Three human populations – three food security situations

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Livestock-dependent societies

In societies that depend on livestock as their most important source of livelihood and food security, management of livestock shapes their way of life. These livestock-dependent societies have production systems based on grazing land. According to one definition (Sere and Steinfeld, 1996) at least 90 percent of the total value of farm production comes from livestock and more than 90 percent of dry matter fed to animals comes from rangelands, pastures and annual forages.

The largest number of livestock dependent people, currently around 120 million (Raas, 2006, based on data from 2002), is found in pastoralist societies, where livestock provide milk and occasionally blood and meat for their owners, carry the possessions of nomadic families when they move, are the main or only source of income when they or their products are sold, and the main capital asset owned by the family. Some communities practice mobile grazing, moving animals over wide communal grazing areas, while others are sedentary graziers on communal grasslands.

Ranchers who keep animals extensively on the rangelands are another example of a livestock-dependent society, considerably fewer in number than pastoralists but important in their contribution to the total supply of livestock in their countries and the world. Animals are kept primarily for income, although they also make a direct contribution by supplying milk and meat to ranch families and employees. Ranchers and stock farmers often use grassland that they own or where they can have control over its use.

By definition, a livestock-dependent society relies heavily on livestock for its food security and livelihood and, as the discussion in this chapter will show, these societies have a special niche in global food security. At the same time, they face many challenges and need support in order to continue to play their important role. The level of production from these systems may be close to the limit, given limitations on natural resources, and they will increasingly need to rely on activities outside of agriculture for sustainable livelihoods.

CONTRIBUTIONS AND CHALLENGES TO FOOD SECURITY

Pastoralism and ranching contribute to food security in three important ways: they add to the total food supply, they strongly support food access by livestock owners and managers and, when managed appropriately, they contribute to a positive protein balance.

Rainfed grazing systems provide around 19.2 million tonnes of ruminant meat or 19 percent of world production (based on data in Table 6). They also provide about 12 percent of the world's milk. Ranching systems, which produce almost entirely for income, have more reliable access than pastoralists to higher value markets, putting them in a stronger position to contribute to global supplies. The Australian rangeland systems, for example, are the second largest producers of sheep meat in the world and export approximately 45 percent of their production (ABARE, 2010; Meat and Livestock Australia, 2011).

In some countries, pastoralism makes an important contribution to national food production and to GDP and, in a few cases, it also contributes significantly to export. The livestock of Mongolia produce one-third of the country's GDP and up to 21 percent of its export earnings. The rangelands of Morocco contribute an estimated 25 percent to agricultural GDP. Approximately 46 percent of the bovine meat in East Africa and just over 40 percent of small ruminant meat are estimated to come from pastoral systems (Raas, 2006) while in West Africa, pastoralism contributes 37 percent of bovine meat and 33 percent of small ruminant meat (Raas, 2006).

Livestock also have a very important function in supporting food access for pastoralist families. Their value is illustrated by the fact that, throughout the Horn of Africa, pastoralists define their wealth and poverty in terms of their ownership of livestock (Aklilu and Catley, 2009). In pastoralist households, all of the livestock source food may be produced from their own animals, and income from livestock makes up a large part of total household income. In Kenya, for example, livestock production is estimated to contribute between 50 and 95 percent of the income of pastoralist families (Aklilu and Catley, 2009; Kenya Ministry of Agriculture, 2008) while in Senegal, 80 percent of milk produced by pastoralist and agro-pastoralists is consumed by the household (Knips, 2006). Animals are also sold as needed to stabilize income or consumption during drought, or preserved to allow families to recover from disaster (Bailey *et al.*, 1999; Umar and Baulch, 2007; Pavanello, 2010).

Productivity from extensive grazing systems is low in terms of output per animal and per labour unit but high in terms of output from limited resources (water and grain). In these systems, livestock can be favourable to the protein balance because they use forage resources that cannot be used for any other form of food production. They also occupy land areas where there are limited alternatives for other types of production because good soil and water are in short supply, the terrain is hilly or the location is remote. However, dependence on livestock presents risks, because it occurs in fragile and challenging ecologies where there are limited prospects for diversification. Livestock owners are expert, specialized and their way of life is adapted to a harsh environment. They can be quite self-sufficient, requiring only limited inputs from outside. At the same time, the foundation of their livelihoods and food security, the livestock herd, is susceptible to disease, drought and harsh climate, and the output of individual animals is, on average, low.

Ranchers, who rely on selling animals or wool, have seen slower growth in demand for ruminant meat than meat from pigs and poultry. Production of ruminant meat has approximately doubled over the past 40 years, but has increased seven-fold for poultry meat (as shown in Table 4). Trade growth for beef and ruminant meat is also lagging behind the total for meat (Morgan and Tallard, undated). The trade shocks caused by diseases such as FMD and BSE hurt some countries that suffered outbreaks but benefited those that did not (Morgan and Tallard, undat-

ed). Climate change and difficult market conditions have caused ranchers in the USA, Australia and New Zealand to reduce their herds. The Australian national sheep flock has approximately halved in the past 20 years, even though there is growing demand for sheep meat in the Middle East. Ranchers cope with adversity by diversifying species and products, and investing in enterprises outside of livestock.

In pastoralist societies, people tend to be poor and often their livelihoods and food security are fragile. Forage and water are limited, theft of animals is common and disease outbreaks at times cause heavy losses to pastoralist herds. In recognizing that these are part of the normal course of events, management focuses on building resilience into the system, targeting stability rather than high levels of production (FAO, 2003; Mamo, 2007; Barrow *et al.*, 2007).

Mating in some systems is restricted to narrow windows of time to allow lactating animals to make best use of forage and allow young animals to grow during the most favourable weather. Destocking and restocking are used to cope with fluctuations in the forage supply, young animals being sold and the breeding herd maintained. Movements are timed to reduce exposure to raiders, and armed young men guard the animals. A number of measures are used to restrict exposure to disease and risks are weighed carefully. Quarantining of new animals, avoiding neighbouring herds when a disease outbreak has occurred in the vicinity, avoiding wildlife, controlling ticks and tsetse flies, and the use of antibiotics to cure CBPP are all risk management practices used by pastoralists.

There is limited potential to diversify livelihoods out of livestock other than by sending family members away to seek education and work in cities and foreign countries, which has the risk that they will not return. Loss of land through encroachment by settled farmers, development of wildlife areas or building of dams, as well as the threats of drought, conflict and insecurity are all identified as reasons why African pastoralists have migrated to urban areas. They seek work in the informal sector, yet their livelihoods and food security do not necessarily improve (UN HABITAT, 2010). Others have acquired rights to land and become mixed farmers.

It is rare that an entire country represents a case study for one type of society or production system. Mongolia represents that unusual situation because to a large degree, the country as a whole could be said to be livestock dependent. The following case study examines the extent to which this is true and the way conditions are changing.

CASE STUDY
MONGOLIA: THE LIMITS OF THE LAST PLACE ON EARTH[2]

Mongolia is sometimes (and with respect) called "the last place on earth" referring to its remoteness and its open spaces. The popular image of Mongolia is of wide open steppe or desert dotted with white round tents (*gers*, sometimes called *yurts*) and nomadic herders on horseback following their flocks of sheep, goats, horses, cattle and Bactrian camels against a backdrop of mountains and a deep blue sky. A land with no fences, it is almost three times the size of France but has only 2.7 million people.

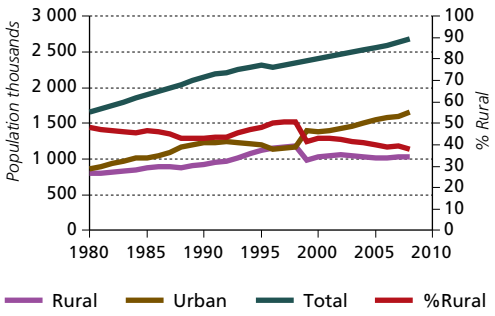
With livestock numbers at record high levels, solar charging panels on the roofs of many *gers*, and a satellite dish providing television reception in every community, livestock producers seem to be doing well. In the capital, Ulaanbaatar, shops are well stocked with televisions, computers and luxury consumer goods, a great change since the mid-1990s. Appearances are partly true, but they are no longer typical and serious problems often go unnoticed.

Mongolia is one of the last countries where livestock raising provides the greatest source of employment – around 40 percent of the population – and where few other forms of land use are possible. It is perhaps as livestock dependent a country as can still be found.

Mongolia is entirely landlocked, sandwiched

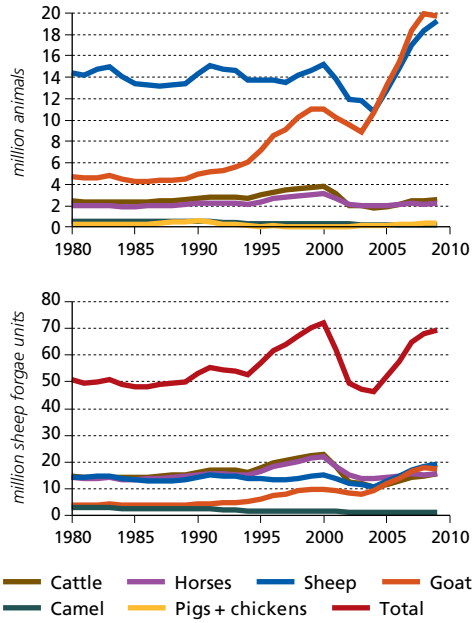
[2] The case study is adapted from Honhold, 2010.

8 HUMAN POPULATION OF MONGOLIA 1980 TO 2007



Source: Annual yearbooks of the National Statistical Office of Mongolia.

9 LIVESTOCK POPULATION OF MONGOLIA BY SPECIES 1980 TO 2009



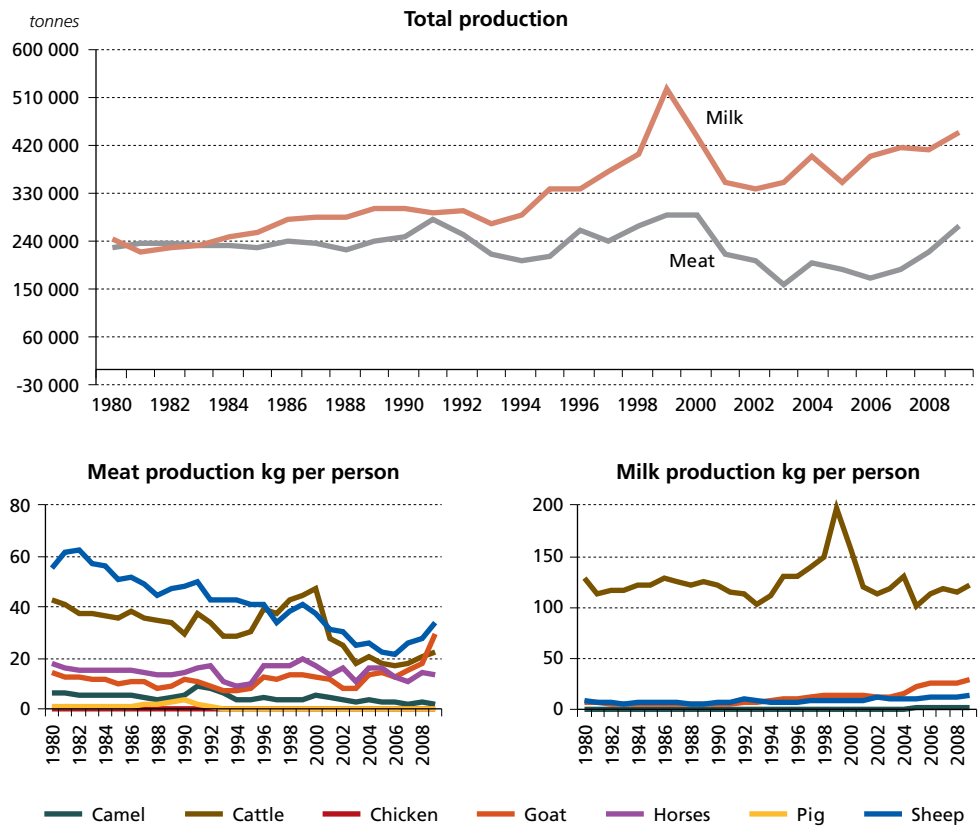
Source: Annual yearbooks of the National Statistical Office of Mongolia.

between Russia (Siberia) to the north and China (largely Inner Mongolia) to the south. The countryside is open, with virtually no fences, and ranges from desert to mountains to steppe to forest. However, where visitors see apparently empty, wide open spaces, herders see the countryside defined by water sources and wintering sites. These are limited and their number, particularly of the latter, is difficult to change. Water resources have been increased in the past by establishing wells, but this can have the effect of enabling livestock to use pastures that would otherwise be kept for winter pastures or fodder.

