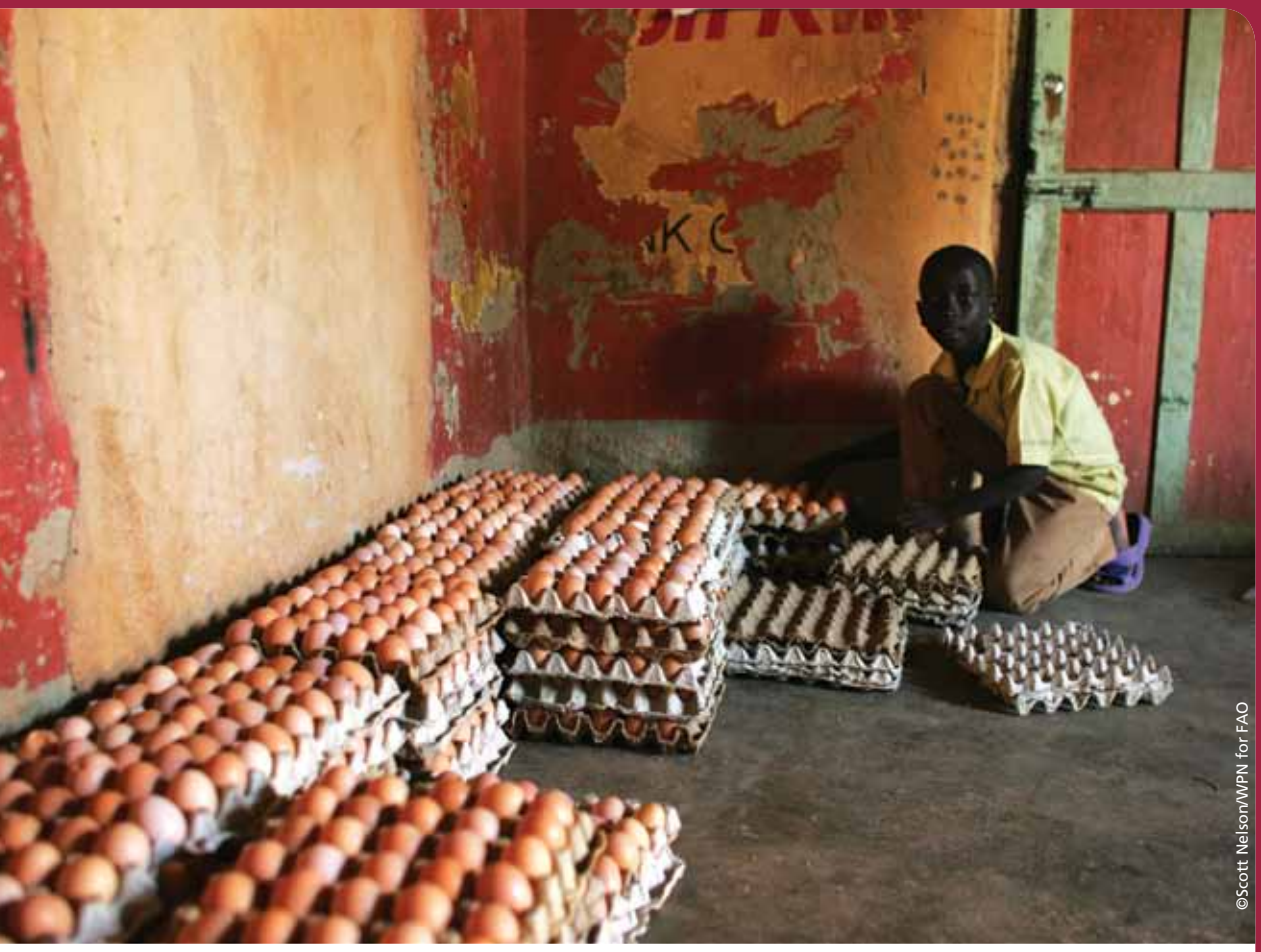


©Scott Nelson/WPN for FAO

Livestock and global food security

©FAO/Vasily Maximov

Measuring food security

In 1996, the World Food Summit Rome Declaration set a target to reduce hunger by half by 2015.

In 2000, the United Nations Millennium Summit re-affirmed the target, making the halving of extreme hunger and poverty its primary Millennium Development Goal (MDG).

Notwithstanding these optimistic goals, in 2010, 925 million of the world's inhabitants still suffered from chronic hunger, and world food security was an uncertain prospect. Predictions concerning future food security must factor in assumptions about the growth of the economy, the distribution of income, the possibility of dealing with environmental challenges, and the political and logistical capacity to make food accessible everywhere, to everyone.

SIX DIMENSIONS

FAO defines four "pillars" of food security and two temporal dimensions related to food insecurity, all of which must be addressed in efforts to reach hunger reduction targets. The four pillars, detailed in Box 1, include: **food availability** which refers to food supply, and **food access** which means the ability of people to obtain food when it is available. As both availability and access must be stable, the third pillar, **stability**, refers to ensuring adequate food at all times while the fourth, **utilization**, incorporates food safety and nutritional well being.

Pillars. Paying simultaneous attention to all four pillars is a constant challenge. Sufficient food can be produced today to feed everyone in the world, but it is not always available in every country, let alone every community. Some countries produce enough food to be self sufficient while others rely on imports, meaning that when international prices rise or global value chains break down, the food supply becomes unstable. Even when food is available, many people cannot afford to buy what they need for a healthy diet and, in parallel, prices that can be paid by the poorest consumers may not be sufficient to provide a living for producers. Waste in food chains from oversupply and spoilage adds to costs and reduces the amount available to eat.

BOX 1

FOUR PILLARS OF FOOD SECURITY

Food Availability: The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports (including food aid).

Food access: Access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet. Entitlements are defined as the set of all commodity bundles over which a person can establish command given the legal, political, economic and social arrangements of the community in which they live (including traditional rights such as access to common resources).

Stability: To be food secure, a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity). The concept of stability can therefore refer to both the availability and access dimensions of food security.

Utilization: Utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. This brings out the importance of non-food inputs in food security.

Source: FAO, 2006a.

Food security problems also arise when people lack knowledge about nutrition, food handling and preparation, lack access to clean water and sanitation or when their food supplies change and they have to deal with unfamiliar foodstuffs.

Every major conflict in history has destabilized local food supplies, often with wide ripple effects. So have crop and livestock pests and diseases, and natural disasters such as recurring drought in Ethiopia, annual floods in Bangladesh, earthquakes in Pakistan and Indonesia, and the 2010 fires that affected the Russian wheat crop. Fluctuating economic conditions drive vulnerable families below the poverty line and send them into food security crises, putting a strain on existing safety nets. For a middle class population with solid economic resources, a temporary rise in prices or a fluctuation in the food supply may be merely inconvenient – people must drive further to buy preferred foods, or divert a little more of their income into food purchases, or eat something different – but for vulnerable households, it creates a food security crisis.

Dimensions. The temporal dimensions normally refer to food insecurity, which can be **chronic**, resulting from a persistent shortage in supply or a systemic weakness that limits individuals' ability to access food, or **transitory**, arising because of a crisis. Both need to be addressed at the same time (Pingali *et al.*, 2005), because individuals and communities facing chronic food insecurity lack safety nets and are highly vulnerable to transitory problems, while an inappropriate response to a crisis may weaken the base for long-term food security by weakening local markets or creating dependencies. In 2005, the Committee on World Food Security (CFS, 2005) identified conflict as the most common cause of transitory food insecurity, followed by weather-related problems. In 2008 and 2009, the food security repercussions of the world economic crisis were a serious cause for concern (FAO, 2009a). As a result of transitory problems starting to blur into chronic food insecurity – mainly due to long-term systemic failures in the way that food is produced and distributed – the world is now facing the problem of protracted food crises (FAO, 2010a).

BOX 2

DEALING WITH PROTRACTED FOOD CRISIS: THE CASE OF ETHIOPIA

In Ethiopia, where crop failure is an almost annual phenomenon, some 7 million people – more than 8 percent of the country's population – can support themselves from their own income for only six months a year. For the remaining six months, they rely on a recently introduced Productive Safety Net Programme that addresses the underlying structural problem of food insecurity by putting safety nets in place ahead of crises, such as by guaranteeing employment in public works for food or cash and direct subsistence payments. Supplying predictable disbursements of cash and food transfers at frequent intervals, as opposed to unpredictable disbursements at varying intervals, seems to have reduced the need to sell assets (especially livestock) to buy food, leaving people less prone to destitution from adverse weather events. However, even this could not provide ample protection from the soaring food prices and the drop in foreign investment and remittances that followed the 2007–08 economic crisis. (FAO, 2009a).

Long-term goals. The various pillars and dimensions of food security are encapsulated in two long-term goals that preoccupy the international community: **sustainable healthy diets** and **resilient food systems** (sometimes combined as sustainable and resilient food systems).

Sustainable healthy diets can be attainable if all of the conditions for food security are met in ways that do not unduly deplete natural resources or pollute the environment. "Sustainable" means that both present and future generations have sufficient food of adequate nutritional quality to promote their well-being (Pinstrup-Andersen, 2009; Harding, 2010). Under these conditions, food systems would have sufficient capacity to produce enough food of sufficient variety consistently, transport it with minimum waste to where it is needed, provide it at prices that people can afford while also covering the costs of the externalities associated with food production, and to promote healthy choices in buying and preparing food. Currently, we face a growing population, finite fossil energy and water, and competition for land needed to produce human food, biofuel and livestock feed. For food systems to be sustainable, there is a need to address the structural and policy weaknesses that have contributed to creating the present situation.

Resilient food systems are those that withstand shocks from conflict, weather, economic crises, human or livestock diseases and crop pests. It is well recognized by relief agencies that their emergency aid efforts are most effective when they are injected into already resilient systems in ways that create minimum disruption. A more resilient global food system, therefore, would reduce the level and impact of transitory food insecurity. The food systems of developed countries are generally resilient, underpinned by strong economies and infrastructure, while those of most developing countries are not.

MEASURES

There is no one method to measure all of food security's dimensions, determine whether a food system is sustainable and resilient, and quantify the extent to which everyone in the world is consistently well nourished. Thus, it is necessary to rely on a range of measures that address the various aspects of food security.

The most direct, widely available and uniform measurement quantifies the consumption of calories – people who consume insufficient calories for their age and sex are considered undernourished. When the target was set in 1996 to halve hunger by 2015, there was already a promising trend in combating undernutrition. The number of undernourished people, standing at close to a billion in 1970, fell to 900 million in 1980, and to 845 million in 1990–92 (Table 1). Numbers stayed fairly static for the next ten years, rising

TABLE 1
NUMBER (MILLIONS) AND SHARE OF UNDERNOURISHED PEOPLE BY REGION 1990 TO 2007

COUNTRY GROUPS	1990–1992	1995–1997	2000–2002	2005–2007
World	843.4	787.5	833.0	847.5
Developed countries	16.7	19.4	17.0	12.3
	(2.0%)	*(2.5%)*	*(2.0%)*	*(1.5%)*
Developing World	826.6	768.1	816.0	835.2
	(98.0%)	*(97.5%)*	*(98.0%)*	*(98.5%)*
Asia and the Pacific	587.9	498.1	531.8	554.5
	(69.7%)	*(63.3%)*	*(63.8%)*	*(65.4%)*
Latin America and the Caribbean	54.3	53.3	50.7	47.1
	(6.4%)	*(6.8%)*	*(6.1%)*	*(5.6%)*
Near East and North Africa	19.6	29.5	31.8	32.4
	(2.3%)	*(3.7%)*	*(3.8%)*	*(3.8%)*
Sub-Saharan Africa	164.9	187.2	201.7	201.2
	(19.6%)	*(23.8%)*	*(24.2%)*	*(23.7%)*

Note: Percentages are share of total for the year.
Source: FAOSTAT.

slightly to 873 million in 2005. In percentage terms, the numbers were even more encouraging. In 1980, 28 percent of the world's population was undernourished. By 1990–92, the average had fallen to 16 percent for the world and 20 percent for developing countries, and in 2005–07 (the latest period for which comparable statistics are available), the figures stood at 13 percent for world population and 16 percent for developing countries (FAO, 2008a).

Since then, two global problems – increasing demand for biofuel and the world economic crisis – have created a serious block to halving hunger. Competition between food and fuel crops together with other factors resulted in rises in food prices in 2007 and the wider economic crisis that immediately followed reduced purchasing power. According to estimates, approximately 925 million people were undernourished in 2010, representing roughly 14 percent of the world's population of 6.8 billion. FAO databases show that undernourishment is unevenly distributed across regions, nations, households and individuals, with the main burden borne by the poorest countries and the poorest people.

Undernourishment is an important indicator of food insecurity, but it only tells part of the story. Food security is more than the consumption of sufficient calories; it is also about consuming food of adequate quality. People are malnourished if they eat insufficient calories or protein, food of poor quality, or if they are unable to utilize fully the food they eat (WHO, 2001). Diets can be poor if they lack minerals and vitamins, have insufficient fruits, vegetables or livestock products, or contain too much of elements that are harmful when taken in excess such as saturated fats and sugar (IFPRI, 2004). While 925 million people were undernourished in 2010, some 2 billion were estimated to be malnourished. Unlike undernourishment, which is associated with poverty, the problem of malnourishment is found across all income groups, although it takes different forms for the poor and the rich. The poorest lack an adequate supply of energy, protein and micronutrients, while for those who can afford sufficient calories, overconsumption and poorly balanced diets, together with their associated health problems, are an increasing problem (WHO, 2003).

BOX 3

COSTS OF MALNUTRITION

Preventing one child from being born with low birth weight in low-income countries was estimated to be worth US$580 in 2003 (Alderman and Behrman, 2003).

