important inputs in other production activities. Concentration has meant that these outputs are often seen as wastes that must be disposed of. In addition, increasing concentration of animals, often in close proximity to major centres of human population, may exacerbate problems of animal diseases and related human-health risks.

Challenges from continued livestock sector growth

Continued growth in demand for and production of livestock products clearly has significant long-term implications in three areas that require attention. It implies increasing pressures on the world's

natural resources as feed demand grows and livestock production is increasingly decoupled from the local natural-resource base. It has implications for both animal and human health as the number and concentration of people and animals increases, because some disease agents pass easily between species. Finally, the social implications for smallholders, whose opportunities to supply new markets are constrained, pose serious policy challenges.

The likely continuing rapid expansion of the livestock sector highlights the critical issues for the future of the sector that require the attention of national governments and the international community. These include harnessing the potential for growing livestock demand to contribute to poverty alleviation and improved food security, increasing the sustainability of natural-resource use and improving efforts to manage animal diseases.

Key messages of the chapter

- The livestock sector is large and growing rapidly in a number of developing countries, driven by growth in incomes, population and urbanization. The potential for increasing demand for livestock products is substantial and implies challenges in terms of efficient use of natural resources, managing animal- and human-health risks, alleviating poverty and ensuring food security.
- Growing demand for livestock products and the implementation of technological changes along the food chain have spurred major changes in livestock production systems. Small-scale mixed production systems are facing increased competition from large-scale specialized production units based on purchased inputs. These trends present major competitive challenges for smallholders and have implications for the ability of the sector to promote poverty reduction.
- The shift from small-scale mixed production systems, based on locally available resources, to large-scale industrial systems has also changed the location of livestock production units. As the constraint of locally available natural resources is removed, the spatial distribution of livestock production facilities is becoming more clustered to exploit linkages along the supply chain. This has increased the efficiency of production but has implications for natural-resource use.
- The increasing concentration of production and growth in trade are leading to new challenges in the management of animal diseases.