The current human population of Mongolia is around 2.7 million, with a population density of 1.7 per km^2, making it one of the most sparsely populated countries in the world. However, since 1977, 50 percent or more of the population has lived in urban centres, either the capital city or the major province centres. Figure 8 shows the growth in the total population since 1980 and the increasing proportion made up by the urban population.

The livestock population almost doubled between 1988 and 2009, increasing to around 44 million, almost entirely ruminant livestock and horses. There are very few chickens or pigs in the country (see Figure 9). However, this total does not take into account the change in the composition of the national herd, in which the sheep and goat populations have grown rapidly in recent years. The Mongolians use their own measure of a livestock unit, a Sheep Forage Unit (SFU), to create equivalence between different grazing species in terms of the amount of forage each requires. Calculations using these units indicate the change in the size and composition of the national herd in relation to its use of forage, as shown in Figure 9. The total national herd size has risen from 50 to 70 million SFUs. The total was fairly level until around 1990, but since then, there have been rapid rises and equally rapid declines. These latter have been linked to the occurrence of severe winter conditions (*dzuds*) and summer droughts. As the rural population is dependent on livestock rearing for income, such fluctuations create obvious impacts on their livelihoods. Equally, the prices they obtain

10 MILK AND MEAT PRODUCTION IN MONGOLIA 1980 TO 2005



Source: FAOSTAT (production data) and World Development Indicators (human population).

for their products have a strong impact, and they have been affected by recent changes in the price of cashmere. The number of animals is a poor guide to the health of the livestock industry.

Livestock supply meat, milk, fibre and transport, although the last is decreasing. Meat production grew from 1961 to 1978, from around 150 000 tonnes to 230 000 tonnes but then levelled off until the late 1980s. Since then, as shown in Figure 10, total meat production has fluctuated from 280 000 to 150 000 tonnes annually and the species contributing to meat production have varied from year to year. Part of this fluctuation was due to a series of *dzuds* and droughts that occurred from 1999 to 2002. On a per person basis, there was an overall downward trend in production between 1980 and 2009, despite record high numbers of livestock being kept. Many herders have turned to producing and selling cashmere as a cash crop, which is seen in the increased numbers of goats being kept. There is no reliable public database of cashmere production, therefore the figures are not reproduced here, but estimates in the early 1990s suggested that world production was around 4 500–5 000 tonnes per year, of which Mongolia supplied 20–25 percent (Petrie, 1995). Mongolian cashmere is generally of high quality and commands a good price for the raw product (de Weijer, undated), but this is a non-essential

commodity largely supplying a luxury market where prices fluctuate (Schneider Group, undated).

FOOD SUPPLY

The daily dietary energy requirement recommended for Mongolia is 1 840 kcal per person per day (FAOSTAT, accessed October 2010).

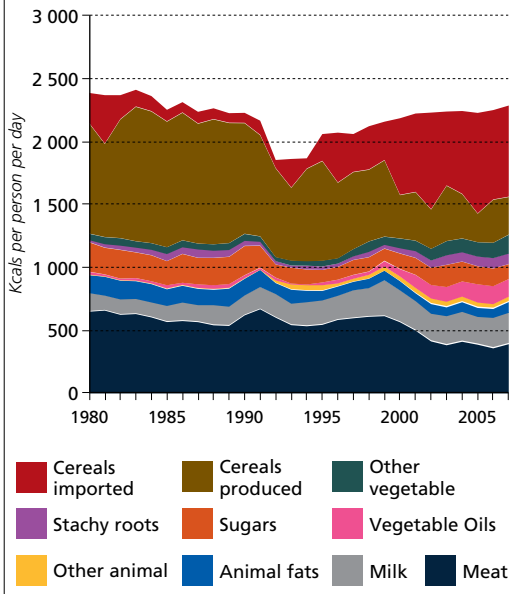
Figures 11 and 12 show the average caloric intake per person per day in Mongolia between 1980 and 2007. Apart from a short period during 1991 to 1994, food supply was over 2 000 kcal per person per day, and the most recent trend was a gradual rise. However, the contribution from animal products declined over this period from just under 1 000 kcal to around 750 kcal per day, from 40 to 30 percent. The decline in the contribution of meat was more marked, with much of the difference made up by an increase in milk supply. Much of what is consumed is produced in Mongolia, including starchy roots (potatoes) and cereals (mostly wheat).

The makeup of the daily energy supply, even in nomad families, has always contained a significant contribution from vegetable products, particularly cereals. However, in the early 1960s, locally produced animal products contributed over 50 percent of a daily energy supply per person of just over 2 000 kcal. By 2007, this had fallen to around 33 percent of a daily per person supply of 2 300. During that time, the proportion of energy supply produced locally had fallen from around 90 percent to 50 percent. Per person meat supply has not kept pace with the increase in population and is falling despite the increased herd size.

Sugars, vegetable oils, other cereals and other vegetables and fruits are mostly imported. The proportion of the calorific intake that is imported has risen from around 20 percent to 50 percent, largely from an increased import of cereals, although vegetable oils are increasingly important in the diet.

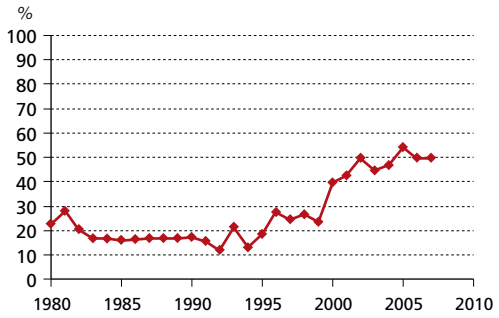
Cereal production was established in the 1960s through the virgin lands system, with monoculture systems using large fields and high levels of mechanization and irrigation established by the state. In the early 1990s, state support for these systems was withdrawn resulting in dramatic declines in locally grown cereals. The decline continued until 2008–09, when local wheat production increased again owing to government

11 KILOCALORIE CONSUMPTION PER DAY IN MONGOLIA BY SOURCE 1980 TO 2007



Source: FAOSTAT.

12 PERCENTAGE OF MONGOLIAN DAILY KILOCALORIE INTAKE THAT IS IMPORTED



Source: FAOSTAT.

investment, and in 2009, Mongolia may have become almost self-sufficient in grains (contrary to Figures 11 and 12). However, the production system gives yields of 0.8 to 1 tonne per hectare (National Statistical Office of Mongolia, 2007), around 10 percent of that for farms in Europe and North America, and relies completely on imported fertilizers, fuel and machinery. National food security will be improved, but at a high financial cost.

FOOD SECURITY FOR HERDERS AND URBAN DWELLERS

Food security for herders (livestock dependent families) is said to be adequate, and on average this is likely to be true. At the time of change from largely government-owned livestock to private ownership in 1990, around 261 000 (58 percent) of 450 000 households, had some livestock. By 2007, this had fallen to 226 000 (35 percent) of 646 000 households (National Statistical Office of Mongolia, 1980 to 2009). The number of herds rose between 1990 and 1995, but has been declining since then. At the same time, the size of herds has fluctuated.

There is a minimum herd size to enable a herd to survive and recover from adverse climate events such as drought or *dzud*, below which the herder is considered poor and vulnerable. Different publications set levels for viability between 50 and 200, although it is not always clear if this number is for animals or animal equivalents such as SFU. For example, a 2003 World Bank report suggested 100 as a viable herd size. However, a 2009 World Bank report suggested 200 but did not specify the units, while FAO, UNICEF and UNDP (2007) suggested 100. These differences could reflect a change in average herd species composition with a switch from cattle and horses to small ruminants and, in particular, goats. Smaller herders, often more distant from administrative district centres (*sums*), tend to have less access to support services such as veterinarians. They are less well off and more likely to suffer food insecurity.

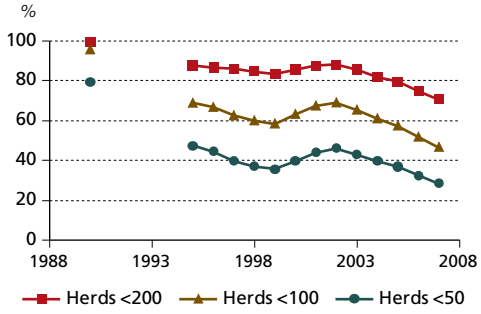
At privatization, very few herds had more than 100 animals and only 20 percent had more than 50. By 2007, 45 percent of flocks were less than 100, around 30 percent were less than 50 and only 30 percent were above 200. There was variation between 1995 and 2007, with herd sizes falling during the 1999–2002 *dzud*-drought combination and then recovering.

Nevertheless, even after five years of relatively good conditions between 2002 and 2007, by some measures almost half of the herds were too small to withstand the next period of climatic stress reliably, as shown in Figure 13.

It appears that herders with smaller numbers of animals are being gradually forced out of herding, a trend that continues even during relatively good years. Among those who remain as herding households, many are acutely vulnerable to poor climatic conditions and are likely to face periodic food insecurity, while the former herders are now counted among the rising number of urban households.

Mongolia is increasingly urban. Recent studies on food security have focused on urban households in Ulaanbaatar and provincial (*aimag*) centres where almost all urban dwellers are found. As much of the urbanization in recent years has been due to a push away from the rural areas, the same problems of lack of infrastructure, access to resources and food insecurity are seen in Mongolia as in other countries. A recent report (FAO,

13 MONGOLIAN LIVESTOCK HERDS BELOW THREE CRITICAL SIZES



Source: Annual yearbooks (1998-2008) of the National Statistical Office of Mongolia with some calculations by authors.

UNICEF and UNDP, 2007) referred to the relative food security of herders and the common practice of family support for poorer households in the smallest urban centres, and contrasted this with the relatively greater food insecurity in the *aimag* centres and Ulaanbaatar where underemployment and unemployment are common, the heating cost for a *ger* in winter is high, and there is a lower intake of animal products and a greater reliance on cereals and potatoes for energy intake. A Mercy Corps study (Hillbruner and Murphy, 2008) found that around one-quarter of households in the *aimag* centres were moderately or severely food insecure, with a further 10 percent somewhat food insecure.

THE FUTURE OF FOOD SECURITY IN MONGOLIA AND THE CONTRIBUTION OF LIVESTOCK

While overall food supply in Mongolia is adequate, there are clear issues of distribution and access (due to poverty) and stability (due to climate, seasonal employment and urbanization). At a minimum, herders with less than 50 animals are at substantial risk of food insecurity while those with less than 100 have some risk. These two groups were respectively around 10 percent and 16 percent of all households in 2007. At the same time, 60 percent of households are urban and of those, 25 percent are food insecure. Thus, by combining the two herder groups with the urban, a total of around 25–30 percent of all households in Mongolia can be said to be food insecure.