- In Nigeria, the annual economic loss due to malnutrition in children under five was estimated at US$489 million in 1994, or about 1.5 percent of GDP (FAO, 2004).
- In South Asia, the losses associated with iron deficiency have been estimated at US$5 million per year (Ross and Horton, 1998).
- In Bangladesh, the cost of iron deficiency in children has been estimated at nearly 2 percent of GDP (Ross and Horton, 1998).
- In India, elimination of child malnutrition would increase national income by US$28 billion. This is more than its combined expenditures for nutrition, health, and education.
- Diet-related chronic diseases were estimated to cost 2.1 percent of China's GDP in 1995 and 0.3 percent of Sri Lanka's (Popkin *et al.*, 2001).
- The cost of obesity has been estimated at 0.2 percent of GDP for Germany, 0.6 percent for Switzerland, 1.2 percent for the United States (WHO, 2007), 1 percent for Latin America and the Caribbean (PAHO, 2006), 1.1 percent for India, 1.2 percent for the USA and 2.1 percent for China (Yach *et al.*, 2006).
- The cost of diabetes has been estimated at 1.3 percent of GDP for the USA, 2.6 percent for Mexico and 3.8 percent for Brazil (Yach *et al.*, 2006).

Malnourishment is harder to measure than undernourishment, since it requires data on protein and micronutrients which are not routinely measured on a wide scale. Rough estimates can be made from the kilograms of different foods consumed and their average content of different nutrients. More commonly, malnourishment levels are deduced indirectly from proxy measures that show its resulting effects.

Malnutrition has a devastating effect on child survival, particularly in developing countries. It has been estimated that protein-energy malnutrition is a causative factor in 49 percent of the approximately 10.4 million annual deaths of children under five years of age (WHO, 2000). It is also manifested in underweight and stunting. In 2007, UNICEF estimated that approximately 146 million children were underweight (UNICEF, 2007), over 70 percent of them in developing countries, and that 31.2 percent of children in developing countries were stunted (UNSC, 2010). This represented an improvement since 1980, when 49 percent of children under five in the developing world were stunted, and 38 percent were underweight (Opio, 2007).

At the other end of the scale, over-consumption can be deduced from statistics on obesity, defined as having a Body Mass Index (BMI), which measures body fat based on weight and height, of 30 or above. The most recent WHO global summary suggests that in 2008, at least 500 million adults were clinically obese (WHO, 2100), a figure which may rise to 700 million in 2015. Obesity is linked to diabetes and heart disease and possibly certain kinds of cancer.

Malnutrition not only affects an individual's health, it is expensive for society. It reduces human productivity and creates costs for the health system, as shown in Box 3. A conservative estimate in 1990 put the global economic loss from malnutrition at US$8.7 billion (Pinstrup-Andersen *et al.*, 1993).

The sustainability and resilience of food systems can be measured by a variety of qualitative and quantitative indicators, such as:

- trends in production and consumption levels per person as well as patterns of consumption among different income groups which give a general indication of resilience;
- long- and short-term trends in food prices and livestock disease prevalence which provide information about potential sources of food instability;
- information about water quality and other environmental indicators which provide underlying information about the resource base on which food production depends.

Key indicators can differ with individual national and local situations. For example, a country that relies on domestic production for the bulk of its food supply may be primarily concerned with measuring the ability of its own agricultural system to keep producing a stable supply or to store buffers against shocks, while a country that expects to import a proportion of its food every year will be equally concerned with the robustness of the international trade system and the political capital that gives access to food aid in times of crisis.

In rangeland areas of Africa, the terms of trade between livestock and food grains are an indicator of prolonged food emergencies because, as a crisis continues, more and more animals need to be sold to buy the same amount of grain. The EC-FAO Food Security Programme has developed a "resilience tool" to help policy-makers understand what makes families more resilient to crises. This tool combines several factors into an index, including income and access to food; assets such as land and livestock; social safety nets such as food assistance and social security; access to basic services such as water, health care and electricity; household adaptive capacity which is linked to education and diversity of income sources; and the stability of all these factors over time.

©FAO/L. Rlung

Livestock food in the diet

Animal source foods, a choice for many people in many societies, add taste, texture and variety to the diet. Some foods have specific social and cultural roles, such as turkey at Christmas, a duck taken as a gift on a social visit, eggs or milk given to lactating mothers, meat cooked for honoured visitors, tea with milk given to guests. Cultural norms also prohibit consumption of some foods, such as pork in Muslim and Jewish communities. Livestock contribute around 12.9 percent of global calories and 27.9 percent of protein directly through provision of meat, milk, eggs and offal, and also contribute to crop production through the provision of transport and manure.

NUTRITIONAL VALUE

In spite of recent growth in consumption, many people are still deficient in the nutrients that can be provided by animal source foods, which are complete, nutrient-dense and important for the high quality protein and bio-available micronutrients they contain, particularly for children and pregnant and lactating women. Even quite small amounts of animal source foods are important for improving the nutritional status of low-income households. Meat, milk and eggs provide proteins with a wide range of amino acids that match human needs as well as bio-available micro-nutrients such as iron, zinc, vitamin A, vitamin B12 and calcium in which many malnourished people are deficient.

It is generally agreed that livestock source foods can be beneficial, but there are no universal guidelines that set an ideal level of consumption of livestock products for an individual. International dietary guidelines on levels of energy and protein consumption do not distinguish between plant and animal sources. They suggest that the intake of energy needed by an adult in a day varies from 1 680 to 1 990 kilocalories (kcals) in total, depending on the country. They also suggest that the safe level of protein consumption is about 58 g per adult per day. “Safe” in this case is defined as the average protein requirement of the individuals in the population, plus twice the standard deviation and it is an accepted practice to refer to this measure rather than a minimum (WHO, FAO, UNU, 2007).

TABLE 2
AVERAGE DIETARY PROTEIN AND ENERGY CONSUMPTION AND UNDERNOURISHMENT BY REGION

COUNTRY GROUPS	PROTEIN CONSUMPTION *g/day 2003–05*	ENERGY CONSUMPTION *kcals/day 2005–07*	PERCENT OF POPULATION CONSUMING INSUFFICIENT CALORIES *2005–07*
World	76	2 780	13
Developed countries	102	3 420	<5
Developing World	70	2 630	16
United States of America	116	3 770	<5
Asia, the Pacific and Oceania	70	2 610	16
Latin America and the Caribbean	79	2 900	8
Near East and North Africa	83	3 130	7
Sub-Saharan Africa	53	2 240	28
Recommended "safe" consumption (adults)	58		
Minimum energy requirement		1 680–1 990	

Sources: FAOSTAT for all except "safe" consumption. Recommended "safe" consumption is estimated as the minimum average plus 2x standard deviation WHO, FAO, UNU (2007).

In most parts of the world, average consumption is above the minimum recommended level of energy and the safe level of protein, according to the most recent comparable consumption statistics. As shown in Table 2, only in sub-Saharan Africa is the average consumption of protein below the recommended safe levels. However, these averages hide a significant problem of malnutrition, with 16 percent of people in the developing world (28 percent in sub-Saharan Africa) estimated to be undernourished. Energy and protein consumption are quite closely linked, and insufficient calorie consumption tends to go in tandem with insufficient protein consumption.

These are average guidelines. Actual individual requirements depend on height, age, lifestyle and stage of life. Pregnant or lactating women, for example, need extra energy and protein. However, even the more detailed guidelines give only limited guidance about minimum requirements of livestock source food. National nutritional guides, such as those provided in the USA or the Netherlands, suggest including some livestock products in the diet but recommend that the largest proportion of food by weight should be in the form of fruit, vegetables and grains.

Excessive or inappropriate intake of livestock products creates risks and detrimental health effects. Increased consumption of red meats can increase the risk of colon cancer, and increased intake of saturated fats and cholesterol from meat, dairy products and eggs can increase the risk of chronic non-communicable diseases such as cardiovascular disease (UNSCN, 2005). National dietary guidelines typically warn against consumption of too much animal fat from meat and hard cheese and suggest a balance between livestock products and fish.

Since protein with a wide range of amino acids is a valuable dietary contribution from livestock, the range in livestock protein intake levels according to geographic area is worth examining. Table 3 shows that the consumption per person of livestock protein increased in all areas of the world between 1995 and 2005. However, it also shows that average consumption in Africa remained at less than a quarter of that in the Americas, Europe and Oceania, and Africa's livestock protein consumption was a modest 17 percent of the recommended safe level for all proteins. By contrast, the consumption of livestock protein in the Americas, Europe and Oceania in

TABLE 3
AVERAGE DAILY CONSUMPTION PER PERSON OF LIVESTOCK PROTEIN COMPARED TO SAFE LEVEL 1995 AND 2005

AREA	YEAR	G/DAY				% OF RECOMMENDED "SAFE"[1] CONSUMPTION FROM LIVESTOCK
		MEAT	DAIRY (NOT BUTTER)	EGGS	TOTAL	
Africa	1995	5.3	3.1	0.6	9	
	2005	5.9	3.4	0.6	9.9	17
Americas	1995	26.1	14.3	2.7	43.1	
	2005	28.1	14.1	3.1	45.3	78
Asia	1995	7.5	3.8	2.2	13.5	
	2005	9.2	4.7	2.7	16.6	29
Europe	1995	24.1	17.9	3.6	45.6	
	2005	24.7	19.2	3.8	47.7	82
Oceania	1995	24.9	18	1.9	44.8	
	2005	39.3	15.8	1.7	56.8	98
Least developed countries	1995	3.3	2.2	0.2	5.7	
	2005	4.1	2.7	0.3	7.1	12

Source: FAOSTAT for consumption figures.
[1] Recommended "safe" consumption is 58 g per person per day, estimated as the minimum average plus 2x standard deviation (WHO, FAO, UNU, 2007).

2005 was between 78 and 98 percent of the total protein requirement, suggesting that livestock products were being over-consumed. The high level of meat and saturated fat consumption in high-income countries has been associated with high rates of cardiovascular disease, diabetes and some cancers (Walker, 2005).

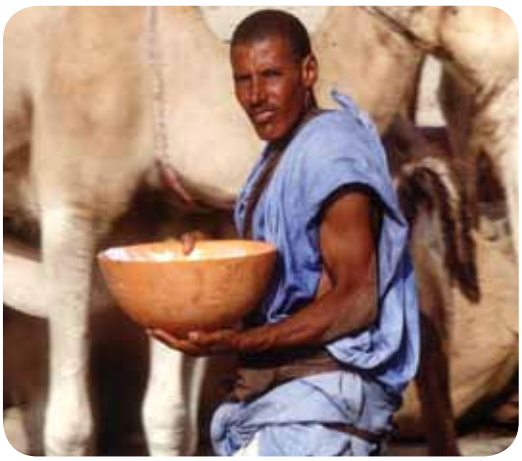
Even in small amounts, food of animal origin can play an important role in improving the nutritional status of low income households by addressing micro- and macronutrient deficiencies, particularly of children and pregnant and lactating women. It is possible to live healthily without eating animal products, but they do provide nutritional benefits, particularly through micronutrients. Small amounts of meat, for example, provide easily absorbable haem iron and help in the absorption of iron from plant foods (Bender, 1992), which helps prevent anaemia arising from iron deficiency. Meat and milk are good sources of vitamin B12, riboflavin and vitamin A. Meat also provides zinc, and milk provides calcium. Adding a small amount of animal source food to the diets of malnourished children can increase their energy and cognitive ability (Neuman *et al.*, 2010). However, it is important that babies receive human milk up to age 6 months, rather than a livestock source substitute (Neuman, 1999). Iron deficiency, for example, is estimated to affect 1.6 billion people worldwide (deBenoist *et al.*, 2008) and to impair the mental development of 40–60 percent of children in developing countries (UNICEF, 2007). A multi-agency report in 2009 stated that iron deficiency anaemia during pregnancy is associated with one-fifth of total maternal deaths each year. (Micronutrient Initiative, 2009). Meat is not the only source of dietary iron, but it is a good source. It seems clear that the poor would benefit from a higher intake of food, with a diet that includes livestock source food. Therefore, the next section examines the sources of animal products in the diets of poor households.

LIVESTOCK PRODUCTS IN THE DIETS OF THE POOR

Poorer households spend less than richer ones on food, particularly on livestock food items. This topic is dealt with in considerable detail in a later chapter, which looks at food access, but it is worth mentioning a few statistics here. National consumption figures show that consumption of livestock source foods rises as average income rises (Delgado, 2003), which is illustrated in Figure 6. Studies within individual countries also show differences between rich and poor households. For example, a comparative study of Uganda, India and Peru (Maltsologu, 2007) found that poor households consumed less in both volume and total value of livestock products than rich ones, with the poorest households allocating less than 10 percent of their food budget (purchases and home consumption) to livestock products. Within the budget given to livestock source foods, the highest percentage was allocated to meat. In Uganda, milk was also important, while eggs were more prominent in Viet Nam.

While there are differences in food preferences and access between countries and even within households (described later when reviewing food access), both poultry products and dairy products tend to be prominent within the diets of poor households.

Poultry meat and eggs. Globally, the supply of and demand for poultry products has shown a very rapid upward trajectory, with poultry now providing 28 percent of all meat (see the next chapter for trends in livestock production). Poultry meat and eggs are acceptable foods in many cultures, and poultry can be raised at home even by families with very little land or capital, making them easily accessible to the poor. In some countries, poultry meat is cheaper, such as in Egypt where at times, it is only one-third the price of other meats (Hancock, 2006). Poultry products make up 0.6 percent of the average of 2 077 kcals per person per day in Africa and 2.9 percent of 2 300 kcals per person per day in Asia (Hancock, 2006). They form a somewhat



©FAO/Ivo Balderi

greater share of average protein consumption, up to 5 percent in the poorest households. Anecdotal and recorded evidence points to poultry products contributing over 20 percent of meat consumption in sub-Saharan Africa, around 50 percent in Egypt and the more food insecure countries of Latin America, and a high percent in the poorer Middle Eastern countries. This makes these populations particularly vulnerable when local production of poultry is disrupted because of disease or other problems.

Quickly cooked and digested, poultry meat and especially eggs also have good micronutrient properties important for children and pregnant women. Female-earned income from poultry keeping is an important factor for improved child health, and smallholder poultry development projects for poor households in Bangladesh and South Africa indicate that both the direct consumption of poultry and income from poultry contribute to reduced malnutrition (Dolberg, 2003).