Nomadic livestock keeping is a highly sophisticated and evolved system for making a living from a difficult environment. If traditional Mongolian herders still use systems and artefacts that are recognizable from historical tales, it is because they are very well adapted to the nature of the land and climate. Changing or "improving" such production systems is difficult. Bringing in external inputs can help, but this must be sustainable and not lead to a degradation of the environment on which the livestock system depends. Every animal that grazes needs a certain amount of feed biomass to grow, reproduce and, importantly, to build up fat reserves for the winter. Although fodder is conserved for winter feeding, it has always been more common to conserve the excess summer grass growth as fat reserves on the animal, rather than as standing or cut hay. Biomass production is limited by soil fertility, growing season and rainfall. In Mongolia, the first two of these are limited and the third uncertain. The key factors are water supply in the summer and winter camp sites that have access to water and provide shelter but also have enough exposure for snow to blow away. A DANIDA report from 1992, quoted by Honhold (1995), estimated the total biomass production from Mongolian rangeland to be around 380 kg per hectare, sufficient to support 62.5 million SFU, assuming a 50 percent utilization by livestock. However, such a figure does not address annual variations, which are likely to be significant. Given that irrigated and artificially fertilized cropping land, probably some of the better land, produces around 800–1 000 kg of wheat per hectare, the figure of 380 kg of forage from un-irrigated land fertilized only by animal dung, would seem to be optimistic.

It is unlikely that extensive livestock systems can be adapted to produce enough protein to feed the country's growing human population, and there are limited prospects for establishing intensive systems. Livestock are still important in food supply but increasingly less so and, at the same time, livestock production may be at the peak levels possible with the resources available. Much of the country is remote, but little of it is wilderness untouched by human use. Some of the increase in livestock production has been achieved at the expense of once extensive herds of wild antelope. Livestock still contribute to the stability of income, with movements of people to and from herding due to different crises and shocks, but as herding household numbers fall in relation to urban households, this buffering effect has limits. Herding families are now only 28 percent of households.

Livestock dependant as it is, Mongolia relies on

imported food for its food security, either as grain or the inputs required for growing grain in a hostile environment. There is increasing reliance on imported foodstuffs or the inputs needed to produce them locally (although there are also limits to domestic crop production). The move to goats and the income they provide from cashmere has increased incomes and hence access to imported foods. However, Since most is exported mainly through informal channels, income depends on (volatile) world market. The export potential for other livestock products is probably limited because local demand is high. Export would create the need to import other products as substitutes. The animal health situation limits the export of live animals and most livestock food products. The recent opening up of large mining ventures, often with a significant government stake, may provide a source of income with which to import food, since profits are expected to contribute to a sovereign wealth fund for the country that will be used to support the population.

PROSPECTS FOR LIVESTOCK DEPENDENCE

Livestock-dependent societies, or those that are nearly so, play an important role in the contribution of the livestock sector to global food security. By supporting their own population and generating some surplus for export, they contribute to the world's supply of livestock protein as well as their own access to food.

However, the total production from these societies has probably reached the limit. Production per hectare is close to or at the maximum possible under the prevailing climatic and soil fertility conditions, given that many factors affecting production are beyond the control of livestock owners. The total area in the world available for extensive grazing is unlikely to expand because of competition for land from agriculture and human settlement, and therefore total production is likely to reach its limit sooner than in other systems. Existing levels of production should be protected to the extent possible because of their contribution to the food supply and the protein balance, but the percentage that these societies contribute to global food supply can be expected to fall.

There may be shifts in location in the future brought about by climate change, which Black *et al.* (2008) describe as "one of the defining challenges of the 21st Century," one that is expected to change the shape of livestock production in Australia and perhaps in other countries where extensive grazing is widely practised. Decreased and more variable rainfall may require changes in management to cope with additional instability, while also creating new challenges for animal health systems.

Investment in market access will be important since this offers the potential for livestock owners to gain greater value from what they produce and to manage risk by managing stocking levels. The highest income comes from export markets for live animals, meat and fibres, but they are also volatile and particularly difficult for the poorest to access. Here the government has a role to play at national and international levels. For example, in Mongolia, if further development of the cashmere market were possible, it could increase the potential of the livestock sector to support food access. In the Horn of Africa, Aklilu and Catley (2009) suggest that regional policy frameworks within the IGAD and Common Market for Eastern and Southern Africa (COMESA) regional groupings could be supportive of livestock herders, including the poorest, by exploring a range of options for trade.

Over time it is likely livestock dependant societies will become less dependent on livestock, with their animals supporting and supported by other activities. There is a gradual trend for people to move into towns and away from pastoral agriculture. For those who choose to remain in rural areas, tourism, recreation and payment for environmental services such as wildlife conservation and carbon sequestration into grassland (as explained in more detail later) all offer ways to earn income that are complementary to livestock keeping.

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Small-scale mixed farmers

Almost every country in the world has communities centred on mixed farms with a diverse portfolio of activities that includes crops, livestock, other farm enterprises and non-agricultural work. A practical definition of a mixed farm is one where more than 10 percent of the dry matter fed to livestock comes from crop by-products and stubble or more than 10 percent of the value of farm production comes from non-livestock activities (Seré and Steinfeld, 1996). They are highly variable in terms of their size and location, the wealth of their owners, the way animals are managed and the part livestock play in food security. Mixed farms are estimated to produce the majority of the global meat and milk supply (48 percent of beef production, 53 percent of milk production and 33 percent of mutton from rain-fed mixed systems according to Steinfeld *et al.*, 2006).

Given the heterogeneity of the group, it is meaningless to generalize. Thus, this report focuses on the subset of mixed farmers for whom food security is least assured – those who live in developing and transitional economies and have small farms. In these countries, it is common to find communities where mixed farming, mostly small farms, predominates as a way of life.

Even among smallholder mixed farmers, there is still considerable variation in assets, income and social customs. However, a characteristic common to all of them is that livestock are managed as part of an integrated and tightly-woven system, in a way that fits the needs of the farm family, the available labour and the demands of other enterprises. Animals provide food, income, traction, manure, social capital, financial assets and a means of recycling crop wastes, all to varying degrees in varying situations. This is similar to their role previously described in livestock-dependent societies, but for mixed farmers, livestock are usually a much smaller farmers, livestock are usually a much smaller part of the portfolio, albeit an important one.

As this chapter will describe, livestock bring value, versatility and resilience to mixed farming households, which are more robust and food secure with animals than they would be without them. At the same time, there is an important un-

answered question about the role of small-scale mixed farms in the food security of the future. These farms support the families who own them and provide extra food for local communities, but they offer limited prospects for supplying growing urban populations and limited opportunities for the economic advancement of farm households. They have the biological potential to produce a larger supply of food, and they produce food in ways that are positive for the edible protein balance, but there is little economic incentive for them to expand their production.

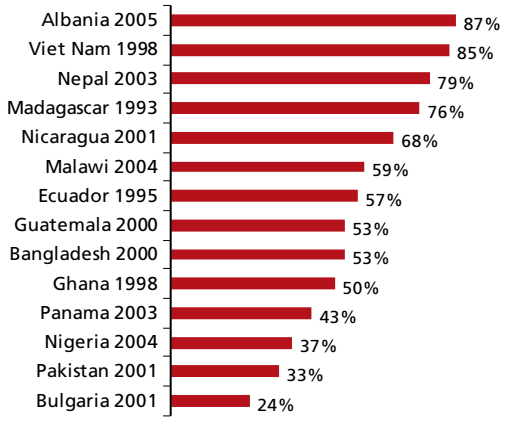
CONTRIBUTION OF LIVESTOCK TO FOOD SECURITY

Many farmers in rural areas survive by managing a mix of different crops and livestock activities, creating synergy when crop residues are used to feed animals and the manure from the animals is used to fertilize the crops. The different enterprises may be concentrated into the same small space or on separate farm plots. Other forms of mixed farming include grazing under fruit trees to keep the grass short or using manure from pigs to "feed" a fish pond. The prevalence of mixed farming varies by country and region. Figure 14, using figures from the RIGA dataset, shows an analysis from 14 countries where the proportion of rural households that practice both cropping and livestock ranges from 24 to 87 percent. Ly *et al.* (2010) reported that in 2004, 83 percent of the cattle in West Africa and 75 percent of the small ruminants were kept in mixed crop-livestock systems, with traction being an important reason for keeping cattle. Chacko *et al.* (2010) reported that from 2004 data, 83 percent of agricultural land in India was occupied by mixed farming systems.

Livestock contribute to food availability, access and stability. In some cases, direct provision of food is their primary contribution while, in others, the main motivation for keeping them is income. A rural household in India or Tanzania with one or two dairy animals will use the majority of their milk for home consumption (Garcia *et al.*, 2003; Knips, 2006). In Viet Nam, poor households that own small numbers of poultry as scavenging flocks use them mostly for home consumption (Maltsoglou and Rapsomanikis, 2005), while peri-urban poultry keepers are more likely than those in remote rural areas to keep flocks of sufficient size to have birds and eggs for sale (Hancock, 2006). In the countries shown in Figure 14, livestock's contribution to the income of mixed farming households ranges from a very small percentage to over 30 percent, with no consistent pattern according to the wealth of the family. Other studies show contributions of up to 50 percent at any given time.

The asset value of livestock is important to household resilience and food stability because it provides collateral to expand or diversify farming operations and gives households a capital item that can be sold in times of great need. Access to both formal and informal credit can be facilitated through ownership of livestock. A recent report found that in the countries represented in the RIGA dataset, livestock farmers were more likely to get credit from formal sources than non-livestock-keeping households within the same income bracket (Pica-Ciamarra, *et al.*, in preparation). The authors found this surprising, because in developing countries, unlike the

14 RURAL HOUSEHOLDS IN SELECTED COUNTRIES ENGAGED IN MIXED FARMING



Source: RIGA dataset.

more developed financial markets, "moveable assets" such as livestock are rarely used as collateral for formal loans. They concluded that livestock might act as a "buffer stock", allowing farmers to allocate part of their resources to relatively risky but high-return activities which financial institutions are willing to finance. For example, in Kenya, Imai (2003) found that that having a higher value of livestock assets enables households to invest more into high risk activities such as coffee and tea production. Another use of assets is to sell them for income smoothing – at times when other enterprises are not providing income or when the household is in crisis. Small animals provide more flexibility than large ones in these cases, since they do not require their owners to liquidate such a large proportion of their capital.

Gender affects the contribution of livestock in mixed farming households. In most developing and emerging economies, ownership of livestock is less common in female-headed than male-headed households. In the 14 countries shown in Table 10, only three have a higher percentage of livestock ownership in households headed by women. In spite of this trend, many examples of women contributing to food security can be found in mixed farming communities. Medium-sized duck breeding enterprises near Viet Nam's capital city Hanoi are equally likely to be owned and managed by women or men, and represent an important asset and income source for the household. Women are central to many of the dairy projects in India and East Africa, including Operation Flood (Arpi, 2006) and the Food and Agriculture Research Management-Africa's (FARM-Africa's) dairy goat project in Ethiopia (FARM-Africa, 2007) which has trained women as well as men animal health workers in recognition of a predominantly female clientele.

Two features distinguish livestock's role in small-scale mixed farming households from the contribution they make in other situations: the synergy between livestock and other enterprises, and the diversity and flexibility that livestock bring to the household's activities.