Dairy. Milk from cattle and goats, a good source of amino acids and Vitamin A, is widely consumed in all parts of the world except East Asia. In South Asia, Africa and the Middle East, it is particularly important in the diet and, in fact, can contribute more than 50 percent of pastoralist families' energy intake. School milk programmes have been used to boost consumption

by children while supporting the local dairy industries. A 2004 survey of 35 countries found that schemes to promote milk consumption in schools had increased the proportion of school milk in the domestic market. In Thailand, where milk is not a large part of the national diet, school milk accounted for 25 percent of national milk consumption, while in other countries that responded to the survey, the contribution was between 1 and 9 percent (Griffin, 2004).

Smallholder dairy production also has been important to rural economies, although not to the poorest of the poor since the maintenance of a cow or even a dairy goat is normally beyond their capacity. Women often have control of dairy animals and of the income they provide, which has had positive consequences for household nutrition, a topic that is explored further in a later chapter reviewing food access.

©FAO/Florita Botts

Livestock and food supply

Livestock products supply around 12.9 percent of calories consumed worldwide (FAO, 2009b) and 20.3 percent in developed countries. Even more important, perhaps, is their contribution to protein consumption, estimated at 27.9 percent worldwide and 47.8 percent in developed countries.

SUPPLY OF ANIMAL SOURCE FOODS

The availability of livestock products worldwide and within nations is determined by the volume of production and the scale and reach of international trade. During the past 40 years (1967–2007), global production of meat, milk and eggs has grown steadily. Particularly striking have been the increases in production of poultry meat by a factor of 7.0, eggs by a factor of 3.5, and pig meat by a factor of 3.0 (Table 4). Production per person has also grown, albeit at a slower rate. For the decade from 1995 to 2005, the annual global growth rate in consumption and production of meat and milk averaged between 3.5 and 4 percent, double the growth rate for major staple crops during the same period (Ahuja *et al.*, 2009). Trade in livestock products also has grown enormously during these 40 years (Table 5), by a factor of 30.0 for poultry meat, more than 7.0 for pig meat and 5.0 for milk.

While the global supply of livestock products has more than kept up with the human population expansion, the situation has not been the same in all regions. Production levels have expanded rapidly in East and Southeast Asia, and in Latin America and the Caribbean, but growth in sub-Saharan Africa has been very slow. Fast growth in human populations in some developing countries coupled with low productivity per animal have made it hard for livestock production in those areas to keep up. There is also considerable variation within the developing world, with sub-Saharan Africa and South Asia producing at much lower levels per person than Latin America and the Caribbean.

Pigs and poultry, especially those kept in intensive, peri-urban production systems, are mostly responsible for per person growth of livestock source foods. Three of the largest emerging economies – China, Brazil and India –

TABLE 4
CHANGES IN GLOBAL LIVESTOCK PRODUCTION TOTAL AND PER PERSON 1967 TO 2007

ITEM	PRODUCTION *(million tonnes)*			PRODUCTION PER PERSON *(kg)*		
	1967	2007	2007/1967	1967	2007	2007/1967
Pig meat	33.86	99.53	294%	9.79	14.92	152%
Beef and buffalo meat	36.50	65.61	180%	10.55	9.84	93%
Eggs, primary	18.16	64.03	353%	5.25	9.60	183%
Milk, total	381.81	680.66	178%	110.34	102.04	92%
Poultry meat	12.39	88.02	711%	3.58	13.20	369%
Sheep and goat meat	6.49	13.11	202%	1.88	1.97	105%

Source: FAOSTAT.

have fast-growing poultry industries (Figure 1). China is by far the largest player, with approximately 70 million tonnes of egg production annually compared to 3 million tonnes in India and 2 million in Brazil, and 15 million tonnes of meat compared to 9 million tonnes in Brazil and 0.6 million in India. However, poultry make an important contribution to the food supply in all three economies. In India, poultry is the fastest growing livestock subsector. Poultry products accounted for approximately 50 percent of per person livestock protein consumption in 2003, compared to about 22 percent in 1985 (Pica-Ciamarra and Otte, 2009, based on Government of India, 2006). China and Brazil are also rapidly expanding their production of pig meat (Figure 1). In China in particular, this is an important part of the diet.

Dairy production has expanded to meet demand in some growing economies of Asia, such as in Thailand where domestic dairy production rose sharply from 7 percent of national consumption in 1980–82 to 44 percent in 2000–02 (Knips, 2006). Viet Nam, which only has a short national tradition in the production and consumption of dairy products, saw a tripling in milk production between 1996 and 2002 (Garcia *et al.*, 2006). Although Pakistan still faces milk shortages, because of limited feed and grazing areas coupled with a rising population, farmers

TABLE 5
CHANGES IN GLOBAL TRADE OF LIVESTOCK PRODUCTS 1967 TO 2007

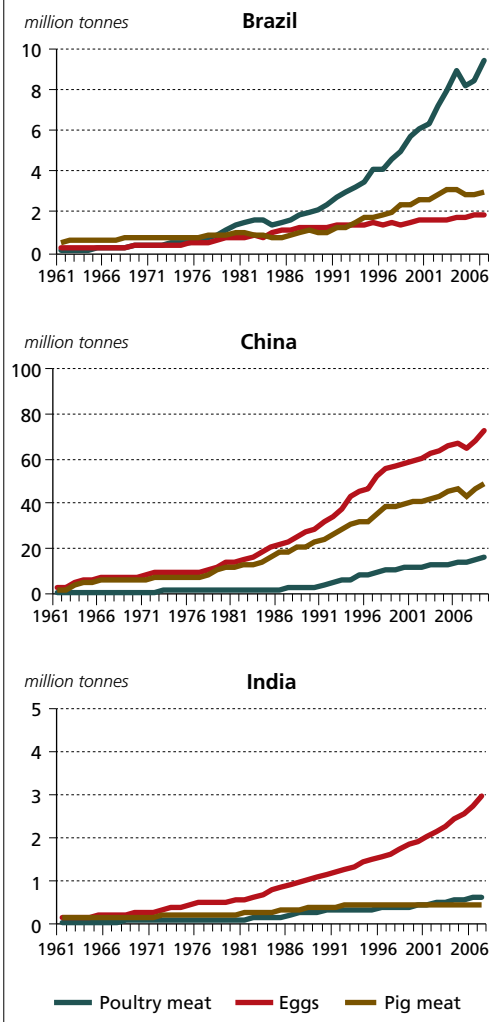
ITEM	EXPORT *(million tonnes)*		
	1967	2007	2007/1967
Pig meat	1.48	11.13	750%
Beef and buffalo meat	2.41	9.46	392%
Eggs, primary	0.33	1.44	442%
Milk, total	18.84	93.19	495%
Poultry meat	0.39	12.66	3 206%
Sheep and goat meat	0.58	1.04	180%

Source: FAOSTAT.

have responded to increased demands for milk by increasing milk yields (Garcia *et al.*, 2003). In India, where milk has always been important, the latest statistics from the National Dairy Development Board (NDDB) show that availability per person has grown from 178 g per day in 1991–92 to 258 g per day in 2008–09 (NDDB, 2010).

Many poor countries, however, have failed to increase national production or consumption of livestock and livestock products. In Bangladesh, for example, high milk production costs and low yields have resulted in low per person

1 PRODUCTION FROM POULTRY AND PIGS IN INDIA, BRAZIL AND CHINA 1967 TO 2007



Source: FAOSTAT.

milk production of 13 kg per year. Even with imports, the country is struggling to meet a domestic milk demand that has increased as a result of rising incomes and population growth (Garcia *et al*., 2004a). Ethiopia, which has one of the largest livestock populations in Africa, has seen a decline over the past 30 years in the number of livestock and the volume of livestock production per person, and a corresponding decline in consumption per person of livestock products (Halderman, 2005).

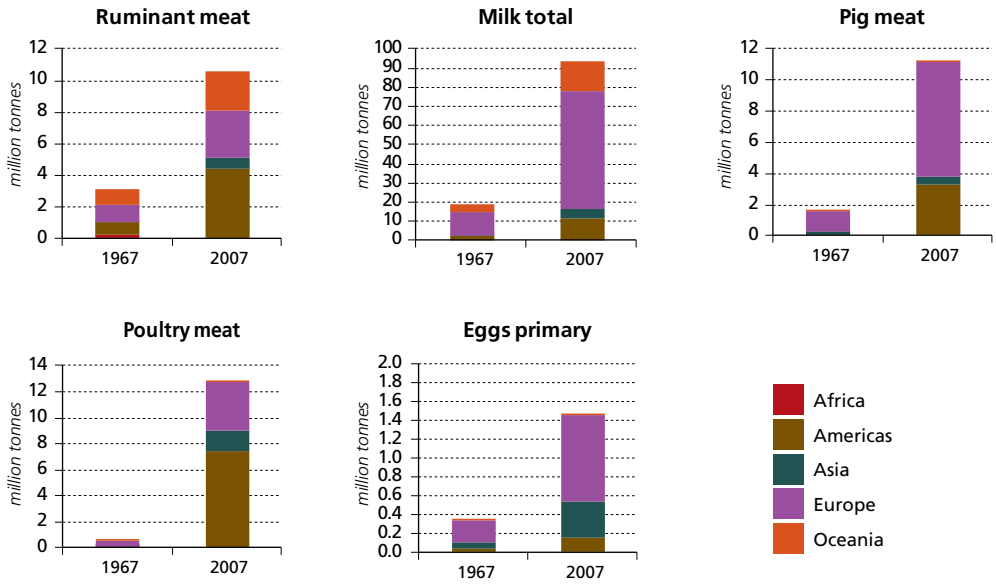
Export trade, which in 1967 was relatively small and dominated by Europe, has not only expanded greatly, it has diversified, with the Americas becoming the dominant exporter of poultry meat, Asia taking a growing share of egg and poultry meat trade, and Oceania showing strong growth in milk and ruminant meat exports (Figure 2).

There is a large gap in self sufficiency in livestock products between the developed and the developing regions. Oceania is a major net exporter of ruminant meat and milk, including exports of live sheep, many to the Middle East and North Africa. The Americas are increasingly net exporters of pig and poultry meat, Europe is self sufficient in some products and a minor net importer of others, and Africa is a net importer of almost all livestock products (Figure 3).

Within regions, some countries stand out as major producers and net exporters while others are net importers and rely on trade to make livestock products available in their domestic markets. For example, Asia as a whole is barely self sufficient in poultry meat, but Thailand has been among the top ten exporters, and China is a major producer with a growing export market. Within the Americas, the USA and Brazil stand out as exporters of livestock products while some of the smaller countries are net importers. The biggest milk powder importers are oil exporters such as Mexico, Algeria, Venezuela and Malaysia, and the fast-growing economies of India, the Philippines and Thailand (Knips, 2005). In China, domestic milk production has risen but still has not been able to keep up with rising demand as domestic milk consumption has increased even faster. As a result, milk powder imports have risen rapidly to meet demand. North Africa, which has experienced rapid income growth in the past few years, has become a large importer of milk powder to meet increased demand for dairy products.

Global availability of livestock products has grown, but how close does it come to what is

2 EXPORT OF LIVESTOCK PRODUCTS BY REGION 1967 AND 2007



Source: FAOSTAT.

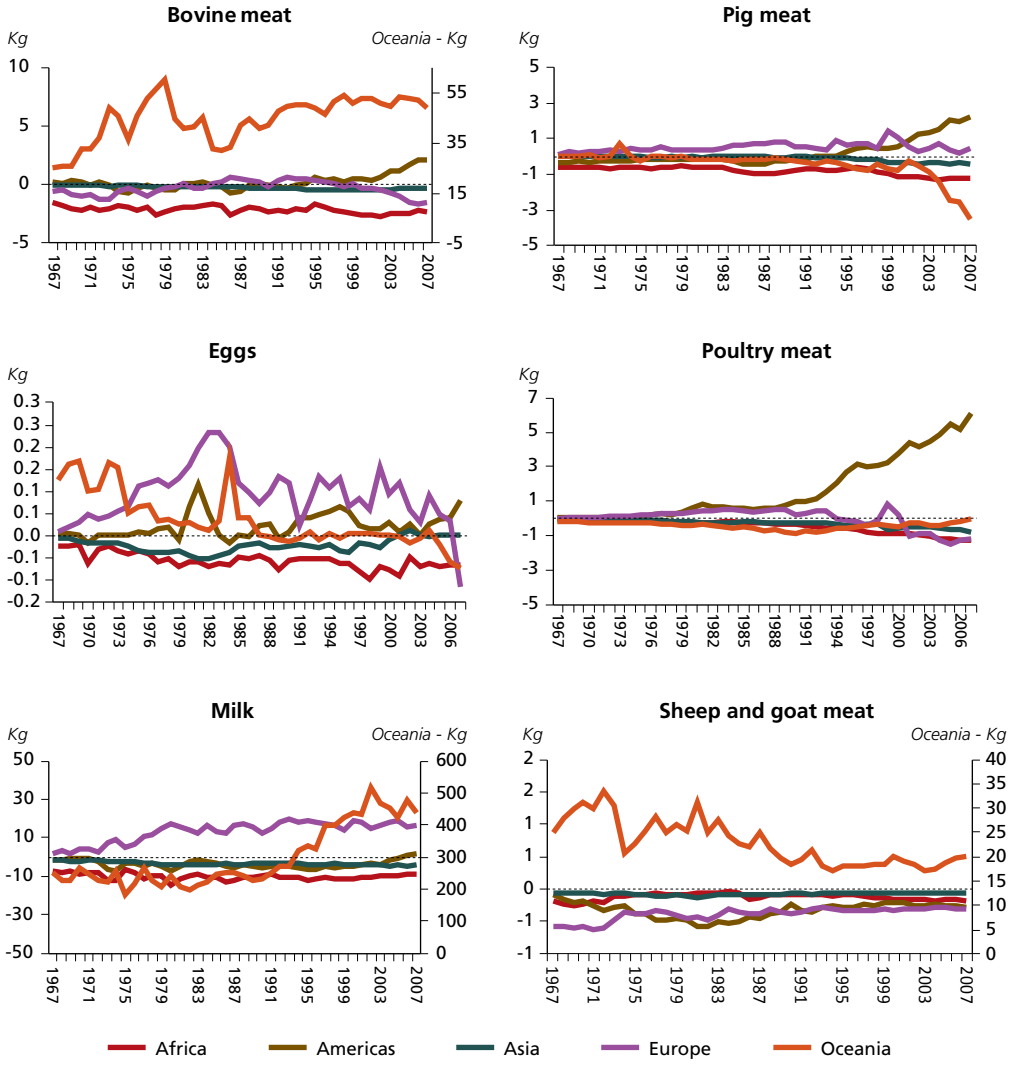
needed for food security? The literature tends to compare developed to developing country statistics rather than comparing the consumption in the developing world to acceptable nutrition standards. Perhaps this is because the question has no simple answers. The recommended standards for consumption of calories, proteins and certain critical micronutrients do not generally distinguish between the sources of food, other than to say that a balanced diet should contain a mixture of nutrients from plant and animal sources with a higher proportion coming from plant sources.

Expert opinion suggests that sufficient food of all kinds is currently being produced for everyone, but that the problem lies with access. At the same time, cognizant of the fact that food security requires a sufficient supply of both crop and livestock products, it is important to examine the interplay between crop and livestock production. They interact in both positive and negative ways. In mixed farming systems, the two add value to each other – livestock provide traction and manure for crop production and crops, in return, provide forage and residues as livestock feed. A tug-of-war develops when livestock consume grains and other seeds that could otherwise be fed to humans and, in doing so, compete for the food needed for direct human consumption.

LIVESTOCK CONTRIBUTING TO CROP PRODUCTION

In addition to contributing directly to food supply through provision of their own products, livestock contribute indirectly by supporting crop production with inputs of manure and traction. In both cases, their contribution is greatest in developing countries. In the developed world, the use of traction has fallen to almost nothing, and the manure produced by livestock raised for food is more than can be used conveniently on local cropland.

3 NET TRADE PER PERSON IN LIVESTOCK PRODUCTS BY YEAR AND REGION



Source: FAOSTAT.

DRAFT POWER

Draft power from working animals has reduced human drudgery, allowed cropping areas to be expanded beyond what can be cultivated by hand, and made it possible to till land without waiting for it to be softened by rain which gives farmers more flexibility in when they plant crops. In spite of this, a recent review (Starkey, 2010) indicates that the number of working animals in the world has probably fallen from 300–400 million in the 1980s to 200–250 million today.

Numbers in Africa have increased (Box 4), but there have been significant decreases in other parts of the world. In Western Europe and North America, the use of animal power has almost disappeared since WW II other than for

BOX 4

EXPANSION OF ANIMAL TRACTION IN AFRICA

West Africa – animal traction continued expanding during the twentieth century, due to its promotion by commodity companies and extension services. There have been high levels of adoption in the 400–800 mm rainfall zone, and use of work oxen in francophone West Africa increased six fold – from 350 000 to 2 million – in the past 50 years. Oxen are the main agricultural work animals, but horses and donkeys are also used in the drier areas. Donkeys have increased in numbers, from 4.5 to 6.3 million in the past decade, and in geographical area, with the "donkey line" moving southward. In the humid zone, there are few cattle and no equids, but projects are considering the introduction of work oxen. An increasing number of farmers use trypanotolerant Ndama cattle for work in Guinea.

East Africa – animal traction is gradually increasing, notably in Tanzania, with 1 million work animals, and in Uganda, while in Madagascar, where 300 000 ox carts are in use for transport, bovine traction was badly affected by the 2006 drought. Animal use is slowly diversifying from the traditional ploughing and pulling of carts to increased use for weeding and conservation tillage and increased use of donkeys for transport and light tillage.

Ethiopian highlands and some neighbouring areas – 7 million oxen provide the main source of power for soil tillage, while 5 million donkeys are used for pack transport. Donkey carts are few but increasing. Horses and mules are used widely for riding, although urban horse carts are being replaced by motorized three-wheelers. In Ethiopia, ox-drawn ploughing is so important that poor households that do not own oxen will practice sharecropping with those that do and give as much as 50 percent of their harvest in exchange for the use of oxen (Ashley and Sandford, 2008).

Southern Africa – animal traction has been in use since the seventeenth century, making it traditional in many smallholder systems. In recent decades, it has been promoted and is spreading in several countries, including Malawi, Namibia and Zambia.

South Africa and neighbouring countries – the use of tractors on large farms and subsidized tractor hire schemes have diminished people's perception of the value of animal traction. However, no viable system for using tractors for rainfed crops on fragmented small-scale farms has been found. Oxen are the preferred animal for ploughing, but droughts, overgrazing and theft have made donkeys more attractive.

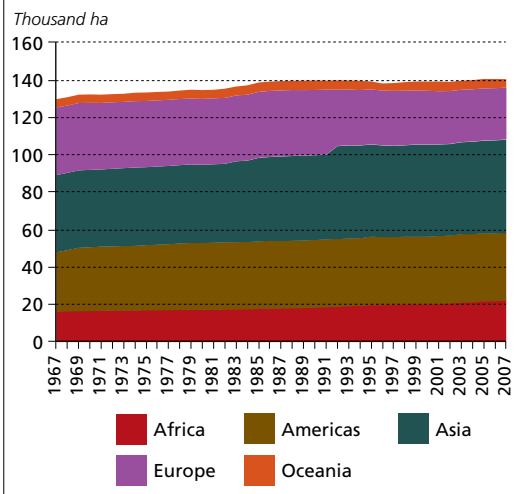
North Africa – traditional use of work animals in agriculture remains important in Egypt and Morocco.

Source: Starkey (2010), except where indicated.

specialized uses and in traditional communities, such as the Amish in North America. In Eastern Europe, it is steadily decreasing as tractors become more affordable and available and farm sizes shrink.

In much of South and Southeast Asia, draught animals are being replaced by mechanization. In Central and South America, oxen and horses remain common on smallholder farms in spite of increasing adoption of tractors, and animal-drawn carts are quite widely used for rural and urban transport. The traditional use of pack llamas has declined greatly but donkeys remain important in the Andes and in Mexico. Animal traction also remains important for agriculture and transport in Haiti and the Dominican Republic, although motorcycles, three-wheelers and power tillers may eventually reduce de-

4 ARABLE LAND AREA BY YEAR AND REGION



Source: FAOSTAT.

mand. Throughout the world, even in countries where the number of work animals is falling, pockets of use remain in remote and poor communities, where livestock make an important contribution to livelihoods.

The land devoted to crops increased globally by less than ten percent between 1967 and 2007 (Figure 4), although cropland locations shifted as cities expanded and forests contracted or expanded. The proportion of the world's cropland located in Asia and the Americas grew slightly while that in Europe decreased (Figure 4). This means that trends in the use of draft animals do not depend on a growing cropland base but rather on factors such as comparative costs and convenience of power tillers and tractors, farm size and remoteness, social custom and policies that support or depress the use of work animals (Starkey, 2010).

People will replace human-powered tillage and transport with animals when they are available, adapted to the environment, affordable, profitable and socially acceptable, and where no viable mechanization alternatives are available. This explains the animal traction growth in areas such as sub-Saharan Africa, as well as the persistence of animal power in both poor and rapidly industrializing countries, and the stability of some donkey populations. However, people replace animals when motor power is available, affordable, profitable and socially acceptable. Young people influenced by media images may consider animal power too old-fashioned to be socially acceptable. Also, with the exception of a few African countries, government support to research, education, training and promotion in the use of animal traction has declined.

The implications of the trends are complex. On a national scale, animal traction may be less energy efficient than mechanical tillers (Sharma, 2010), and there may be no incentive for many governments to promote it. Work animals also have their drawbacks. They need to be fed and cared for daily, they are vulnerable to disease and theft, they need feed either grown or purchased, they require specialist expertise, and they may be seen as old fashioned by young people. Tractors also increase labour productivity, giving some family members the option to migrate to cities.

Against these drawbacks must be set the very important role that work animals play in the lives and livelihoods of many families, particularly those that are poor or live in remote or hilly areas. Where animal traction is growing, increased farm power, crop-livestock integration and transport capacity should lead to greater, more stable production, marketed produce and incomes. Replacing animals with tractors can increase soil compaction and reduce manure availability for fertilizer or fuel, while tractors seldom increase yields per hectare (Starkey, 2010). As climate change is associated with higher frequencies of extreme weather, transport animals such as donkeys may prove increasingly important for access following natural disasters.

Animal traction is resilient even without a supporting policy environment, and the existing trends will generally continue, with areas of decline, stability and slow growth. However, as fewer people learn about work animals, it will

be more difficult to formulate appropriate policies relating to their use in agriculture and transport. A reasonable level of public investment in animal traction will need to be maintained for farmers in zones where such technology can directly reduce poverty and drudgery. Building a critical mass of knowledgeable users and support services, however, generally requires project support.

MANURE

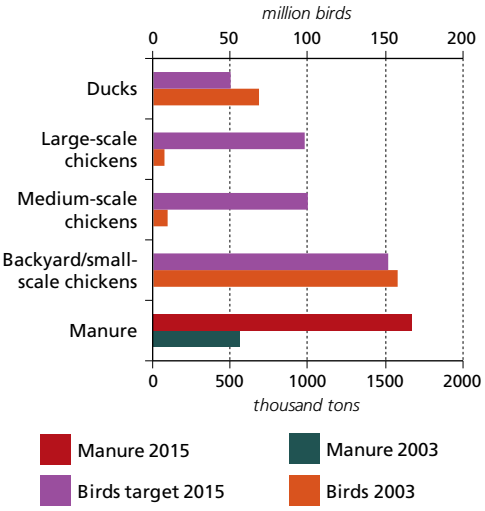
The potential contribution of animal manure to crop production is well understood although there is no convenient global database to summarize its current contribution. It is easier to determine the extent of artificial fertilizer use, which is expected to double in developing countries by 2020 (Bumb and Baanante, 1996). In developed countries, it has been suggested that only about 15 percent of the nitrogen applied to crops comes from livestock manure. In developing countries, the relative contribution of livestock manure can be high but is not well documented.

The relationship between manure and food production is interesting and complex. It is a valuable input, but also a comparatively inconvenient one. Manure is known to be better than artificial fertilizer for soil structure and long-term fertility. Its greatest value can be seen in developing countries, where small-scale farmers report that they do not have enough manure to apply to their crops (Jackson and Mtengeti, 2005) and exchange of grain and manure occurs between settled farmers and pastoralists (Hoffman *et al.*, 2004). The distance that manure is sometimes transported attests to its perceived value. For example, chicken manure is reportedly transported 100 km or more in Viet Nam. Calculations made for Bolivia point to the considerable potential benefits of using more of the national manure production as an input to small-scale cropping (Walker, 2007). It also has multiple uses for household fuel, construction and biogas production as well as fertilizer, although these are not being fully exploited. One estimate suggests that only 1 percent of global manure production is recycled as biogas (Thøy *et al.*, 2009). At the same time, it is less convenient to handle than artificial fertilizer, has variable quality, and the reduction in animal traction in many countries has also reduced the availability of this resource. Research into rice production in Asia, where work animals have been replaced by tractors and power tillers, is increasingly centered around more efficient ways to formulate and deliver artificial fertilizer.

In countries where the livestock sector is dominated by large-scale intensive production, manure can be as much a problem as a benefit. The challenge of recycling waste in ways that do not add to water pollution is substantial (Steinfeld *et al.*, 2006). For example, the EU and Canada (Hofmann, 2006) have strict rules and detailed guidelines about storage, processing and application of animal waste to avoid pollution of runoff water and the build-up of heavy metals in the soil. Denmark has successfully reduced leaching intensification, and concentration of its livestock sector has resulted in more manure being generated in smaller areas. For example, Figure 5 shows the large increase in manure production expected from increasing commercialization of the Vietnamese poultry sector in a country where poultry manure is already transported over quite long distances.

The extent to which livestock manure is applied to crops is a question of economics, logistics and regulation. There is evidence that using manure on small- to medium-sized mixed farms has economic viability (Bamire and Amujoyegbe, 2004). However, storage needs, transport requirements and the relative locations of livestock and crops all affect the cost and convenience of applying manure, as do government regulations on nutrient management (Kaplan *et al.*, 2004). Much current research is focussed on ways to tighten nutrient cycles, so that more nitrogen (N) and phosphorus (P) cycle through plants and animals and less is lost. In other words, the goal is to use more of these nutrients directly in agriculture (Steinfeld *et al.*, 2010).

5 PROJECTIONS FOR CHICKEN MANURE PRODUCTION IN VIET NAM WITH CHANGES IN SECTOR STRUCTURE



Source: Hinrichs, 2006.

LIVESTOCK AND THE FOOD BALANCE

Livestock make their most important contribution to total food availability when they are produced in places where crops cannot be grown easily, such as marginal areas, or when they scavenge on public land, use feed sources that cannot directly be eaten by humans, or supply manure and traction for crop production. In these situations, they add to the balance of energy and protein available for human consumption. When livestock are raised in intensive systems, they convert carbohydrates and protein that might otherwise be eaten directly by humans and use them to produce a smaller quantity of energy and protein. In these situations, livestock can be said to reduce the food balance.

In a world that is increasingly concerned with sustainable food production, ideally the contribution of livestock to the food balance should be at least neutral, making the conversion of natural resources to human food as efficient as possible while also ensuring that people still have the possibility of eating a diverse diet that includes livestock products. However, on a global scale, this is not the case and may not even be possible. It is estimated that 77 million tonnes of plant protein are consumed annually to produce 58 million tonnes of livestock protein (Steinfeld *et al.*, 2006).

The production system and the species of livestock both affect the food balance. Monogastrics such as pigs and poultry naturally eat a diet that is closer to a human one than that of ruminants. Extensive systems require animals to find a large proportion of their feed from sources not edible to humans, such as grasses and insects, grains left over from harvests and kitchen waste, while animals in intensive systems are fed concentrate feed that includes cereals, soya and fishmeal as well as roughage. Intensive poultry and pigs are the biggest consumers of grain and protein edible by humans, although both have been bred to be efficient feed converters. Intensive beef systems in feed lots convert concentrates less efficiently but can be fed partly on brewers' waste. Intensive dairy cows are fed concentrates that enable them to produce much greater volumes of milk than they could manage from a roughage-only diet.