Synergy. Synergy with crops exists through the exchange of draft power, manure, pest control and crop residues. For example, herded ducks in the Mekong Delta and China travel from field to field eating snails, insects and discarded grain, thus providing pest control for rice crops (Yu *et al.*, 2008). As previously described, the use of draft power is widespread throughout the world although it is diminishing in most areas except Africa, where it appears to be increasing. In some cases, larger landholders own animals that smaller landowners share or contract for their use. Animal power allows the cropping area to be extended beyond what would be possible with hand cultivation, and allows land to be ploughed when it is dry in preparation for planting immediately after the first rains. Manure is most likely to be used for crops where animals and crops are in close proximity, although as explained previously, there are competing demands for manure and it can be in short supply.

Synergy with other livelihood enterprises is most evident with scavenging livestock. Income from these animals is low, but they often provide "something for nothing" by eating crop residues, insects, scraps and rubbish found within the community and requiring very little labour, equipment or housing. Scavenging poultry can provide a 600 percent return on the tiny investment they require (Otte, 2006). Scavenging pigs in Asia and Africa live on household waste, acting as garbage disposal units, and are housed at night in a rough shelter or kept in or under the family dwelling. Goats in Nepal live by grazing and on forages cut from communal grazing areas and forests, costing little in money although they demand time from women and children (ADB, 2010).

Diversity and flexibility. The contribution of livestock to food security varies over time depending on family need which can be for daily nutrition, for dealing with a food crisis or for developing a more solid economic base in which food security is assured. Poultry are particularly flexible because they have dual usage (meat and

TABLE 10

PERCENTAGE OF MALE AND FEMALE HEADED RURAL HOUSEHOLDS OWNING LIVESTOCK IN SELECTED COUNTRIES

		EXPENDITURE QUINTILE				
	HOUSEHOLD HEAD	**1**	**2**	**3**	**4**	**5**
Ghana 1998	Female	68	67	63	53	48
	Male	39	37	29	38	27
Madagascar 1993	Female	63	72	73	54	62
	Male	77	85	84	80	78
Malawi 2004	Female	49	58	64	61	59
	Male	63	74	73	74	66
Nigeria 2004	Female	26	25	24	31	32
	Male	50	49	47	43	39
Bangladesh 2000	Female	31	40	43	47	55
	Male	31	34	40	44	52
Nepal 2003	Female	67	86	73	73	75
	Male	81	87	87	85	83
Pakistan 2001	Female	52	49	58	54	54
	Male	57	62	63	67	66
Viet Nam 1998	Female	81	88	82	84	82
	Male	95	95	93	89	82
Albania 2005	Female	87	74	71	85	58
	Male	89	88	93	96	89
Bulgaria 2001	Female	27	46	73	77	75
	Male	34	67	76	78	73
Ecuador 1995	Female	76	80	78	79	69
	Male	69	72	79	68	74
Guatemala 2000	Female	67	71	63	58	52
	Male	68	72	70	67	57
Nicaragua 2001	Female	88	27	71	50	89
	Male	78	83	58	89	67
Panama 2003	Female	83	45	55	52	46
	Male	76	73	72	64	52

Source: RIGA dataset.

eggs) and can quickly be scaled up or down according to need. They have the fortunate characteristic of taking up little space so they fit well into peri-urban mixed farms – it is possible to keep 2 000 birds in a back garden. Larger flocks tend to be kept primarily for income and can be profitable when their owners have access to a well organized market chain (Ahuja *et al.*, 2008). In Southeast Asia, countries such as Indonesia, Viet Nam and Thailand have had a steadily growing demand for poultry. The gap in supply was first filled by small-scale entrepreneurs who moved quickly to meet a market need, but many of these producers left the market just as quickly when competition or government policies to control HPAI made market access more difficult (ACI, 2006; NaRanong, 2007).

Small ruminants also have short reproductive cycles and are particularly valuable where families have access to common grazing land or land where forage can be gathered and brought back to the animals. Small-scale commercial pig production fits well into mixed farms because it takes limited space and there can be some ex-

change of inputs between livestock and crops. In Viet Nam, crossbreds with indigenous pigs are not cost-effective to produce in large intensive units but are highly productive when fattened in small-scale units that hold 20–30 animals. Herds can be scaled up or down in a matter of weeks to meet demand cycles. They are such a delicacy that there is a thriving export of frozen piglet carcases from Viet Nam to Hong Kong (McLeod *et al.*, 2002).

CONSTRAINTS TO EXPANSION

The strengths of mixed farming also can be its weaknesses. The low-input, low-output systems that provide the family with "something for nothing" are efficient and effective in using waste, but poor producers of income or food. The intensively reared zero-grazed dairy cattle, dairy goats and small-scale commercial poultry and pigs common on peri-urban farms produce a higher output, but small land holdings and the need to diversify enterprises to spread risk mean that they tend to be small in scale and unable to benefit from certain kinds of new technologies. Indigenous livestock thrive under the conditions of mixed farms, which are often the best way of supplying niche markets. However, when small-scale farmers try to rear larger and faster growing crossbred and exotic animals, they cannot compete cost-wise with large and specialized commercial farms in the commodity markets to which these animals are suited.

Biosecurity measures. Keeping a mixture of livestock together within a small space makes it difficult to fully implement biosecurity measures. These are the physical and management barriers established to keep disease from entering or leaving herds and flocks. Under the best conditions, they require animals to be segregated by species and type and kept within fences or houses, call for keeping housing units a set distance apart, and restrict entry of people to the places where animals are kept. Lack of biosecurity creates a greater chance that animals will be exposed to disease. Lack of biosecurity measures also can prevent small-scale farmers from accessing lucrative urban markets that demand "certified safe" products.

Disease outbreak and control. If disease outbreaks do occur and control measures are implemented by the government to prevent disease from spreading, many farmers may suffer losses from culling (compulsory slaughter) of animals in and around the area of an outbreak, with small farmers more likely than large ones to have their animals culled without compensation (World Bank *et al.*, 2006). Imposition of quarantine measures also creates losses for small-scale livestock keepers, although traders may benefit from the prices that they can charge when the quarantine is lifted and animals flood the market (McLeod *et al.*, 2006). Expectation of losses from disease and disease control are built into the way the system is managed, often by keeping local animals that are better adapted to local conditions but produce less.

Resource scarcity. Small mixed farm households tend to be resource-constrained. Land is often in short supply, and many farming families are caught in a "poverty trap" when the small size of their landholdings restricts their access to credit and prospects for expansion. Family labour is often limited and hiring fulltime labour requires a certain scale of enterprise. Labour constraints are particularly noticeable when estimates of production are disaggregated by the sex of the head of household. In the countries represented in the RIGA dataset, the fact that female-headed households are less likely to be engaged in livestock farming than male-headed households can be interpreted as partly a labour constraint, since families with more working women own larger herds (Pica-Ciamarra *et al.*, in preparation).

Feed supply. In many countries, good quality feed is in short supply, which is a major constraint to expanding livestock production. In the State of Orissa, India, for example, even though

buffalo-based dairy farming offers the lowest net milk production costs, it hardly exists because of the scarcity of feed sources (Garcia *et al.*, 2004b). Where possible, poor farmers will use agricultural by-products instead of commercial feed (Upton, 2004), but these can be limited. In India, even though poultry is an important source of protein for home consumption, backyard poultry producers cannot increase production because of the limited availability of scavenge-based feed sources (Pica-Ciamarra and Otte, 2009). Cereals in Africa and Asia are often contaminated with aflatoxin (Hell *et al.*, 2008), meaning that commercial companies prefer to import cereal for their compound feeds.

Improvement costs. While commercializing or scaling-up livestock production can be seen by outsiders as an attractive option to improve income for mixed farmers, those proposing it often fail to appreciate the extra effort and expenditure involved. Transforming a scavenging system into one where animals are entirely or mostly confined can greatly increase their output but, at the same time, will greatly increase the cost of housing, feed and animal health care plus the time that is spent caring for the animals. Acquiring a high-value, high-producing animal such as a crossbred dairy goat or dairy cow requires a large up-front investment in a shed and incurs recurrent expenses of feed and health care, as well as the need to be connected to a reliable market to sell the extra produce. For this reason, NGOs such as Heifer International and FARM-Africa which run small-scale dairy projects always require farmers to be very well trained and prepared before they receive an animal.

Small-scale mixed farming is found throughout the world, in both developed and developing countries.. As shown in the examples mentioned in this chapter, no one country is representative of all. However, the following case study of Nepal provides a good illustration of several of the issues raised in this chapter. It looks at the contribution small-scale mixed farming households make to the economy of Nepal, the constraints they face and the part livestock play in the food security of these households.

CASE STUDY
MIXED FARMING IN NEPAL

Of Nepal's population of 29.1 million, around 80 percent live in rural areas, 79 percent of whom practice mixed farming. As with many other countries, Nepal is urbanizing. In 1985, just 7 percent of the population lived in urban areas, compared to 20 percent in 2001. The rate of out-migration to other countries is also increasing (FAO, 2009a), mostly to India, the Near East, Malaysia and the USA. Nevertheless, mixed farming is still a very important contributor to livelihoods, with agriculture providing more than one-third of GDP (39.1 percent in 2001) (Maltsoglou and Taniguchi, 2004).

Mixed farming is carried out in conditions of poverty and intermittent social instability. Nepal is one of the poorest countries in the world, ranked 99 out of 135 countries in the Human Poverty Index (UNDP, 2009), and has become a food-deficit country. In 2006, 4.2 million people, representing 16 percent of its total population, were undernourished (FAO, 2009a). A recent government report found that 3.35 million people and 40 percent of the population in the mountain and hill districts were facing a severe food crisis (Kharel, undated). The nutritional status of mothers and children under five is extremely poor. There is no or very restricted basic infrastructure in rural and peri-urban communities, and social services such as medical care, clean drinking water and adequate sanitation are very limited. Although agriculture is very important, the performance of the sector has been inadequate to meet increasing food demand, and low agricultural productivity is a major cause of food insecurity.

LIVESTOCK IN THE SYSTEM

The country is divided into three main geographical and ecological regions, the mountain region, the mid-hill region including the Kathmandu valley, and the Terai (lowland) region.

TABLE 11
NUMBER OF LANDOWNERS AND LANDLESS HOUSEHOLDS BY GEOGRAPHICAL REGION OF NEPAL

	EASTERN	CENTRAL	WESTERN	MIDWEST	FARWEST	TOTAL
Hhs owning land	462	604	424	292	308	2 090
Hhs not owning land	184	189	109	35	3	520
Total	646	793	533	327	311	2 610

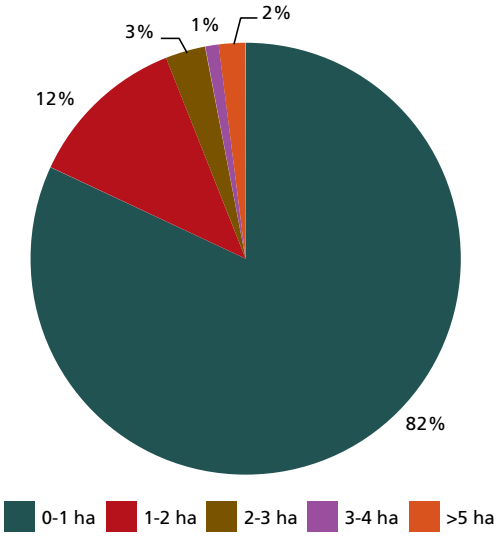
Source: RIGA dataset for 2003–04 (survey of 2610 households).

The mountainous and hilly regions are quite isolated since road access can sometimes be very difficult. The average time to travel from a mountain farm to a health post or a primary school has been estimated between 1.8 and 2.2 hours. The Terai as well as Kathmandu and the other urban areas have better road connections, and the Terai is generally very accessible.