The systems that compete least for human food – those that primarily depend on grazing – produce only about 12 percent of the world's milk and 9 percent of its meat. Mixed systems in which animals eat grass and crop residues as well as concentrates produce 88 percent of the world's milk and 6 percent of its meat. The most intensive industrial livestock systems are termed "landless" because the animals themselves occupy little land – they are kept in controlled environments and can be housed almost anywhere. These systems (Table 6) produce 45 percent of the world's meat, much of it from poultry and pigs, and 61 percent of the world's eggs (FAO, 2009b).

Since livestock have an important role in protein production, it serves as a valuable exercise to consider the effect of livestock production systems on the available balance of human-edible protein. This report makes an initial attempt to compare national figures for livestock output

TABLE 6
GLOBAL LIVESTOCK PRODUCTION AVERAGE BY PRODUCTION SYSTEM 2001 TO 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

and feed input for a selection of countries. Using FAOSTAT production and trade statistics and feed and primary crop data, the estimated volume of edible livestock produced in each country has been adjusted for protein content of each commodity and then compared with the estimated volume of human edible protein that has been used for feed (domestically produced and imported). The input and output figures have then been compared as net figures and ratios, shown in Table 7. The numbers need to be treated with some caution, as feed data are somewhat limited and likely to underestimate the use of feed that is produced on small farms. However, the trend fits with what common sense might suggest: the countries with the most concentrated and intensive systems have an output/input ratio of below or near one (1), meaning that the livestock sector consumes more human-edible protein than it provides, while those countries with a predominance of extensive ruminants have considerably higher ratios, meaning that they add to the overall supply of protein.

Reducing the amount of human-edible food needed to produce each kilogram of livestock source food processed through livestock would be a valuable contribution to food security. There are two ways that this might be done: i) produce a larger percentage of the world's livestock protein within grazing and low intensity mixed systems, leaving more plant protein to be eaten by humans, or ii) recycle more waste products, including agro-industrial by-products, through animals. Both of these possibilities will be examined under "Producing enough food". There is no single approach to producing sufficient livestock source foods in a sustainable way. Rather than making blanket recommendations about livestock production, there is a need to balance the food security needs of the different human societies, a discussion also explored later in the report.

STABILITY OF FOOD SUPPLIES

Food security can be compromised when crops and livestock are destroyed or market chains disrupted, cutting off supplies, or when economic crises or loss of livelihoods abruptly reduce

TABLE 7
HUMAN-EDIBLE PROTEIN BALANCE IN THE LIVESTOCK PRODUCTION OF SELECTED COUNTRIES

	EDIBLE PROTEIN OUTPUT/INPUT		EDIBLE PROTEIN OUTPUT–INPUT TONNES	
	AV. 1995–1997	AV. 2005–2007	AV. 1995–1997	AV. 2005–2007
Saudi Arabia	0.15	0.19	-533 731	-659 588
USA	0.48	0.53	-7 846 859	-7 650 830
Germany	0.66	0.62	-921 449	-1 183 290
China	0.75	0.95	-2 822 998	-665 276
Netherlands	1.66	1.02	322 804	18 070
Brazil	0.79	1.17	-622 177	550 402
Nepal	2.25	1.88	37 370	40 803
India	3.60	4.30	2 249 741	3 379 440
Sudan	18.22	8.75	235 868	340 895
New Zealand	8.04	10.06	460 366	638 015
Mongolia	14.72	14.60	42 987	35 858
Ethiopia	16.02	16.95	99 909	141 395
Kenya	18.08	21.16	124 513	202 803

Original data: FAOSTAT, November 2010. Calculations by FAO Animal Production and Health Division.
Edible protein output estimated from indigenous meat, milk and eggs. "Indigenous" meat production = production from slaughtered animals plus the meat equivalent of live animal exports minus the meat equivalent of live animal imports.
Edible protein input estimated from available feed (domestically produced and imported) and primary crops that are edible by humans (excluding canary seed and vetches).

access to food. Wars and conflicts, economic crises, fires, floods, droughts, earthquakes, tsunamis and major epidemic diseases have all destabilized food security, sometimes affecting both supply and demand (Box 5). Long global food chains and the dominance of some exporting countries mean that local problems can have regional or global effects (Stage *et al.*, 2010). Resilient food systems have inbuilt factors that help stabilize them or help them recover from instability. Livestock contribute in a number of ways to the food stability of their owners and the nations where they are produced. However, they are vulnerable to disease and natural disasters and, if these effects are not addressed, the beneficial effect of livestock on the stability of food supplies will be reduced.

LIVESTOCK AS A BUFFER

Livestock represent part of a family's risk management strategy. Building an economic and social buffer against shocks is an important part of ensuring food stability. It is well known that families below or near the poverty line are particularly vulnerable to shocks since they already devote a large proportion of their income and resources to securing food and have very little margin to cope with extra stress. Livestock are an asset that can help to build these buffers. They grow and reproduce, providing an expanding asset base for their owners. Herd accumulation is a common practice even among agropastoralists, for whom livestock represent a minor income source during normal times (Ashley and Sandford, 2008). Several years of crop failure in Pakistan motivated farmers to increase their livestock numbers, in order to manage risk through diversification (Garica *et al.*, 2003). Very poor landless urban dwellers also may keep a few small livestock as a buffer against risk. A 2003 study in Uganda found that livestock ownership in Kampala increased dur-

BOX 5

NATURAL AND ECONOMIC SHOCKS TO FOOD SYSTEMS

Natural: El Niño events

El Niño events are weather events that usually take place every four to seven years and last for one or two years. Recently, they have been occurring more frequently, causing flooding in some parts of the world and drought conditions in others, resulting in loss of crops, livestock, infrastructure and property as well as displacement of people. El Niño events are a particular concern because their effects are unpredictable and it is hard to take preventive action.

The 1987–88 El Niño caused massive flooding in 41 countries along the coast of Latin America and in parts of the Horn of Africa, droughts or dry spells in Southeast Asia and major forest fires in Indonesia and Brazil, with a total cost of between US$32 billion and US$96 billion. In Indonesia, drought caused a shortfall of over 3.5 million tonnes in the cereal harvest, and food prices rose sharply. In Somalia, harvests stored underground were destroyed by flooding. There were considerable losses of livestock in Kenya, Somalia and Ethiopia due to unseasonable and heavy rainfall and floods, as well as an outbreak of the zoonotic disease Rift Valley fever (RVF) in Kenya and Somalia. In Southern Africa, El Niño tends to cause prolonged dry spells during the period between January and March when rainfall is most required by crops, resulting in reduced yields or, in some cases, complete crop failure as well as reduced output from pastures. The prices of staple foods rise, livestock conditions deteriorate and livestock prices decline when households make emergency sales of animals to meet household expenses.

Economic: global economic crisis

The economic crisis of 2007–2008 produced unusually rapid food price increases when the rising cost of energy had knock-on impacts on food production costs, creating a livelihoods shock for poor families. In 2007, increases in the number of undernourished people occurred in Asia and the Pacific and in sub-Saharan Africa, the two regions that together accounted for nearly 90 percent of the undernourished people in the world. In 2008, FAO estimated that rising prices plunged an additional 41 million people in Asia and the Pacific and 24 million in sub-Saharan Africa into hunger.

In these circumstances, the poorest, landless and female-headed households are always the hardest hit, and children, pregnant women and lactating mothers face the highest risk. Even in countries with a large proportion of people engaged in agriculture, most people buy food and are adversely affected by rising food prices. Poor people are disproportionately affected because they spend a larger share of their income on food. In trying to cope with the burden of consecutive food and economic crises, they cut expenditures on health and education or sell productive assets, creating poverty traps and negatively affecting longer-term food security. In Latin America and the Caribbean, livestock industries were disproportionally affected during the crisis by high fuel prices as transport and logistics costs are a high proportion of total production and marketing costs in this region. Fuel-importing countries were at a particular disadvantage.

Sources: FAO, 1998; Sponberg, 1999 ; CARE, 1998; USAID, 2009; FAO, 2008a; FAO, 2009a; World Bank, undated.

ing times of social upheaval (Ashley and Sandford, 2008). Diversifying livestock enterprises between small and large stock is a sound strategy for food security since small animals reproduce faster while large animals have greater value.

Keeping livestock also allows farmers to stabilize their income and consumption by selling eggs and milk on a regular basis and selling small animals such as poultry and guinea pigs at need. Dairy development projects that link smallholder farmers to markets promote food stability by securing regular income. Livestock help preserve and build the human capital that provides the family's active workforce by paying for medical bills and education; there are numerous reports of income from livestock contributing to these expenses (Nakiganda *et al.*, 2006; Rymer, 2006). They may also build social capital to help a family through a crisis. Smallholders and pastoralists will sometimes lend or give animals to relatives, knowing that this gives them social standing and puts them in a stronger position to ask for help in the face of a disaster. Because of their portability, livestock have a special role to play when people are physically displaced by conflicts or natural disasters. A family can move animals, but must leave buildings and crops behind.

Livestock owners respond in different ways to crises. In northern Kenya, pastoralists are reported to build their herds (particularly breeding animals) in times when feed is plentiful (Bailey *et al.*, 1999; Umar and Baulch, 2007) and sell them during droughts to cover essential expenses. In India, buffalo owners are reported to sell their animals to cover expenses (Rosenzweig and Wolpin, 1993). On the other hand, pastoralists in West Africa are reported to hold on to their animals even in times of food insecurity, possibly choosing not to sell large animals at a time when prices are low (Kazianga and Udry, 2006; Fafchamps *et al.*, 1998; Pavanello, 2010), preferring to retain them to start again when the crisis is over. They use other coping mechanisms such as skipping meals and increasing reliance on tea and sugar intake.

In systems where destocking and restocking are normal practice, breeding females are maintained so that the herd can be rebuilt when conditions improve and only sold in extreme emergencies, but if a crisis becomes prolonged, animals of any age and sex may be sold. Small livestock are a convenient buffer against shocks for several reasons: they require lower capital investment, they are easier to sell quickly, if one dies it is less damaging, they grow and breed faster, and they survive on harsher terrain (Costales *et al.*, 2005). It is often the small livestock owned by women that are sold at short notice to cover periods of income deficit.

At global and national levels, the livestock sector can provide a buffering effect for food system stability. In a severe economic crisis, global consumption and production of meat falls, thus freeing cereal grains for other uses and damping down price shocks for staple foods (FAO, 2009b). Nationally, livestock production for domestic use can contribute to food security by buffering countries against problems with international food supplies. Livestock exports also have the potential to make an important contribution to the national balance of payments for countries that are net exporters.

International trade can make an important positive contribution to food security but it exposes countries to volatility in international markets. Additionally, export subsidies and tariff and non-tariff barriers of both developed and developing countries bring cheap, subsidized imports into developing country markets. It is said that small-scale livestock producers cannot match the higher quality and lower prices of imported products and are squeezed out of their traditional markets (Costales *et al.*, 2005). However, an economic analysis of milk powder imports in six countries found that, in many cases, milk powder was primarily sold in major cities, which means rural dairy producers selling milk in rural areas would not be affected by the competition (Knips, 2006). There appears to be limited evidence that dairy imports affect the welfare of most producers, market agents or consumers (Jabbar *et al.*, 2008). As for exports,

in developing countries where not all livestock owners can take advantage of export markets, the poorest tend to benefit least. In the Horn of Africa, for instance, where livestock export has been growing, richer producers and traders have been able to benefit from the variety of export markets while some poorer herders have been forced by economic circumstances to sell animals and become contract herders (Aklilu and Catley, 2010).

VULNERABILITY TO CLIMATE CHANGE

While livestock contribute to food stability, livestock systems face threats to their own stability. One aspect of vulnerability is manifested in the effects of long-term trends associated with climate change, the increasing need to find renewable forms of energy and the growing human population displacing grazing livestock systems. Recurring droughts in the Horn of Africa have forced poor pastoralists and agro-pastoralists to sell animals that they might not normally choose to sell, to diversify their herds (Pavanello, 2010) and to rely on a wider income range than livestock ownership (Ashley and Sandford, 2008). In Burkina Faso, the successive droughts of the 1970s and 1980s led to a depletion of natural resources and migration which, accompanied by vague land tenure laws, became key constraints to livestock owners securing pasture and water (Gning, 2005). Livestock markets are one way to improve the ability of these producers to regulate stocking rates. Various government-regulated schemes have been tried in the past but today there is increasing focus on the functioning of private markets. However, lack of infrastructure, distance between producers and consumers, high transactions costs (Okike *et al.*, 2004) and poor price information are still constraints in many places. Well-designed restocking schemes (LEGS, 2009) can help livestock owners restock after a serious disaster when normal restocking mechanisms are overloaded

There are often links among access to grazing land, conflict and environmental degradation which can affect the food security of poor livestock owners. For example, tension exists between pastoralists and settled farmers in the Intergovernmental Authority for Development (IGAD) region that stretches across Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan and Uganda. Here, land tenure policies that have not clearly defined the rights of land users and have allowed privatization of grazing land for agricultural purposes are often at the centre of conflicts (Ashley and Sandford, 2008). Pastoralists who have lost grazing land to settled farmers suffer from restricted movement which leads to overgrazing and consequent environmental degradation. As a coping mechanism, some have chosen to keep smaller animals which they can sell quickly and use to buy cereals, or have reduced herd sizes to have more land for crop production.

DESTABILIZING EFFECT OF ANIMAL DISEASES

Occurrence of infectious animal diseases reduces the stability and resilience of the food supply from livestock, affecting everyone along the production and market chains. They can have four different effects: i) reducing the livestock population through death or culling; ii) reducing productivity of livestock; iii) creating market shocks when demand falls and supply contracts in response; and iv) disrupting international trade in livestock products. These effects can have impacts at macro and micro levels.