Mixed farms are found in all regions but livestock play a more central role in the mountain region where, because of harsh cold climatic conditions and infertile land, it is hard to grow crops. Animals are kept in low input, extensive systems (Parthasarathy and Birthal, 2008), and people are more dependent on livestock husbandry than in other regions. Households use livestock mostly for home consumption, especially in the mountains and rural hills due to their remoteness, but livestock are also an important source of the little cash the households in these areas earn. In the Terai and hill regions, about two-thirds of livestock keepers are smallholders (Gurung *et al.*, 2005) and most of them are mixed farmers.

A high percentage of households in rural areas own land (80 percent), but most landholdings are very small (Figure 15), with plots becoming further fragmented as they are divided up for inheritance. No major differences in land size are found in the different areas of the country or among households of different expenditure quintiles. In the far west, almost everyone owns land, with ownership decreasing progressively from west to east, reaching the lower limit, 72 percent, in the east (Table 11).

15 LAND SIZE AMONG LANDOWNER HOUSEHOLDS OF NEPAL



Source: RIGA dataset for Nepal, 2003–04.

Wealth does not influence whether rural households own livestock (Table 12) but it does influence how many they own. Almost every household has livestock of some kind, but landowners are more likely to own more than one tropical livestock unit (TLU) – which is equivalent to 5 pigs or 2 cattle using the international measurement for South Asian livestock – than those who are landless (Table 13). Herd sizes are generally very small. Mixed farmers tend to own more of each species than other households

TABLE 12
PERCENT OF NEPALI RURAL HOUSEHOLDS OWNING LIVESTOCK, BY EXPENDITURE QUINTILES

RURAL HHS	EXPENDITURE QUINTILES				
	1	2	3	4	5
2 610	87%	90%	88%	87%	86%

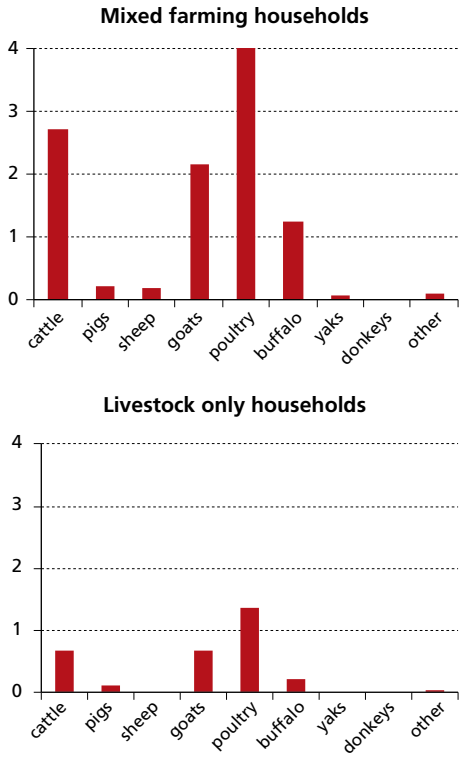
Source: RIGA dataset for Nepal, 2003-4.

TABLE 13
PERCENT OF LANDOWNING AND LANDLESS HOUSEHOLDS BY TROPICAL LIVESTOCK UNIT (TLU) OWNED

TLU OWNED	LANDOWNER HOUSEHOLDS	LANDLESS HOUSEHOLDS	TOTAL HOUSEHOLDS
0	1%	1%	1%
0-1	14%	33%	18%
>1	85%	66%	81%
Total	100%	100%	100%

TLU estimated using international units for South Asian livestock.
Source: RIGA dataset for Nepal, 2003–04.

16 TYPE AND AVERAGE NUMBER OF LIVESTOCK OWNED BY MIXED FARMING AND LIVESTOCK-ONLY HOUSEHOLDS IN NEPAL



Source: RIGA dataset for Nepal, 2003–04.

(Figure 16) but the average number of TLUs owned is around two, regardless of the wealth of the household (Table 14). Female-headed households tend to own fewer animals, averaging 1.2–1.8 TLUs compared to 1.9–2.0 TLUs for male-headed households.

Subsistence cropping is predominant, with households growing crops mostly to consume at home rather than for sale. Only a few families with larger landholdings are able to produce in excess of their consumption requirements and profit from the sale of their products. Most small landowners have to seek alternative means of income and still face food shortages for several months of the year. Paddy rice is the most commonly produced staple, followed by coarse cereals and wheat. Pulses, oilseeds, vegetables and potatoes are also grown in smaller quantities. Livestock play the usual wide range of roles in a mixed farming society. They have an economic role since they can be used for income and as insurance to hedge against risk. Mixed farming households in all wealth categories have a higher average income than non-mixed farming households (Table 15). Regardless of wealth, these households earn roughly 60 percent of

TABLE 14
DISTRIBUTION OF TLU AND TYPOLOGY OF LIVESTOCK, BY EXPENDITURE QUINTILES

EXPENDITURE QUINTILE	TOTAL TLU	NUMBER OF LARGE RUMINANTS	NUMBER OF SMALL RUMINANTS	NUMBER OF POULTRY	NUMBER OF PIGS
Poorest	1.94	3.39	2.07	2.76	0.23
2	1.96	3.52	2.18	3.54	0.22
3	1.80	2.99	1.83	3.27	0.16
4	2.01	3.40	2.06	3.22	0.14
Richest	1.96	3.09	1.97	4.16	0.21

TLU estimated using international units for South Asian livestock.
Source: RIGA dataset for Nepal 2003–04.

TABLE 15
INCOME TOTAL FROM LIVESTOCK AND CROPPING (IN NEPALESE RUPEES)

EXPENDITURE QUINTILE	TOTAL INCOME FOR NON-MIXED FARMING HOUSEHOLDS	TOTAL INCOME FOR MIXED FARMING HOUSEHOLDS
Poorest households	16 805	22 474
2	24 662	26 982
3	19 617	27 687
4	25 210	31 654
Richest households	35 721	33 621

Income = cash and production for home consumption.
Source: RIGA dataset for Nepal 2003–04.

their income from agricultural activities, of which livestock contribute close to 40 percent. This is similar to other Asian countries in the RIGA dataset, a level of around 30 percent being usual, while countries in all of the other regions have lower percentages.

Households without livestock are much more reliant on off-farm income and wage labour. The social and cultural role of livestock is also important, especially during ceremonies. Goats and chicken are kept to provide for guests and for religious purposes, as some ethnic communities believe it is necessary to sacrifice one goat and chicken every year (Gurung *et al.*, 2005). Livestock also provide status in the community and create employment opportunities within and beyond a given household.

SOCIAL INFLUENCES

Nepal is a pluralistic society with about 60 recorded caste and ethnic groups, and 70 languages and dialects (Gurung *et al.*, 2005). Ethnicity is an important phenomenon and, along with caste, is the most important focus around which individuals, households and communities aggregate and, as such, it influences livelihood options. Some 37 percent of the population is made up of indigenous "ethnic groups" outside of the caste system and 13 percent are in untouchable caste groups. Many of these groups have been historically disadvantaged and continue to lag behind in income and asset levels, educational achievements and human development indicators. Religious customs affect livestock ownership and the role of livestock in food security. For example, strict Brahmins do not eat meat, and Hindu castes do not rear pigs and consider them unclean.

The other social factor that affects livestock keeping is gender. Most mixed farming households (87 percent) are headed by men and, as in many other countries, male-headed households have easier access to land and to both formal and informal credit, which are important for households to buy livestock. Women and men traditionally have different responsibilities, knowledge and decision-making roles in livestock management as well as other intra- and

inter-household activities. Women's major responsibilities lie in caring for poultry, collecting grasses and fodders, and feeding, cleaning and milking the animals. Women and children generally are responsible for small ruminants and poultry as well as pregnant and sick animals kept at the home. Men's specific roles include providing veterinary services, livestock investment and spending cash for various household economic and community activities. They generally care for and control more lucrative animals with higher commercial value, such as cattle and buffaloes. They are responsible for selling and often are the sole decision-makers on how to use the resulting income. Men and women share activities such as cropping, grass and fodder production, traditional livestock breeding and species selection (Gurung *et al.,* 2005).

The picture that emerges is that livestock keeping is very much a joint activity. Men and women from all socio-economic groups and regions take part in caring for animals and selling their products. However, even though women have higher decision-making power with regard to small animals, their decisions over large animals, sale of products, investment and animal health care are very limited. Women often depend on men (husbands or male relatives) for access to land and other inputs needed for more productive agriculture. However, the responsibility of women in many livestock management activities has been growing in the past few years (Gurung *et al.*, 2005). With increased migration of men to cities or to other countries, agriculture has "feminized" in rural Nepal, meaning that women must often take on new responsibilities – often with limited knowledge, technology and time. This suggests that the need for men to seek income outside of their home communities may be another factor limiting the productivity of mixed farms.

THE FUTURE FOR MIXED FARMING AND THE CONTRIBUTION OF LIVESTOCK

Within the options available in a very poor country, mixed farming activities appear to be a winning strategy for rural Nepalese. They provide higher income than can be obtained by families relying on wage labour and off-farm employment, and they offer a measure of stability and control. Mixed farming is possible for many rural families, in part because of the very high rate of land ownership. Livestock make an important contribution to income and social functions. There is also a growing demand for food, including livestock products, in the urban population.

However, the opportunities for mixed farming to provide a pathway out of poverty, or to expand its production, are very few. Farm sizes are extremely small, and much of the country is on hilly terrain that requires huge efforts to farm, meaning that even if families decided to combine efforts, they would find it hard to upscale. In the Terai, there is more chance to combine landholdings and upscale because the terrain is flat, and the climate and water supply are more favourable. However, increases in productivity through upscaling could only come about through change in land tenure, either through a reduced number of people owning land or through cooperative arrangements in landholding, neither of which is likely to be socially acceptable at present.

Most families in Nepal have very limited access to the level of funding that would allow them to innovate. The migration of men away from rural areas also reduces the labour force. At best, mixed farming has the prospect of continuing to provide food security for the communities in which it is practised, with a small surplus being exported to towns. Livestock contributes by adding stability to the system and providing much of the cash that can sustain families when crops are not there. Some small possibilities exist to increase livestock productivity through slightly improved feeding, better veterinary care and more organized marketing. Technical options for accomplishing this have been explored within the national research systems and development projects but, only very small incremental changes to improve produc-

tivity, based mainly on better rural service provision have been recorded.

PROSPECTS FOR SMALL-SCALE MIXED FARMERS

Small-scale mixed farms remain enormously important because of the large number of rural households they support. They also make a useful contribution to the food supply of urban populations in developing countries and use and recycle resources effectively.

At the same time, they have limited prospects to expand their production or increase productivity. The Nepal case study provides a sharp reminder of the reasons for those limits. Lack of opportunity or capital to increase farm sizes, limited assets and therefore limited access to credit, lack of investment capital, limited land availability, reduced access to common land, higher unit costs than those of large producers, and restricted opportunities to market produce through physical distance or barriers imposed by quality and safety requirements are all factors that prevent many small-scale farmers in many places from expanding or intensifying their production. These factors constrain the stability of their own food security and the extent to which they can contribute to national food security.

All small-scale farmers do not face all of the same constraints. For example, in peri-urban India and Kenya they have excellent connections to milk markets, as previously described. In Kenya and Uganda, they face severe constraints on land size but have benefited from improved fodder species, and in some cases, access to animal health service through projects or cooperative arrangements. However, most small farmers face limits to intensification. Even in India, where small-scale livestock producers are supported by state investment, the average number of poultry kept by farmers with 0.5 to 2 ha has grown much more slowly than that kept by farmers with more than 4 ha, and the number of cattle has declined slightly on the smaller farms and increased slightly on large ones (Chacko *et al.*, 2010). Many successful small-scale peri-urban farmers in Africa have other jobs – including civil service jobs – and do not rely on mixed farming for their food security.