Rinderpest provides a dramatic example. Outbreaks in the 1890s killed approximately 80 percent of the cattle in southern Africa and caused widespread starvation in the Horn of Africa. One hundred years later, in the 1980s, the disease killed an estimated 100 million cattle in Africa and West Asia. A decades-long international control effort has resulted in the disappearance of clinical disease throughout the world. More recently, the global epidemic of highly pathogenic avian influenza (HPAI), which began in 2003–4, resulted in market shocks in a number of countries, the loss of 250–300 million poultry and the realignment of international trade

(McLeod, 2009). At the global level, the poultry sector recovered surprisingly quickly and widespread effects on food security were limited and short term. However, there were pockets of severe effects, such as in Cairo and Jakarta where family diets diminished when poultry were no longer available as a source of income and food (Geerlings *et al*., 2007; ICASEPS, 2008). Other diseases have locally devastating effects such as *Peste des petits ruminants*, a disease that causes high mortality in sheep and goats, and has been reported several times in eastern and northern Africa since 2007.

Transboundary diseases place severe limits on international trade and have a high cost, but their precise effects on the stability of the food supply are hard to assess. FAO/OECD projections describe them as "damping down" export trade. For example, the bovine spongiform encephalopathy (BSE) outbreak in the UK in 1996 resulted in a 6 percent drop in beef consumption within the EU that took four years to return to previous levels (Morgan, undated). However, its impact on global consumption was obscured by a strong growth in demand from developing countries which compensated for reduced demand in the EU. There must have been some impact on meat supplies with culling of animals, but it was not reported. Similarly, the 2001 foot-and-mouth disease (FMD) outbreaks in the UK resulted in a large loss of animals through culling, including valuable breeding stock, but losses in supply from the UK were largely made up by supplies from elsewhere and there has been no estimate of the impact on the global food supply. When Brazil experienced FMD outbreaks in 2005, some parts of the country lost export markets but, by compensating internally, the industry as a whole maintained its export market share (FAO, 2006b).

The food supply also is impacted by a myriad of animal health problems that occur at community and herd levels. They decrease the productivity of animals by causing death or reducing the efficiency with which they convert feed into meat, milk and eggs (FAO, 2009b). These may cause chronic or seasonal losses and often require families to manage animals in risk-averse ways that reduce the level of production.

Poor livestock owners often face multiple shocks that hit at the same time, threatening their livelihoods and therefore access to food – a situation such as the sickness or death of an animal during a drought with prices of livestock feed increasing and prices for livestock products dropping. Crises can be recurrent or long term – in this respect, a livestock disease such as FMD that permanently reduces the productivity of an animal is a threat to resilience. For this reason, livestock's contribution to food security relies on a multi-faceted approach that builds resilience into the livestock sector and livestock-owning communities, and takes particular account of the needs of vulnerable people when planning and implementing crisis responses.

©FAO/F. McDougall

Access to food

Even when sufficient food is available within a country, households and individuals will only be food secure if they have the ability to access it. The majority of undernourished people suffer from lack of access, not from lack of food availability. Access requires people to have income to buy food or the means to barter for it. Food must be affordable within household budgets, and it must be available in convenient places and forms. There are social and cultural factors that affect entitlement to income and food, one of which is the gender dynamic within households and communities. Each of these elements of access is discussed in this chapter, which first examines the contribution that livestock make to accessing food of all kinds, and then reviews the affordability of and markets for foods of animal origin.

FINANCIAL, HUMAN AND SOCIAL CAPITAL

Livestock provide income and bartering power that contribute to their owners' ability to access food of all kinds. Livestock also contribute to human capital and hence the ability to buy and produce food, by financing education and medical expenses. They can be a source of social capital, giving people a safety net to sustain them in food insecure times, through networks of gifts, loans and other transfers such as dowries. They provide income and employment not only to farmers but also to contract herders, animal handlers, traders, market operators and slaughterhouse owners and workers.

The contribution that livestock make to income is highly variable. A close look at 14 countries of the FAO Rural Income Generating Activities (RIGA) database found at least 50 percent of households in every country are recorded as keeping livestock and in some cases close to 90 percent. For those households, livestock are estimated to provide between 2 and 32 percent of their income (Table 8). The importance of livestock as an income source differs more by country than by income level.

There is no clear pattern of association between income levels and the contribution of livestock in Table 8 or in other sources. Several research reports link poverty levels and livestock ownership, but they use a variety of

TABLE 8

PERCENTAGE OF TOTAL INCOME OF RURAL HOUSEHOLDS COMING FROM LIVESTOCK ACTIVITIES, BY EXPENDITURE QUINTILES

COUNTRY AND YEAR	% OF HOUSEHOLDS OWNING LIVESTOCK	% OF HOUSEHOLD INCOME FROM LIVESTOCK IN EXPENDITURE QUINTILES					
		1	2	3	4	5	TOTAL
AFRICA							
Ghana 1998	50	20	19	19	17	16	18
Madagascar 1993	77	18	19	18	16	19	18
Malawi 2004	63	12	14	14	15	15	14
Nigeria 2004	46	6	5	5	5	5	5
ASIA							
Bangladesh 2000	62	6	6	8	8	7	7
Nepal 2003	88	18	22	23	24	26	23
Pakistan 2001	47	19	22	24	26	28	24
Viet Nam 1998	82	21	20	19	19	16	19
EASTERN EUROPE							
Albania 2005	84	32	29	23	25	20	26
Bulgaria 2001	72	7	16	17	17	15	15
LATIN AMERICA							
Ecuador 1995	84	15	16	17	18	15	16
Guatemala 2000	70	4	5	5	5	7	5
Nicaragua 2001	55	10	17	19	19	20	17
Panama 2003	61	2	3	6	5	7	5

Source: RIGA dataset, accessed September 2010.

variables, indicators, methodologies and data sources (Pozzi and Robinson, 2007). Although each contributes to understanding the role of livestock in household food security, they are hard to aggregate or compare. In a study of 16 countries, Delgado *et al.* (1999) found that the poorest households tend to be less dependent on livestock than those that are slightly less poor, while Quisumbing *et al.* (1995) found that poor households often earn a larger share of income from livestock than the wealthy. It is evident from the available information that livestock do contribute to the incomes of the poor, although perhaps less to the very poorest households who have no space to keep animals, cannot afford to feed them or find them too risky to own.

Livestock-owning households make choices about which of their animals or animal products they will produce to eat and which to sell, depending on their cash needs, access to markets and cultural preferences, but these do not fit into a universal pattern. In Bangladesh, for example, small-scale dairy farmers only consume a small amount of the milk they produce, selling most of it to meet immediate cash needs, even though milk is important to the Bangladeshi diet (Knips, 2006). Small-scale milk producers in Thailand, where milk is not a traditionally important part of the national diet, are responsible for almost all the country's milk production, but only consume 1 percent on-farm (Knips, 2006). In Cambodia, where meat is not central to the diet, livestock represent an important source of income rather than meeting immediate household food needs (Ear, 2005). A 2006 report from Senegal (Kazybayeva *et al.*, 2006) found relationships existing among geographic location, livestock type and the role of livestock

in poverty alleviation in that country. In Viet Nam, rural poultry owners sell a smaller proportion of their product than those in peri-urban areas (Hancock, 2006). By contrast, a study from Nepal (Maltsoglolu and Taniguchi, 2004) found that livestock made a very important contribution to total household income in isolated hill and mountain areas with limited access to markets and cash income sources.

There are many potential uses for income from livestock (Nakiganda *et al.*, 2006). The proportion spent on food will depend on family needs at the time. A poultry project in Bangladesh resulted in asset accumulation from increased income, which was spent on education, improved housing, fencing, latrines, bedding, furniture, other livestock and investing in a family business (Dolberg, 2003). A more direct relationship can be seen in the IGAD region of East Africa where pastoralists and agro-pastoralists sell their high value livestock products and buy low cost cereal products for consumption (Ashley and Sandford, 2008). A community-level poverty assessment in three districts of Western Kenya (Krishna *et al.*, 2004) found that as households climbed out of poverty, they spent money on (in order of priority): food, clothing, shelter, primary education and then small animals, at which point they were no longer considered poor. At the same time, the loss of livestock can cause a household's descent into poverty, due to factors such animal disease, theft or an unplanned sale or slaughter to meet heavy funeral or human health expenses.

National livestock policies as well as national attitudes towards the role of livestock in agriculture have a significant impact on livestock production. By supporting or constraining the incomes of small-scale livestock producers, they also have indirect influence on access to food. Some national policies fail to promote livestock production or consumption in a way that favours the poor. Livestock are under-represented in most Poverty Reduction Strategy Papers (PRSPs), and even when they are considered, it tends to be in relation to the potential for boosting national GDP rather than alleviating poverty (Blench *et al.*, 2003). Such support tends to favour wealthier producers at the expense of poor producers, and focuses on livestock and technical issues rather than on people and poverty reduction (Ahuja *et al.*, 2009). This may be due to a misunderstanding among policy-makers who do not consider that livestock are a key income source for the poor or that pro-poor livestock production policies are important (Ashley and Sandford, 2008).

In addition, poorly planned attempts to reduce public spending through privatization of veterinary services have resulted in under-funded state veterinary and livestock extension systems and a private sector incapable of filling the gap, leaving small-scale livestock owners highly vulnerable to losses from epidemic and endemic diseases. The livestock producers who can organize themselves sufficiently to make demands on the government tend to be exclusive and not pro-poor. The fragility of the livelihoods of small-scale producers and pastoralists in countries such as Ethiopia, Senegal and Bolivia demonstrates the damage that such unsupportive policies can do to small-scale livestock production (Gning, 2005; Fairfield, 2004; Jabbar, *et al.*, 2008; Halderman, 2005; Ear, 2005).

Some plans and policies have been more supportive. For example, the Indian government's 11th 5-year plan pledged more equitable benefits from poultry production for small, marginal and landless farmers (Pica-Ciamarra and Otte, 2009). In Thailand, the recent rapid increase in milk production has been largely thanks to government support to cooperatives, credit access and training in the dairy subsector (Knips, 2006). The Thai government's support to the dairy subsector has been accompanied by a government school milk programme. In Kenya, positive dairy development policies once provided a regulatory framework, quality control, breeding services, animal health inputs, research, extension, pricing and tax policies, and expansion of rural infrastructure such as roads (Jabbar *et al.*, 2008). As a result of these policies,

which were backed by the private sector, smallholder dairy farmers came to dominate production until the early 1980s. However, subsequent reduced budget allocations led to a decrease in the quality of services, and policies did not recognize the activities of the burgeoning number of farmers selling milk, milk bar operators and milk transporters, whose activities were effectively rendered illegal. In 2004, the dairy policy was revised to allow the Kenya Dairy Board to license and train small-scale traders (Kaitibie *et al.*, 2008).

Government policies also have directly promoted the food security of consumers through food assistance programmes. In Peru, for example, the government spends approximately US$200 million a year providing milk and milk products to the poor and children through food assistance programmes (Knips, 2006).

GENDER DIMENSIONS OF ACCESS

Gender dynamics are important in the food security of families and individuals, particularly the poor. They influence who can earn income or gain social capital from livestock, and the way that animals are managed which impacts how they contribute to animal source foods produced for the household. Gender dynamics also affect the way food is divided within families, especially in time of shortage. All of this can add up to greater or lesser food security for individuals and the family as a whole. Things play out differently across countries and social settings and the picture painted here is a broad-brush summary of what has been reported for developing countries.

Women contribute to producing income from livestock, alone and in partnership with male family members. Their ability to do this is constrained by limited access to inputs and services and by cultural norms that affect their daily lives. However, there is limited information on the way that gender dynamics change and roles that women play when livestock systems scale-up and concentrate beyond a certain level. Most of the information on gender influences on livestock production, productivity and income are from research reports derived from studies of small-scale farms in rural areas of developing countries.

One way of considering the effect of gender is to compare male- and female-headed households. In 10 of the 14 countries shown in Table 8, livestock contribute a noticeably greater percentage to household income in male-headed than female-headed households (Table 9), especially in the African and Asian countries. In the Latin American countries, there is no difference or livestock make a greater contribution in female-headed households. Where there is a difference in income between male- and female-headed households, it is likely to be a result of difference in herd and flock sizes. Female-headed households have lower access to resources such as credit and labour, which restricts the number of animals they can own. However, with the animals they have, they are as productive as male-headed households (Pica-Ciamarra *et al.*, in preparation).

Whether heading a household or operating within a male-headed household, cultural biases in many countries constrain women's access to services of all kinds and this, along with their limited or nonexistent individual entitlements to natural resources, is associated with a lack of incentive to be more productive (Geerlings *et al.*, 2007; Quisumbing *et al.*, 2004). For example, there are numerous stories of women being excluded from animal production and health training because it is offered only to the heads of households, being unable to access credit because they have insufficient collateral, or not being directly informed about emergency animal disease control measures because the information is given out at a place or time that does not take account of their daily schedules.

Women are likely to own or have control over smaller livestock although they may have access to the products of larger livestock. The main exception to this is ownership of improved dairy animals, often provided through projects. Small livestock, as well as dairy products, are widely

TABLE 9

PERCENTAGE OF TOTAL INCOME COMING FROM LIVESTOCK ACTIVITIES, BY SEX OF HOUSEHOLD HEAD AND EXPENDITURE QUINTILE

	HOUSEHOLD HEAD	Q1	Q2	Q3	Q4	Q5
Ghana 1998	Female	14	12	12	11	11
	Male	22	23	23	19	18
	M/F	1.6	1.9	1.9	1.7	1.6
Madagascar 1993	Female	13	13	12	10	14
	Male	20	20	20	17	20
	M/F	1.5	1.5	1.7	1.7	1.4
Malawi 2004	Female	10	13	13	16	14
	Male	12	14	15	15	15
	M/F	1.2	1.1	1.2	0.9	1.1
Nigeria 2004	Female	3	2	3	4	5
	Male	6	5	5	5	5
	M/F	2.0	2.5	1.7	1.3	1.0
Bangladesh 2000	Female	3	3	4	3	4
	Male	6	6	8	9	7
	M/F	2.0	2.0	2.0	3.0	1.8
Nepal 2003	Female	10	19	16	18	18
	Male	19	22	23	23	24
	M/F	1.9	1.2	1.4	1.3	1.3
Pakistan 2001	Female	15	14	13	14	13
	Male	19	23	25	27	31
	M/F	1.3	1.6	1.9	1.9	2.4
Viet Nam 1998	Female	16	15	16	15	14
	Male	22	21	20	20	16
	M/F	1.4	1.4	1.3	1.3	1.1
Albania 2005	Female	19	22	17	20	6
	Male	32	29	24	25	22
	M/F	1.7	1.3	1.4	1.3	3.7
Bulgaria 2001	Female	8	5	12	11	14
	Male	6	19	19	20	15
	M/F	0.8	3.8	1.6	1.8	1.1
Ecuador 1995	Female	14	21	20	13	17
	Male	15	16	17	19	15
	M/F	1.1	0.8	0.9	1.5	0.9
Guatemala 2000	Female	7	6	4	6	7
	Male	4	5	6	5	7
	M/F	0.6	0.8	1.5	0.8	1.0
Nicaragua 2001	Female	8	12	16	13	14
	Male	11	18	20	21	22
	M/F	1.4	1.5	1.3	1.6	1.6
Panama 2003	Female	3	2	3	4	7
	Male	2	3	7	5	7
	M/F	0.7	1.5	2.3	1.3	1.0

Source: RIGA dataset. The figures used are the most recent available in the dataset for each country.

identified as resources over which women have both access and control.

There are significant examples of women earning income and contributing to food supplies by joining dairy producer cooperatives. In India and Pakistan, women are members of many of the cooperatives built around large specialized milk herds that meet urban milk demand. There are also a few reports of small-scale, independent individual producers who have invested in more intensive production units based on special milk breeds, improved feed regimes and improved disease control (Okali, 2009). There is no detailed demographic information about the women involved, except perhaps that they are poor.

There are two important points to consider. First, both women and men (husbands and wives) are involved, at times, in a joint activity. Apart from the cost of the animals themselves, these small-scale systems may use hired labour and depend on purchased feed, which suggests that only wealthier individuals can invest in these new intensive production systems. Second, the new institutional arrangements provided by the cooperatives have enabled poor women to overcome constraints to their access to services and credit (Arpi, 2006). The cooperative reduces the risk for actors at the lower end of the chain while enabling them to contribute to increasing the availability of livestock products through new markets. It also facilitates the investment required to ensure that food safety rules are followed.

Outside of programmes designed to ensure women's access to livestock, there is some evidence of women losing their access to milk animals at widowhood and divorce (Okali, 2009). Equally, there is evidence that individual women, and especially poor women, are not able to manage intensive systems on their own. Under these circumstances, the capital asset is likely to be viewed as a joint or household asset in which most members have some interest. Given that the animals are kept close to or even within the living quarters, this would not seem to be an unrealistic expectation (Okali, 2009). On the other hand, in a number of areas, especially in Southern Africa and Latin America, there is some suggestion that animals acquired by women through projects are treated differently, regardless of their size. In these cases, they are not socially embedded and control over the animals and the income gained from product sales is unlikely to be challenged.

In Bangladesh, BRAC's[1] poultry programme provides support for poor women and bypasses gender-biased public services. There is only limited information on the impact of these activities on livelihoods and food security, although there is some suggestion that the women involved in the BRAC poultry programme can climb the "livestock ladder" by acquiring a larger number of poultry and exchanging them for a more valuable animal.

The importance of poultry production for maintaining the nutritional well-being of poor households is emphasised in much of the livestock literature. In a number of countries, poultry production is presented as their main or even only source of protein, yet evidence from the H5N1 Highly Pathogenic Avian Influenza outbreak demonstrated that poultry are difficult for them to sustain in the face of disease outbreak and control measures. The food security impact of this is quite situation specific. A study carried out in the poorest governorates of Egypt (Geerlings *et al.*, 2007) found that poultry income was often the only contribution women made to household income, and if those contributions were reduced, their ability to negotiate with male relatives for money to fulfil their food security obligations was reduced, causing tension and intra-household conflicts.

In terms of decision-making over livestock sales and use within household flocks and herds, Nyungu and Sithole (1999) found that small livestock in both backyard and small-scale commercial systems must be seen as a joint house-

[1] BRAC, originally the Bangladesh Rehabilitation Assistance Committee but now known solely by its acronym, is a development organization based in Bangladesh, well known for its work with small-scale poultry producers.

hold resource, even if those individual animals were acquired by different individuals. As a joint resource, decisions about use, including sale, are likely to be open to negotiation, even joint decision-making, with final decisions dependent on need and who is present at the time. Small livestock may be seen simply as "small things", not to be bargained over, especially in circumstances where it is difficult to protect livestock health. In these situations, mortalities are likely to be high, and the number of animals can fluctuate dramatically over time. The wider gender literature shows that not all decisions about benefit allocations and even work are bargained over, as in the case of animals managed as household flocks or herds. Rather, they may be taken for granted and therefore unquestioned (Bourdieu, 1977), not even regarded as an imposition by those who ostensibly might lose out.

When it comes to food allocation within households, preference for one household member or another can be displayed through their being served more or higher quality food, which means they will have higher caloric intake, more variety and the possibility of greater nutrient density (Gittlesohn *et al.*, 1997). There is almost a universal expectation of food allocation bias against females of all ages, and against younger household members (Gittlesohn *et al.*, 1997). The bias against women is accentuated during food shortages (Agarwal, 1992a; 1992b). Household members considered to be at greatest risk of lasting damage from malnutrition are pregnant and lactating women and pre-school children (Lipton and Longhurst, 1989).

However, there is no substantive information on preferential allocations of meat and other livestock products within households. In some societies, pregnant or lactating women receive special nutritional treatment. In Egypt, for example, there is a tradition of giving eggs to women for some days after they give birth. Children generally appear to have claims over milk, but while some gender literature suggests that women will usually choose consumption over sale of milk and other products, there is also information suggesting that both women and men might choose sale over consumption, and indeed this may be a rational decision. There are stories of children being denied eggs because it might encourage an appetite for expensive foods. From a very detailed study, Leonard (1991) concluded that the nutritional needs of younger household members were likely to be protected in situations where they contributed substantially to the household labour force. Jackson and Palmer-Jones (1999) made a similar case for adult men based on calculations that went beyond simply hours of work completed. Other literature suggests that women are denied meat or would not be allocated the "best" cuts, yet they are more often than not the food servers and presumably in some situations have a practical advantage over who is given what to eat.

There is also information describing how women might, in private, work around norms or customary practices that deny them certain foods. They manage to improve their own food intake by manipulating food portions, snacking frequently, increasing their consumption of palliative foods during the hungry season – sugar cane and palm wine that have high energy content, palm nuts that can be chewed for a long time, or possibly even dried meat – planting larger gardens for vegetables when pregnant, cheating on food taboos, and resorting to subterfuge to access desirable foods (Bentley *et al.*, 1999).

ECONOMIC FACTORS AFFECTING CHOICE OF LIVESTOCK SOURCE FOODS

Livestock source foods are a choice for many people in many societies, as well as a valuable source of nutrition. However, their place in the household diet depends not just on preference but also on their affordability. This is affected by household income levels and the proportion of household income allocated to different kinds of food, and by the price of livestock source foods compared to crop-based alternatives. Each of these factors will be discussed in turn.

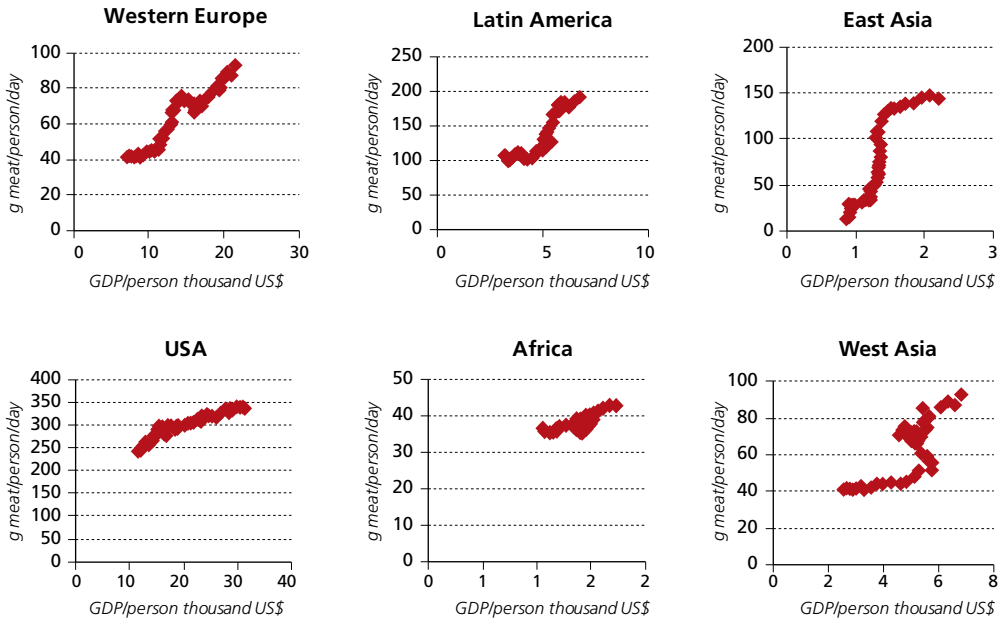
INCOME

Global statistics show that livestock source foods are fairly income elastic. As income levels have risen and urbanization increased, diets have changed. Demand for livestock products has diversified, consumption of livestock products has increased, and wheat and vegetable oils have been substituted for traditional foods such as cassava, maize and lard. These effects have been observable in many parts of the developing world, in poorer countries as well as emerging economies. Figure 6 demonstrates the close relationship between GDP per person and meat consumption per person in six regions, using annual data over a 40-year period.

Several country studies further illustrate the above relationship. In China, a survey of long-term trends showed that the diets of both richer and poorer people became more fat rich over time – with consumption of more vegetable oil for the poorer and of more livestock products for the richer (Guo *et al.*, 1999). A study in Uganda and Viet Nam (Maltsoglou, 2007) found that increased incomes were matched with increased consumption of livestock products. Knips' (2006) review of six countries – Jamaica, Peru, Senegal, Tanzania, Bangladesh, Thailand – found that with rising incomes, accompanied by urbanization and westernization of diets, there has been a demand for diversified dairy products, such as pasteurized milk, ice cream and chocolate. Increased incomes also result in increased health and nutrition awareness which in turn leads to increased demand for higher value, safer and higher quality products (Costales *et al.*, 2005).

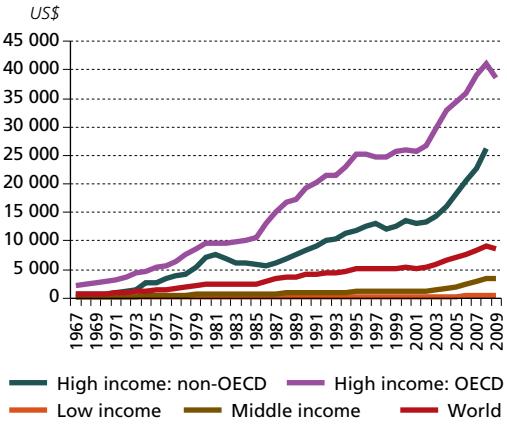
Conversely, low incomes are a major constraint to consumption of livestock products, particularly in poor countries. In Senegal, a litre of fresh milk in the capital, Dakar, could cost up to half the daily wage of a worker while in

6 RELATIONSHIP BETWEEN GDP PER PERSON AND MEAT CONSUMPTION PER PERSON PER DAY IN SELECTED REGIONS



Source: http://www.ggdc.net/maddison/ and http://faostat.fao.org/site/291/default.aspx. Based on annual data from 1967 to 2007.

7 GDP PER PERSON IN CURRENT US$ BY COUNTRY INCOME GROUPING



Source: World Development Indicators accessed January 2010.

St Louis Region, poor consumers could only afford to buy fermented milk and milk powder sold in individual servings (Knips, 2006). In Burkina Faso, most consumers prefer traditional poultry products and cannot afford the products from semi-intensive systems which are cheaper by the kilo but more expensive by the unit, the only measure poor consumers can deal in (Gning, 2005).

GDP per person, which is one measure of people's ability to spend, has been growing in most regions of the world. Between 1990 and 2008, it rose by 219 percent worldwide and by 207 percent in low income countries, although from a considerably lower base. Extreme poverty (people with an income of US$1.25 a day or less at 2005 prices) has been falling worldwide, from 1.9 billion people in 1981 to about 1.4 billion according to recent estimates. Overall this adds up to a slowly growing ability to purchase food, including livestock products.

Consumption of animal source foods is uneven across countries, regions and income levels, although the general trend is upwards. While developed countries have seen a slow growth in consumption from a very high base, the picture in the developing world has been more varied.

In East and Southeast Asia and particularly China, where economic growth and poverty reduction have been strongest, there has been a strong growth in consumption of livestock products. The countries within these regions that have higher per person incomes, such as Malaysia, Thailand and the Philippines, also have relatively high per person meat consumption (Costales, 2007). In China, GDP per person grew by over 1000 percent from 1990 to 2005. During the same period, the proportion of people living in extreme poverty fell from 60 to 16 percent. Consumption of meat rose from approximately 26 to 54 kg per person per year, milk from 7 to 26 kg, and eggs from 17 to 19 kg (FAOSTAT; WDI, 2010).

In South Asia, the poverty rate fell slightly from 1990 to 2005 but the number of people living in extreme poverty did not. While GDP growth in India was slightly above the world average, that of Bangladesh was below it. South Asia has seen a small rise in consumption of meat and eggs and a larger rise in milk consumption, with cultural factors playing a part (many Hindus are vegetarian), as well as a rise in small-scale dairying, making milk easily accessible to farm families.

In Latin America and the Caribbean, consumption of livestock products tends to be higher than in other developing areas and has increased rapidly. Countries such as Chile, Brazil and Ecuador have seen growth in GDP and a drop in poverty rates along with a large increase in consumption of livestock products while growth in other countries has been slower.