There continues to be large growth in demand for pig and poultry products, but small-scale producers of these products face strong competition from large-scale producers with intensive farms that may specialize only in livestock. One estimate suggests that large intensive farms produce 67 percent of world poultry meat, 50 percent of eggs and 42 percent of pork (Blackmore and Keeley, 2009) and they do so with a cost efficiency that small farms find hard to match. Pig and poultry production is scaling up and market chains are becoming more integrated in emerging economies such as Brazil, Costa Rica (Ibrahim *et al.*, 2010) and China (Ke, 2010). In 1996, fewer than 20 percent of pigs in China were produced on large farms, but by 2006, the figure was 64 percent.

Expansion in demand will increasingly come from cities. Peri-urban small-scale farmers tend to be very successful at supplying urban populations in the early stages of demand growth but less so as food safety and land use regulations become stricter, a topic explored in later chapters. Countless reports propose ways to connect small-scale farmers to markets (LPP, 2010), but if they are to continue to access the market chains that supply large towns and cities, they need to be credible competitors. For some, it is possible to become contract farmers to larger operations (Gura, 2008; Delgado *et al.*, 2008). For others, innovative approaches may offer the chance to access niche markets (Ifft *et al.*, 2009), perhaps through cooperative arrangements. For the remainder, in fast-growing developing countries, "it is hard to see a bright future" (Delgado *et al.*, 2008).

What we may see is increasing heterogeneity among small-scale mixed farms, with some, particularly in rural areas, remaining integrated operations with a mixture of crops, livestock and other enterprises and, within their livestock enterprises, a mixture of scavenging herds and flocks and small-scale intensive units. They will

never earn a large income but will remain important contributors to food supply and access for the communities and local markets they supply. Livestock will continue to be essential to these systems although, in some places, they may be overtaken by aquaculture. For others, the best short term option may be contract farming. This implies a shift towards specialization with a smaller number of enterprises, each representing a higher proportion of assets and income. The Chinese poultry sector, for example, still presents good opportunities for contract farmers, providing around 800 000 jobs (Blackmore & Kelley, 2009; Ke and Han, 2007). Contract farmers often earn more income than their independent counterparts, but the stability of their income and hence food access may become better or worse depending on the contract. During the 2005–06 HPAI outbreaks, it was reported (personal communication with various people in the sector) that some Thai contract poultry farmers were protected from losses because the companies owned their birds and re-supplied them as soon as the immediate crisis was over. On the other hand, during the 2007–08 economic crisis, some farmers supplying supermarket food chains lost contracts very suddenly when activities were downsized.

Over time, although it is hard to predict what the time scale will be, we can expect to see a reduction in the number of small mixed farms worldwide, faster in some places than others. As they decline in number, the communities on which they are based will change in character, becoming less dominated by the agricultural calendar and more by the demands of other employment. They may also become more stratified, with some farmers continuing to exist just above the poverty line, some leaving farming for other employment, some becoming financially successful through contract farming, and a few managing to upscale or succeed in niche markets.

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City populations

By 2007, half of the world's population was living in urban areas (UNFPA, 2007), a considerable increase from 29 percent in 1940. The developed world (North America, Japan, Europe, Australia and New Zealand) is highly urbanized, with 75 percent of people living in towns and cities, while in countries defined by the UN as "least developed", the figure is 29 percent but climbing (UNFPA, 2009). This is an important development that affects food supply systems, since urban populations are to a large extent purely consumers of food, unlike those in rural areas who both produce and consume it.

Those responsible for planning and managing urban spaces aim to ensure that stable supplies of reasonably priced food are available for all, through food chains with high standards of hygiene and safety. FAO (2001) identifies areas of concern for urban food supply and distribution:

- food supply – must be sufficient in quantity and quality, produced in hygienic and environmentally sound conditions and brought to the town or city by an efficient transportation system;
- food distribution within the town or city – requires investment by the public and private sector as well as legislation and regulations; and
- health and the environment – includes protection of the air and water supply and the health of people.

Each of these elements tends to be planned and managed differently in industrial market-based economies, centrally planned systems and market-based developing countries.

Urbanization affects the demand for food because urban people are, on average, richer than rural people and have access to food from a variety of sources. People living within or in easy reach of urban areas eat diets that are different from and more diverse than rural dwellers' diets (Regmi and Dyck, undated). However, there is an enormous range of wealth within urban populations. About 300 million urban dwellers worldwide are classified as extremely poor (Ahmed *et al.*, 2007), with the poorest people in cities highly food insecure. Countries with growing urban populations as well as rising wealth face the strongest challenge, because they must deal with two different food security prob-

lems – a large proportion of the population that is undernourished but also a growing number of people who consume more than they need for health or have poorly balanced diets.

The location of livestock production and the shape of livestock market chains are increasingly driven by urbanization and particularly the growth of large cities. This chapter compares approaches and experiences in feeding cities in the USA, Asia, Africa and Latin America.

LIVESTOCK PRODUCTS IN THE URBAN DIET

Urbanization has been associated with a rising demand for livestock products throughout the livestock revolution. Urban people, on average, eat less starch staples and more meat, fruit and vegetables than rural people (ICASEPS, 2008; Hooper *et al.*, 2008; Regmi and Dyck, undated). For the most part, this is because large towns and cities offer more income-earning opportunities than rural areas, and urban people are on average richer. However, poor urban dwellers eat far less livestock source food than their richer counterparts.

For those who can afford it, livestock products are highly accessible in cities. Fast food establishments, restaurants and large supermarkets sell livestock protein conveniently packaged at a wide range of prices. The large numbers of urban poor, however, have low purchasing power and limited food options, and are often physically separated from sources of quality food (Associated Press, 2008).

QUALITY AND SAFETY

Livestock products can be a valuable part of a balanced diet for city dwellers with sufficient incomes. However, many of these consumers who place convenience and immediate satisfaction over nutritional value are faced with the temptation of easily available livestock foods prepared in large portions and cooked with fat and salt, an incentive to overeat. The over-consumption of red meat and fats associated with heart disease and other health problems, mentioned in connection with livestock food in the diet, is very much a problem of urban populations.

Some middle class consumers are highly discerning about their food and, when provided with sufficient information to give them confidence in the product, will choose food that they perceive to be safer or in some other way of higher quality, even if it is slightly more expensive (Birol, Roy and Torero, 2010). This translates into a demand for livestock products certified as having one or more of the following qualities: they come from livestock that have been raised traditionally, kept under high welfare standards or are biosecure, or they are from a particular breed or region or processed in a particular way.

While they represent relatively small numbers, these consumers have raised the standards demanded of livestock producers in Europe and other parts of the developed world, and in pockets in emerging economies or urban markets of developing countries. Food safety carries a high premium for these consumers, because even if they do not search for it, they are quick to retreat from foods that have been associated with outbreaks of human disease. Supermarkets, an important source of city food, are risk averse and pass part of the cost of food safety to their suppliers through demands for high levels of biosecurity and hygiene.

The urban poor, however, eat less livestock protein than their richer counterparts and their choice is restricted by the high prices of many foodstuffs. Food safety is a concern for them if food is delivered through long market chains in which hygiene, refrigeration and toxin and residue levels are not regulated or monitored. In developing countries, the government resources dedicated to food safety tend to be devoted more to quality control of export products than regulation of domestic food chains (FAO, 2009b). Food safety is a concern for the poor in general, but those in large cities have less access than their rural counterparts to local markets where they can purchase a live chicken that they have inspected for its health status, or determine the

provenance and age of meat or milk. As a result, they depend more on the protection conferred by food safety regulations.

EFFECTS OF FOOD PRICE RISES

Poor people are vulnerable to food price rises, as previously discussed, because they spend a large proportion of their household budget on food. Poor people living in large cities are particularly vulnerable because they have weak connections to agriculture (Cohen and Garrett, 2010). They cannot do what mixed farmers do and change the balance of what they sell and directly consume to suit the prevailing economic situation. As the next section discusses, there are mixed farmers living within city limits, but they are far fewer in number than in rural areas.

Urbanization is contributing to the growth of demand for livestock products, but it also may be a minor contributory factor to the rising price of food since urban households are likely to hoard food if they fear future price increases (Stage *et al.*, 2010).

During the economic crisis of 2007–08, world prices of staples rose enormously, by three times for maize and five times for rice. World prices had a much stronger impact on domestic prices in some countries than in others (Cohen and Garrett, 2010, citing several sources), but the poor in many large cities cut back on food consumption and adjusted the composition of their diets. For example in April 2008, it was reported that poor households in Dhaka, Bangladesh, had stopped eating meat, fish and eggs (Cohen and Garrett, 2010) while in Ethiopia, they cut out eggs and vegetables. When food and cooking fuel costs rise, street food consumption tends to increase (FAO, 1997), as street food vendors can buy in bulk, while poor households buy in small quantities.

SOURCES OF LIVESTOCK SOURCE FOOD FOR URBAN POPULATIONS

There are three sources of livestock products for urban areas: the animals kept (often illegally) within city limits, peri-urban farms at the fringes of cities, and large commercial operations delivering their product through integrated market chains that may span many miles and cross international borders. This section begins by reviewing livestock keeping within cities, a topic which is somewhat neglected in the literature. It then looks at the limits from which livestock source food is drawn into cities, the way that different governments approach the supply of city populations, and other factors that affect the shape of livestock market chains.

LIVESTOCK IN CITIES AND ATTEMPTS TO KEEP THEM OUT

Livestock have always been part of urban landscapes, but as cities grow and become more organized, the authorities try to exclude animal farms and slaughter facilities from residential areas and city centres because of concerns about human health, noise, dirt, smells, vermin and contamination of water supplies. These problems stem from pressure on land, meaning that people and their animals are forced to live in close proximity. Urban sanitation infrastructure is already strained and the poorer inhabitants, those most likely to want to keep livestock, often lack water, drainage and rubbish disposal facilities. Therefore, far fewer animals are kept in urban than rural areas, particularly in developed countries.

The history of livestock in cities of the USA (Box 7) has interesting parallels to stories elsewhere. During the early twentieth century, zoning codes, by-laws, regulations governing market chains and industry practice pushed livestock out of residential areas and city centres. In Kenya, Nairobi experienced a similar promulgation of laws restricting animal agriculture within city limits with by-laws dating from colonial times. The Agriculture Act, the Land Control Act and the Physical Planning Act offer local authorities the legal power to decide whether or not to allow urban farming. Yet, the legislation is rife with contradictions, and farm animals are still commonly found within city limits (Foecken, 2006; Foecken and Mwangi, undated).

BOX 7

CITY LIVESTOCK IN THE USA

In the USA, early urban planners integrated animal agriculture facilities with cities. In 1870, New York's Central Park incorporated a dairy barn on the premises as a way of providing the urban poor with milk during a time when transport to rural dairy farms was limited.

Yet the turn of the twentieth century saw a push to exclude farm animals from cities for a variety of reasons. Dairy cows were banned due to the health risk they posed to people from the spread of bovine tuberculosis (Schlebecker, 1967). Farm animals were seen as noise and waste management problems for cities. The birth of "animal welfare" activism created a push to move animals out of cities where they were not properly cared for. Chickens were banned with the excuse of preventing rooster fighting and as part of noise ordinances and anti-nuisance laws.