In Africa, there has been some growth but from a very low base. In many sub-Saharan African countries, GDP growth was up to 150 percent between 1990 and 2005 and, while the poverty rate for the region fell from 58 percent in 1990 to 51 percent in 2005 (calculations from Povcal), it is still high. The consumption of livestock products in the region also remained more or less static, with a slight decline in meat consumption and a slight rise in milk consumption between 1992 and 2002 (Rae and Nayga, 2010).

In addition to regional differences, there are differences between urban and rural consumption. In both poor and emerging economies, urban dwellers tend to have higher incomes and buy more livestock products through formal channels, particularly higher value processed products. A review by Maltsoglou (2007) reported that in Peru, Uganda and Viet Nam, urban households consumed 1.5 to 2.5 times as much livestock source food as those in rural areas. In India, urban consumers eat 2.8 and 4.5 times more eggs and poultry meat respectively than rural consumers (Mehta *et al.*, 2003) while in China, urban people have three times the income of those in rural areas and consume four times as much milk and twice as many eggs (Ke, 2010). In Thailand, 95 percent of dairy products are sold to urban consumers (Knips, 2006). Rising urban income in Bangladesh has led to a rapidly increasing urban demand for milk products, including pasteurized milk, milk powder, flavoured milk, sweet curd, sweet meats, ice cream, ice lollies and chocolate (Knips, 2006).

PRICE

Livestock source foods are rarely listed among household staples. They are more expensive than the grains and starches that provide the basic energy supply and often more expensive than plant-source protein such as lentils or beans. High prices depress consumption levels of livestock products. In Jamaica, for example, high production costs for fresh milk have led to decreased demand because consumers cannot afford it (Knips, 2006).

Worldwide prices of food in general, including livestock source foods, were about 40 percent lower in the mid-1990s and early-2000s than they are today and a little more stable (IMF, undated). In recent years, increasing grain prices have had a double impact on livestock – they have raised the price of staple cereals, reducing people's purchasing power and, at the same time, raised the cost of livestock feed. Interestingly, during the 2007–08 global economic crisis, meat prices increased less than cereal or dairy product prices, but still the growth of demand for livestock products slowed. In richer countries, such as UK, this manifested as a change to cheaper cuts of meat, affecting people's lifestyle but not their food security. In poorer countries, there has been some substitution of crops for livestock protein.

Fish are also an important protein source and farmed fish, being efficient converters of feed, are a growing competitor to livestock. Maltsoglou (2007) found that in Uganda, poor families eat more fish than meat, while richer families eat more meat than fish. In Viet Nam, families in all wealth categories eat more fish than meat, while in Peru, meat is greatly preferred to fish, regardless of wealth status.

It is challenging to balance the need of producers to make a living with consumers' need for affordable food. In Viet Nam, for example, supportive government policies to develop the domestic dairy subsector have resulted in high milk yields, better dairy genetics, better dairy management and a rapid growth in production. However, the strong profitability of milk producers relies on substantial government support which maintains high output prices and low input prices to the disadvantage of the poor consumer – Vietnamese consumers pay European prices for milk (Garcia *et al.*, 2006). One reason for the rapid rise in chicken consumption has almost certainly been the fact that chicken meat it is relatively cheap compared to other meats (FAO, 2007).

MARKET ACCESS AND FOOD ACCESS

Access to livestock source foods is facilitated by the connections that producers and consumers have to markets for livestock products, which range from selling to one's neighbour over the fence to supplying supermarkets in distant cities through integrated market chains. Good market access increases the food security of producers through assured income and the food security of consumers by ensuring that food products will be locally available when needed.

Small-scale producers, pastoralists and poor

consumers do the bulk of their trading through informal markets and often close to home. Formal markets are almost non-existent in remote areas, and rural livestock producers face long distances, poor road networks and high transactions costs (Costales *et al.*, 2005). These factors encourage producers to consume at home and sell milk, meat and eggs in local marketplaces. Closer to town, peri-urban livestock producers have the advantage of proximity to a wider range of markets, so the prices they fetch for their produce are higher. They also benefit from increasing demand for livestock products, a result of rising incomes in urban areas. However, they still face barriers to entering formal markets due to requirements to meet consistent quality standards and volume, and for certification of product safety.

Much recent literature on livestock development and a great many development projects are concerned with linking small-scale producers to larger or more formal markets. The assumptions behind these efforts are that small-scale producers will have more lucrative and stable livelihoods if they are more strongly connected to semi-formal or formal markets, and that this will provide an incentive for them to become more efficient and productive. There is also, sometimes, an assumption that formal markets will ensure safer food for consumers.

DIVERSE MARKETS FOR DAIRY PRODUCTS

The greatest potential for connecting small-scale producers and traders with markets probably lies with dairy products, although not at the same level in every region. For example, Brazil, Latin America's largest dairy market, has intensified production considerably which implies limited prospects for small producers (Bennett *et al.*, 2006). However, in peri-urban areas of South Asia and some parts of Africa, there have been successful efforts to build market chains based on smallholders (Box 6). Dairy production benefits less from economies of scale than other livestock enterprises and provides a frequent and regular income for those who produce and sell milk. The large size of the informal market, probably around 80 percent of marketed milk in developing countries, means that there is still scope for smallholder engagement. The perishable nature of fresh milk also lends itself to marketing close to where it is produced. For these reasons, small-scale peri-urban dairy marketing systems have the potential to make a growing contribution to food production in some regions, at the same time allowing consumers a choice as to where they buy their dairy products.

CONCENTRATION OF POULTRY MARKET CHAINS

Poultry systems are a complete contrast to dairy systems. Poultry production and marketing benefit from economies of scale. They exhibit distinct differences between the very large companies that dominate worldwide supply and trade and the small-scale producers in developing countries. As a country's economy grows, the informal peri-urban market initially thrives as entrepreneurs take advantage of new demand, but soon the subsector intensifies and small-scale producers and traders cannot compete. Concerns about hygiene also encourage urban councils to replace live bird markets with slaughterhouses that charge fees for processing. All of these factors mean that projects to connect small-scale poultry keepers to formal markets face a number of challenges and potentially a short life.

The few successes for commercial poultry smallholders have mainly been in local specialty markets. In Viet Nam, small- and medium-scale duck breeders and traders still predominate, supported by strong demand and little competition from industry. Recent projects to promote biosecure traditional chicken keeping in Viet Nam are also showing promise (Ifft *et al.*, 2007; USAID, 2007). In India, the KeggFarm poultry breeding company has produced a crossbred chicken that has meat similar to a traditional bird's but is suitable for outdoor living. The company has set up

BOX 6

INFORMAL MARKETING OF DAIRY PRODUCTS IN SOUTH ASIA, EAST AND WEST AFRICA

Successful small-scale milk marketing initiatives have added structure to informal dairy markets without excluding small-scale operators.

South Asia

In India, approximately 50 percent of milk is consumed by the people who produce it. Of the milk sold, 80 percent or more passes through informal channels – in 2002, an estimated 80 percent of Indian towns received milk only through informal markets (CALPI, undated). The milkman is often the only means by which the producer can sell and the consumer can buy milk on a daily basis. The well known "Operation Flood" project, which introduced more formality to milk marketing chains, was designed to meet the needs of small-scale operators with frequent local collection and regular payments.

In Bangladesh, 97 percent of milk is sold to milkmen, who then either sell it as sweets to sweet shops or to the consumer as fresh milk, curd or butter oil (Garcia *et al.*, 2004a).

East and West Africa

In East Africa, an estimated 80 percent of milk is sold through informal channels but the milk market varies by country.

In Kenya, dairy products are the largest item of food expenditure (Argwings-Kodhek *et al.*, 2005; Salasya *et al.*, 2006). More than 85 percent of milk is marketed through informal channels, which provide producers with higher prices than formal channels (Omore, 2004). A dairy policy passed in 2004 allows for the licensing and training of small-scale traders (Kaitibie *et al.*, 2008), meaning they participate in the market legally and can build more stable businesses.

In Tanzania, 90 percent or more of milk is consumed on-farm or sold to consumers close by, due to the inaccessibility of markets. In those parts of the country where cattle are not kept, milk consumption is very low (Knips, 2006). In Ethiopia, an average of 76 percent of all domestic milk production is consumed on-farm (Jabbar *et al.*, 2010).

In West Africa's Sahel countries (Kamuanga *et al.*, 2008), poor roads and lack of refrigerated trucks result in high transport costs and therefore low profits for rural producers. Even when they do manage to reach the markets, they have to sell door-to-door or from kiosks in the suburbs. Consequently, 80 percent of milk produced in rural areas of Senegal is consumed on-farm (Knips, 2006).

a marketing chain involving hundreds of traders with bicycles to supply fertilized eggs and chicks to village producers (Ahuja *et al.*, 2009). Once the birds are grown, producers find a strong demand in their local markets.

In spite of the dominance of large producers, village poultry consumed at home or sold locally are still important to food access in rural economies and likely to persist. Reports on poultry keeping in Africa frequently mention the importance of village chickens in providing meat and eggs for home consumption, often indicating that around 50 percent of production is consumed at home. In Viet Nam, poor households that own small numbers of poultry as scavenging flocks use them mostly for home consumption (Maltsoglou and Rapsomanikis, 2005). The proportion of poultry consumed and used for other purposes within the household is much greater in the highland areas than in lowland areas which have better access to markets (Tung, 2005). In Bangladesh, the landless poor have a great need for income and thus are more likely to sell their poultry than consume them.

©FAO/Giulio Napolitano

MARKETING OF LIVE ANIMALS FROM PASTORALIST SYSTEMS

For pastoralists, the key to food access is a sustainable livelihood from marketing live cattle and small ruminants, often across international borders. Ethiopia is estimated to have exported 297 600 animals in 2007–08 with a value of US$41 million (Aklilu and Catley, 2009). A dependable and flexible market allows producers to regulate stocking rates and earn income. However, in the Horn of Africa, market access is affected by wealth, with better-off pastoralists having access to more markets, as well as by mobility, the types of animals owned and the pastoralist's position in social networks. While well-off pastoralists have benefitted from a growing export trade, those less well-off have suffered, with many losing their animals and becoming contract herders (Aklilu and Catley, 2009). Livestock disease also limits the markets that pastoralists can attempt to access. For example, the EU and USA markets are closed when diseases such as contagious bovine pleuropenemonia (CBPP) and FMD are present. They can also close existing markets suddenly. Outbreaks of RVF cut off exports from the Horn of Africa to parts of the Middle East in 1998, 2000 and 2007. Some traders were able to avoid the bans but other traders and livestock owners suffered badly from low prices and the inability to sell animals.

PROCESSING TO ADD VALUE AND PRESERVE PRODUCTS

Home processing of products is one way that rural livestock owners address market inaccessibility. In rural Bangladesh, farmers who have no access to markets for their produce process their milk within their households into traditional products such as ghee, channa and yoghurt, which can be consumed at home or sold or bartered in the village to rural consumers who have no access to high value dairy products such as pasteurized milk (Knips, 2006). In Peru, milk producers who are not located along formal milk collection routes usually convert their own milk into curd and sell it to local cheese-makers, who play an important role in maintaining dairy production in poor remote areas of the country.

Access to processing equipment can extend the shelf life of livestock products, but since much of this equipment is expensive, requires capital input and is subject to economies of scale, it is not an option for poor small-scale livestock producers (Costales *et al.*, 2005). The growth of processing centres in an otherwise remote rural region can remedy this situation and boost availability of livestock products. In Pakistan, one reason for increased domestic milk production is the presence of processing centres.

CONSUMER PREFERENCE

Both informal and formal markets are important to consumers. They generally prefer the taste and texture of meat from indigenous and extensively raised animals, and will choose them for holiday and special occasions. At the same time, they appreciate the lower cost of some products from intensive systems.

For rural consumers in developing countries, local markets may be the only ones within convenient reach. They provide lower prices, traditionally raised livestock and the opportunity to check the quality of products close to source.

In urban areas of developing countries, markets that offer fresh produce appeal to consumers who prefer to buy live animals and have them slaughtered at the market, rather than

trusting the hygiene of food chains supplying meat. This has resulted in a proliferation of live-animal markets near or within cities. As will be discussed later under "City Populations", city councils have concerns about environmental and human health problems associated with these markets and would prefer them not to be there.

Supermarkets have taken over food supply in developed countries and are increasing their reach in the cities of the developing world (Reardon *et al*., 2010). They offer the convenience of having everything under one roof, a consistent level of safety and quality and, for wealthier consumers, competitive prices. Integrated market chains that supply supermarkets are also easier to regulate in countries where a regulatory system and laws exist. However, for the many people who currently lack access to food, informal markets will continue to be important and so will "street food" bought in small quantities from stalls.

©FAO/PPLPI

Key points on livestock and global food security

Livestock make a necessary and important contribution to global calorie and protein supplies, but at the same time, they need to be managed carefully to maximize their contribution.

While livestock products are not absolutely essential to human diets, they are desirable and desired. Meat, milk and eggs in appropriate amounts are valuable sources of complete and easily digestible protein and essential micronutrients. Overconsumption, however, results in health problems.

Livestock can increase the world's edible protein balance by converting protein found in forage that is inedible to humans into forms digestible by humans. They can also reduce the edible protein balance by consuming protein that is edible by humans, from cereal grains and soya, and converting it into small amounts of animal protein. Choice of production systems and good management are important factors in optimizing protein output from livestock.

Livestock production and marketing can help stabilize the food supply, acting as a buffer to economic shocks and natural disasters for individuals and communities. However, the food supply from livestock can be destabilized, particularly by diseases.

Access to livestock source food is affected by income and social customs. Access to livestock as a source of income and hence food is also unequal. Gender dynamics play a part, particularly in pastoralist and small-scale farming communities, where female-headed households tend to have lower resources hence fewer, smaller livestock, and within families where the larger and more commercial livestock are often controlled by men. These problems are not unique to livestock, but they are prevalent among producers and consumers of livestock products and need attention.

The following section looks at three unique types of populations in terms of their relationship to livestock and livestock products: livestock dependent societies, small-scale mixed farming societies and urban dwellers.