Most of the early zoning codes in the USA imposed bans on all "farmyard animals" simply to prevent noise and smell. Exceptions were granted for horses, which were widely used for transportation until the 1920s. Laws regarding food animals were usually not a state or city-wide regulation, but tended to be locally based. Each housing development could have different standards in their zoning ordinances and deeds. The first animal restriction listed in a table of many of the subdivision restrictions, prepared by H. V. Hubbell (1925), was an 1889 Baltimore County, Maryland, statute for "no pigs, allow fowls, four horses, and two cows." Some historians have speculated that the early bans in these early planned communities had a covert reason: to keep out lower income groups that would need animals as supplemental income.

However, the movement of animals out of early American cities was not wholly a factor of early zoning codes and by-laws. As industries achieved aggregate economies of scale starting in the early 1900s with meat markets and poultry, they may have influenced decisions to prohibit potential customers from rearing, slaughtering or selling animal products for private profit. For example, new laws requiring commercial dairies to sell pure milk drove smaller cow stalls in towns out of business simply because of the cost of testing the milk and the lack of space to expand. Other policies, such as immunity to anti-trust laws in agriculture, favoured larger producers and economies of scale over local, small-scale animal agriculture. Immunity to anti-trust laws gives larger companies advantages in terms of favourable marketing and packaging deals for greater quantities of goods. These laws are now being challenged and this may, in time, affect where animal agriculture is located by removing some incentive for large, contract-based farming operations (*The Economist*, 2010).

Despite the century-long bans on urban animal agriculture, practices coupling cities with animal agriculture have persisted. Philadelphia employed a peri-urban swine feeding consortium that consumed up to 1 500 tonnes of residential organic waste a week, as late as the 1980s (Maykuth, 1998). Such practices are still commonplace in cities outside of the USA. Walmart, an international food supplier, now considers garbage feeding part of its sustainability best practices (Walmart, 2010).

Source: Brinkley, 2010.

After decades during which city dwellers reared poultry in Jakarta, Indonesia, the Jakarta Province authorities passed legislation in 2007 and 2008 that banned poultry keeping within city limits except for certain licensed birds not reared for food, and initiated moves to close holding yards and slaughter points in parts of the city (ICASEPS, 2008). The reasons cited were related to HPAI control, but complaints from residents about smells and dirt seem to have added impetus. Another move to ban urban livestock occurred in Cairo in 2009, when the small-scale operations that recycled garbage through pigs were closed down (*The Economist*, 2009). In both of these cases, the overall intention of improving environmental hygiene was positive, but there were negative impacts on the livelihoods of poor city dwellers.

Regulations other than zoning, as well as economic factors, have influenced urban livestock keeping. In the early twentieth century, the UK's banning of swill feeding to prevent the spread of pig diseases quite rapidly led to the cessation of small-scale pig keeping, much of which had been done in the back gardens and allotments of town dwellers. In Thailand, tax incentives encouraged livestock producers to move away from Bangkok (Costales *et al.*, 2006).

Notwithstanding attempts to keep them out, livestock still can be found within and at the periphery of many urban areas throughout Africa, Asia, Latin America and the Near East. Poor households keep small livestock such as poultry, guinea pigs and rabbits on rooftops and in courtyards for their own consumption. In places where they are not prevented, animals scavenge in the streets or, as in the case of Cairo's former pig keepers, are kept as garbage recycling units. Immigrants to urban areas bring their animals with them to satisfy their taste for traditional food from their homelands.

Several studies in the 1990s showed the prevalence of livestock in and immediately around African cities. An average of 17 percent of the inhabitants of six Kenyan towns were keeping livestock (Lee-Smith and Memon, 1994), and the cattle population of Nairobi was estimated at 28 000, with most animals kept for manure and as savings accounts. However, the larger the town, the smaller the proportion of its population that engaged in agriculture of any kind. In and close to Kampala, Uganda, around 25 to 30 percent of people kept livestock (Maxwell, 1994), a tradition that appears to have persisted (Lee-Smith, 2010, citing studies from 2003). In Ghana, 25 percent of small ruminants were kept by people in and around urban areas, and in Mali, there were small communal dairies in the capital city, Bamako, in 1993 (Debrah, 1993).

There is a thriving small-scale poultry industry in and at the fringes of cities in Asia and Africa. In Cairo, small commercial units of a few hundred birds (FAO, 2009c) kept in narrow passageways play an important part in feeding the city's inhabitants. In Indonesia, Jakarta had an estimated 194 200 head of poultry in 2003 and 175 000 in 2007 (Directorate General of Livestock Services, 2007, cited by ICASEPS, 2008) although the number and flock size reduced after the 2007-08 government bans on poultry keeping.

City livestock are more important to the food supply than is sometimes acknowledged. However they only represent a small part of the whole. The next section discusses the diversity of livestock market chains that supply cities and the way that policies have contributed to shaping them.

FOODSHEDS, CITY LIMITS AND LIVESTOCK MARKET CHAINS

Two of the important factors that define a market chain are its physical length and its concentration, meaning the number and scale of units at each link of the chain. Urban planners talk about the "foodshed" – the area around a city that can conveniently provide food for its inhabitants. In the USA, the foodsheds of Philadelphia and San Francisco are defined as a radius of 100 miles from the city centre. Recent studies indicate a highly varied food system, with Philadelphia sourcing nearly 50 percent of its food

from the foodshed and exporting 36 percent of production from the area, while San Francisco's total food demand accounts for only 5 percent of production within the 100 mile radius, with most of the production from its foodshed exported (Thompson *et al.*, 2008). Both the San Francisco and Philadelphia studies indicate that, despite an abundance of peri-urban farming, the cities still draw significantly from the national and international food systems.

These American cities indicate a disconnect between markets and local production, similar to the situation in Belo-Horizonte, capital of Brazil's Minas Gerais State, where the municipal government has invested in partnerships with the private sector, established marketing regulations and developed programmes to support local peri-urban production as well as incentives for consumption of local foods. In Mexico City, mobile markets have been set up that move around the city on specific days and often sell local products.

The Chinese government has taken a very different approach to that of the USA. The foodsheds for large Chinese cities are defined by their city limits. They aim and partly succeed (Girardet, 1999) in being as self sufficient as possible within these limits. This, in turn, has affected their zoning regulations and definitions of city limits. The official boundaries for Chinese mega-cities are larger than city limit lines in much of the rest of the world. The preoccupation with self-sufficiency is partly attributable to changes in city boundaries under the Great Leap Forward policies of the late 1950s that emphasized making the major Chinese cities self-reliant in food.[3]

Beijing increased in land area from 4 822 km² in 1956 to 16 808 km² in 1958, thereby incorporating much peri-urban agriculture under the city's direct control. Within the Beijing city limits, "urban agriculture" supplies 70 percent of non-staple food to city inhabitants, mainly consisting of vegetables and milk (Jianming, 2003). Shanghai has taken a similar approach (Box 8) by defining an area for its "city limits" that is only 13 percent urban. It produces biogas energy as well as food within that area, thereby making a contribution to dealing with pollution from manure, a huge problem when livestock are concentrated close to large cities.

Within large African cities, while the city limits may not be defined as widely as those in China, Lee Smith *et al.* (2010) talk of an "agriculture gradient", with a relatively small number of city farmers near the centre and a progressively larger number towards the periphery and in the surrounding peri-urban area. Surveys do not always define clearly where they assume the city limits to be, which makes it difficult to compare statistics. In some cases, there is a deliberate policy to support urban farmers, as in Kampala where 26 percent of households within urban zones and 56 percent in the peri-urban zones were practicing some kind of agriculture in 2003. Summarizing findings from several papers, Lee Smith *et al.* (2010) suggest that livestock keeping within city limits is beneficial to food security in the city, but may be less beneficial to the poorest households than to richer ones that have better access to urban land.

Notwithstanding the uneasy relationship between livestock and cities, quite a large proportion of livestock product comes from within or close to city limits. FAO estimated that 34 percent of total meat production and nearly 70 percent of egg production worldwide came from peri-urban farms in the late-1990s (FAO, 1999). In the USA in the early 1990s, counties defined as urban influenced, meaning those within or adjacent to metropolitan counties, produced 52 percent of the dairy products in the country (Heimlich and Bernard, 1993). In 2007, Jakarta produced an estimated 80 000 tonnes of poultry meat and 400 tonnes of eggs within city limits (ICASEPS, 2008), with over 200 collection points and over 1 000 small slaughter facilities in the city. Most of the rest of the city's

[3] Self-reliance is related to self-sufficiency but not identical. Self-sufficiency implies producing all of one's own food while self-reliance means relying on one's own resources to obtain food.

BOX 8

FOOD AND BIOGAS PRODUCTION IN SHANGHAI

Shanghai follows China's strategy for food self sufficiency of mega-cities (Yi-Zhong and Zhangen, 2000). The total area of Shanghai covers 6 340.5 km², of which 13 percent is urban and the rest rural. The average population density within the Shanghai city limits is about 2 059 persons per km², very low compared with New York City (Manhattan), USA, which has 27 257 persons per km².

Agriculture contributes only 2 percent of the city's GDP, yet is a highly protected economy. About 8.5 million people in Shanghai have a job, 3.6 million of these in the agricultural production sector. The 2.7 million farmers represent 93 percent of the population of the rural parts of Shanghai, and 13 percent are full-time farmers (Yi-Zhong, and Zhangen, 2000). To prevent rapid turnover of agricultural to non-agricultural land, 80 percent of the arable land is protected under the Agricultural Protection Law. These measures have contributed to 100 percent and 90 percent respectively of the milk and eggs consumed in Shanghai being produced within the city limits. Local pork and poultry production cover just over half of the total supply to the city.

Peri-urban agriculture is encouraged to serve other functions besides food production. One of the most important is biogas production (Kangmin and Ho, 2006; Blobaum, 1980; Ru-Chen, 1981; Gan and Juan, 2008; IFAD, undated; Owens, 2007). According to the government's *Chinese Ecological White Paper* issued in 2002, the total amount of livestock and poultry wastes generated in the country reached 2.485 billion tonnes in 1995, about 3.9 times the total industrial solid wastes (Kangmin and Ho, 2006). Animal agricultural wastes are toxic pollutants when discharged into rivers and streams, but can be valuable resources if managed for compost or energy from methane. It is estimated that 10 million ha of farmland in China are seriously polluted by organic wastewater and solid wastes. China's national plan for biogas (Junfeng, 2007) calls for 4 700 large-scale biogas projects on livestock farms by 2010, thereby increasing biogas-using households by a further 31 million – to a total of 50 million or 35 percent of total rural households.

Source: Brinkley, 2010.

supply came from provinces within a two-hour drive. In the mid-1980s, up to 40 percent of the calories of urban dwellers in Kampala were provided by livestock raised in and close to the city (Smith and Olaloku, 1998). Shanghai produces almost all of the milk and eggs for its citizens within its city limits (see Box 8).

As cities expand and develop economically, animal production systems tend to move farther away. Residential areas encroach onto farmland, and as cropland moves outward, ruminant livestock moves outward in parallel to maintain proximity to available feed in the hinterlands. Pigs and poultry initially stay on the expanding fringes of the growing cities, but eventually are encouraged to move further away to avoid environmental contamination (Gerber *et al.*, 2005; Costales *et al.*, 2006).

Cities also source food through international market chains, both formal and informal. Much of the official international trade in livestock products supplies urban populations. There is regular cross-border movement of live animals in Southeast Asia, Africa and parts of Latin America, although not all of it is recorded. The market chains that supply cities with poultry meat are defined by their diversity. Small- and medium-scale producers are located in peri-urban areas while large intensive production is located all over the world. At the same time,

international market chains are both formal and informal. For example, a recent FAO study suggested that a million birds a month cross the border from China to Viet Nam informally.

There are no precise figures for the relative contribution of small- and large-scale production units to city food supplies. However, the worldwide trend is to upscale and concentrate. In the USA, the majority of production comes from large or very large units. In Brazil and Thailand, an increasing proportion of supply comes from large units, even though there are still many small-scale producers. In Viet Nam, where demand for livestock products has been growing steadily, avian influenza and other forces have pushed many small-scale producers out of business. Their market share was initially taken over by national companies but large regional players see this as an attractive domestic market opportunity and are gradually making inroads (McLeod and de Haan, 2009).

The structure of market chains that supply urban areas is changing. In some cases, markets within cities are being made more hygienic due to regulations, such as those in Hong Kong, Los Baños, in the Philippines, and Ho Chi Minh City, Viet Nam. In others, such as Jakarta, the smallest urban markets are being closed. Elsewhere, markets are changing their nature because of regulations. In Cairo, poultry are no longer assembled at physical markets but are traded through phone connections – when an order is placed, birds are moved from their production unit. This echoes the move towards a more virtual marketing system that followed the UK's FMD outbreak in 2001. Specialist local companies produce processed foods for the urban market within their own integrated chains, such as Farmers Choice in Kenya, which hires small-scale contract farmers to fatten pigs so that the company controls the source of meat for its own bacon, pork and sausages. Within cities, an increasing amount of product is sold in supermarkets (Reardon *et al.*, 2003; Reardon *et al.*, 2010). In the early stages of their development, supermarkets source products from a large variety of farms but, over time, they link to increasingly integrated chains.

The examples provided here demonstrate that there are many ways to define foodsheds and to provide sustainable food supplies to cities. The top-down policy measures used by China are very different from the American scheme to protect peri-urban agriculture through the coordinated efforts of private citizens and non-profits. The deliberate attempts in Brazil and Mexico to bring local food into cities differ from the more *laissez faire* approach in Nairobi that allows livestock to be brought within city limits and slaughtered there, even though this contravenes established regulations. As city populations grow, it will become increasingly important to discover and learn from successful examples.

PROSPECTS FOR LIVESTOCK FEEDING URBAN POPULATIONS

Urban populations are expected to continue to grow in numbers and proportion of the whole from the current 50 percent to 69 percent in 2050 (UN DESA/Population Division, World Urbanization Prospects, 2009). As stated by the UN Population Fund (UNFPA) in 2010, "[the] Urban population will grow to 4.9 billion by 2030. In comparison, the world's rural population is expected to *decrease* by some 28 million between 2005 and 2030. At the global level, *all* future population growth will thus be in towns and cities. ... The urban population of Africa and Asia is expected to double between 2000 and 2030. Meanwhile, the urban population of the developed world is expected to grow relatively little." UNFPA also stressed that the majority of new urban dwellers will be poor.

This presents a challenge to the livestock sector. As urban populations grow, there will be an increase in demand for some time, although the rate of growth will be limited by slow income growth in poor countries. The urban poor obtain much of their livestock source food from within or close to residential areas and it is reasonable to assume that they will continue to do

so. However, there is a finite number of animals that can be kept within the residential area of a city, even when regulations are not applied to keep them out. Even in cities that have appropriate design and zoning to support peri-urban livestock, there is still a ceiling on what can be produced. To meet expanded demand, the area from which cities source their food is likely to become increasingly large.

Ruminants, which tend to be kept near feed supplies, may be located at quite some distance. This is not necessarily a problem for meat production, although transport economics will dictate the viable limits of foodsheds, and production units on average are likely to scale up. For dairy products, however, transport and processing logistics will dictate both the size of the "milkshed" and the scale of enterprises that can supply the city. In some places, it will continue to be viable to source milk through complex networks of small producers, as in India, while in much of Africa and Latin America, this will only be viable with investment in local cooling facilities and refrigerated transport or other methods of preservation.

Much of the growth in food demand is likely to be for poultry and pig products, and the need to keep food prices low will encourage continued up-scaling of these systems. However, large pig and poultry units concentrated around cities bring many problems such as disease risk, environmental pollution and animal welfare concerns. There are good reasons for their production units to be scattered, in order to avoid disease spread or the risk of financial disaster if there is an outbreak, and to be located in different places around the world where production economies are most promising.

Economic forces also may push large-scale livestock units away from densely populated areas, since land in these places is scarce and expensive. Studies in the USA have shown that farms in and near towns are generally smaller, produce more per hectare, have more diverse enterprises, and are more focused on high-value production than those further away (Heimlich and Bernard, 1993; Heimlich, 1988; Heimlich and Brooks, 1989). However, products such as vegetables and fruit, which can be marketed directly, have a greater price advantage in being produced close to town than most livestock products (Lopez *et al.,* 1988).

The most likely prospect is that there will be an ever-expanding series of production rings around large urban areas reflecting returns per unit of land, with the most productive and valuable crops (horticulture) and livestock (organic eggs and specialist animals) closest to cites, and larger commoditized units increasingly far away. The bulk of new city supplies of livestock products will need to come from intensive systems, because poor city dwellers need relatively cheap food, and this cannot be produced extensively in large quantities within reach of cities. Small-scale producers may find themselves unable to compete with prices or standards, particularly where they are few in number and have limited price negotiation power (Knips, 2006).

The points made previously about prospects for smallholder mixed farmers apply here as well. The opportunities for smallholder farmers to supply cities are specific to systems and certain countries, such as dairying in parts of the world where the informal market is strong, and production of small animals during the period when cities are expanding. Although the urban wealthy will be in the minority, they will still exist in sufficient numbers to exert substantial demand. They may continue to drive the demand for welfare and for local livestock breeds produced traditionally (Otte *et al.*, 2008). This presents an opportunity for some smallholder livestock producers to increase their income levels rather than lose out to industrial producers.

It is likely that large and very large units will increasingly predominate in feeding cities. However, intensive livestock will need to become much better at dealing with externalities from pollution, food safety hazards and zoonotic diseases, issues that are discussed in later chapters.

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Key points on three populations

The three populations examined in this section represent a continuum in the contribution of livestock to food security. Societies that depend on livestock, primarily grazing animals, for their most important source of livelihood and food security are shaped by the management of their livestock. Small-scale mixed farmers use livestock as part of a diverse livelihoods portfolio, seldom the main source of income or food but important because of their flexibility of use, asset value and ability to convert roughage and by-products into human-edible food. Urban populations, particularly those in large cities, are primarily consumers of livestock source foods that may be produced far away from the city.

LIVESTOCK-DEPENDENT SOCIETIES

Pastoralists and ranchers. Pastoralists, the largest number of livestock-dependent people at around 120 million, rely on their livestock to provide food, income, transport and fuel. Ranchers, although fewer in number than pastoralists, make an important contribution to the supply of livestock products in their countries and the world through animals that they keep primarily as an income source. For both of these groups, animals convert human-inedible forage into human-edible protein and so contribute positively to the protein balance. By supporting their own population and generating surplus for export, livestock-dependent societies contribute to the world's supply of food as well as their own food access.

Systems under pressure. The global land area available for grazing is close to its biological limit for production under the prevailing climatic and soil fertility conditions, putting pastoralist systems under pressure. The area available for extensive grazing is unlikely to expand because of competition from agriculture and biofuel, human settlement and nature conservation. Decreased and more variable rainfall may require changes in management to cope with additional instability, while also creating new animal health challenges for these systems.

Investment and diversification. Existing

levels of production from livestock-dependent societies should be protected because of their contribution to the food supply and the protein balance. Investment in securing their access to markets is important as this offers livestock owners the opportunity to gain greater value from what they produce and to manage risk by managing stocking levels. The case of Mongolia illustrates that even highly livestock-dependent societies can be expected to become less dependent on livestock in the future. The current trend is a gradual movement of people into towns and away from pastoral agriculture. For those who choose to remain in rural areas, tourism, recreation and payment for environmental services such as wildlife conservation and carbon sequestration into grassland all offer complementary ways for livestock keepers to earn income.

SMALL-SCALE MIXED FARMERS

Integrated system. Livestock are a smaller part of the livelihoods portfolio for small-scale mixed farmers than they are in livestock-dependent societies, but they are still important. Livestock are managed as part of an integrated and tightly-woven system, in a way that fits the needs of the farm family, the available labour and the demands of other enterprises. Animals provide food, income, traction, manure, social capital, financial assets and a means of recycling crop wastes. They bring value, versatility and resilience to mixed farming households, which are more robust and food secure with animals than they would be without them.

Rural livelihoods. Small-scale mixed farms remain enormously important because of the large number of rural households they feed and provide with livelihoods. They also contribute to the food supply of developing countries and use and recycle resources effectively. Policies, public and private investments, and technology have supported small-scale dairying in India and parts of East Africa, where peri-urban small-scale dairy producers have good connections to milk markets and reasonable access to animal health services. However, most small-scale farmers face limits to intensification, few have managed to upscale or specialize to a point where they can advance economically, and many depend partly on off-farm employment for their food security.

Limited potential. The case of Nepal illustrates both the benefits of livestock and the constraints faced by small-scale mixed farmers. Lack of opportunity or capital to increase farm sizes, limited assets and therefore limited access to credit, lack of investment capital, limited land availability, reduced access to communal land, higher unit costs than those of large producers, and restricted opportunities to market produce through physical distance or barriers imposed by quality and safety requirements are all factors that prevent many small-scale farmers in many places from expanding or intensifying their production.

Competition from large-scale producers. The supply of food to growing cities is an important growth areas in demand for livestock products, but here small-scale producers face strong competition from large-scale producers with intensive farms. Peri-urban small-scale farmers tend to be very successful at supplying urban populations in the early stages of demand growth, but less so as food safety and land use regulations become stricter. To compete successfully, they need to be credible competitors. For some, it is possible to become contract farmers to larger operations; for others, innovative approaches may offer the chance to access niche or specialist markets. For the remainder, especially in fast-growing developing countries, future prospects may be limited.

CITY POPULATIONS

Urban demand for livestock. Half the world's population lives in urban areas, and this proportion is estimated to increase to about 70 percent by mid-century. Urbanization has been associated with a rising demand for livestock products, for the most part because urban people are on average richer than rural dwellers. However, poor urban dwellers eat far less livestock source food than their richer counterparts and many

are highly food insecure. Countries with growing urban populations as well as rising wealth must deal with two concurrent food security problems – a large proportion of the population that is undernourished but also a growing number of people who consume more than they need for health or have poorly balanced diets.

Feeding cities. The location of livestock production and the shape of livestock market chains are increasingly driven by the growth of cities. The cases of the USA, Kenya and China illustrate three approaches taken to feeding cities. Their national policies have been, respectively, a market-driven economy combined with strict land-use regulations, a *laissez faire* market economy with strong informal market chains, and a centrally-planned economy in which the objective is to have a high level of food self-sufficiency within tightly defined "foodsheds". While each has applied a different policy approach, all face the challenge of feeding expanding urban populations from what are likely to become increasingly large food supply areas.

Intensification issues. The need to keep food prices low for urban populations drives continued up-scaling and intensification of livestock, particularly of pig and poultry production. However, large livestock units concentrated around cities bring problems of disease risk, environmental pollution and animal welfare concerns. Intensive livestock will need to deal more effectively with externalities from pollution, food safety hazards and zoonotic diseases. Environmental regulations and the need to mitigate risk may also encourage production units to disperse, while economic forces tend to push large-scale livestock units away from densely populated areas where land is expensive.

Urban wealthy and smallholder opportunity. Although the urban wealthy are in the minority, they exist in sufficient numbers to exert substantial demand and will continue to do so as populations grow. They will continue to drive the demand for welfare and for local livestock breeds produced traditionally. This presents an opportunity for some smallholder livestock producers to increase their income levels rather than lose out to industrial producers.