

Beyond milk, meat, and eggs: Role of livestock in food and nutrition security

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Implications

- Livestock contribute to food supply by converting low-value materials, inedible or unpalatable for people, into milk, meat, and eggs; livestock also decrease food supply by competing with people for food, especially grains fed to pigs and poultry. Currently, livestock supply 13% of energy to the world's diet but consume one-half the world's production of grains to do so.
- However, livestock directly contribute to nutrition security. Milk, meat, and eggs, the “animal-source foods,” though expensive sources of energy, are one of the best sources of high quality protein and micronutrients that are essential for normal development and good health. But poor people tend to sell rather than consume the animal-source foods that they produce.
- The contribution of livestock to food, distinguished from nutrition security among the poor, is mostly indirect: sales of animals or produce, demand for which is rapidly growing, can provide cash for the purchase of staple foods, and provision of manure, draft power, and income for purchase of farm inputs can boost sustainable crop production in mixed crop-livestock systems.
- Livestock have the potential to be transformative: by enhancing food and nutrition security, and providing income to pay for education and other needs, livestock can enable poor children to develop into healthy, well-educated, productive adults. The challenge is how to manage complex trade-offs to enable livestock's positive impacts to be realized while minimizing and mitigating negative ones, including threats to the health of people and the environment.

Key words: developing countries, food security, human nutrition, livestock, nutrition security, poverty alleviation

Introduction

A widely used definition, dating back to the World Food Summit in 1996, is that food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets



Amelia Ubisse with one of her goats and a fresh baget in a village near Marracuene, near Maputo, Mozambique (photo credit: ILRI/Stevie Mann).

their dietary needs and food preferences for an active and healthy life (see <http://www.who.int/trade/glossary/story028/en/>). Food security, as commonly used in development discourse, emphasizes food quantity more than food quality: the term “nutrition security” is used to capture the quality dimension.

The contributions made to the diets of the world's seven billion people by cattle, sheep, goats, pigs, chickens, and a dozen or so lesser known but locally important species (such as guinea fowl, yaks, and camels) are complex and multidimensional. They include direct and indirect impacts, which can be either beneficial or harmful to overall food supply and food and nutrition security.

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This article focuses mainly on the impacts and implications of livestock on food and nutrition security in poor countries, which go well beyond being a source of milk, meat, and eggs.

The Challenge of Food and Nutrition Security

Global food security is high on the development agenda. Some estimates anticipate that a 50 to 70% increase in food productivity will be needed by 2050 to feed an additional two billion people (Ingram et al., 2010). This is especially crucial for developing countries, where the problems of feeding poor people have been highlighted by recent food price shocks: the expectation is for more and sustained rises in food prices.

In round numbers, about a billion of the world's population regularly goes to bed hungry and up to two billion intermittently experience food insecurity. Around two billion suffer from "hidden hunger," surviving on diets that fail to meet all their nutritional needs. A further 1.5 billion suffer the effects of overconsumption: they are overweight or obese, which puts them at greater risk from non-communicable diseases, such as cancers, cardiovascular disease, and diabetes (McMichael et al., 2007). Although the number and proportions of people living in the developing world who are undernourished are declining, it appears unlikely that this will be sufficient to meet the Millennium Development Goal of reducing by one-half the percentage of people suffering from chronic hunger by 2015 (FAO, 2012). Shockingly, therefore, at the start of the 21st century, most of the earth's inhabitants have suboptimal diets.

Although poverty, food, and nutrition insecurity are intrinsically linked, these problems are not confined to poor countries; today 14% of U.S. citizens are classified as food insecure (Nord et al., 2009). Similarly, overnutrition is not confined to rich countries; nearly one in three African urban dwellers is overweight or obese, with the fastest rates of body weight increase among the poor (Ziraba et al., 2009).

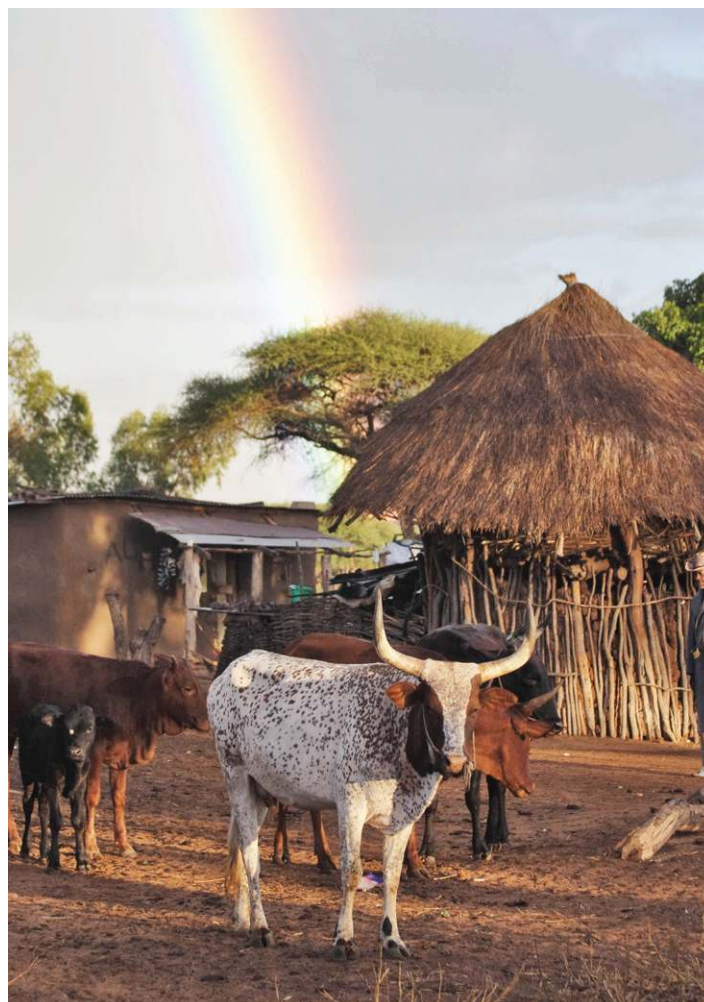
Livestock's Net Impact on Food Supply

Milk, meat, and eggs currently provide around 13% of the energy and 28% of the protein consumed globally; in developed countries, this rises to 20 and 48% for energy and protein, respectively (FAO, 2009).

The world's 17 billion livestock (Herrero et al., 2009, 2013) occur in three main types of production systems: confined intensive, mixed crop–livestock, and open grazing systems. Estimates, based on data for 2001 to 2003, suggest that grazing systems supply 9% of the world's meat and 12% of milk; mixed crop–livestock systems contribute 46% of meat, 88% of milk, and 50% of cereals; while intensive systems provide 45% of meat (Steinfeld et al., 2006; Thornton and Herrero 2009).

By consuming feedstuffs that people could consume directly, such as grains and legumes, animals reduce the total amount of food available. Today, about half the world's production of grain is fed to animals, especially monogastrics (IAASTD, 2009), and 77 million tonnes of plant protein are fed to livestock to produce 58 million tonnes of animal protein (Steinfeld et al., 2006), contributing 13% of the energy to the world's diet. Feed crops occupy an estimated one-half a billion hectares of land; including grazing land, livestock accounts for four-fifths of all agricultural land (Steinfeld et al. (2010).

In 2011, almost 70% of the 900 million metric tons of global compounded feed went to monogastrics (Alltech, 2012); it is projected that the world will require a billion extra tonnes of grain to satisfy future food,



Cattle stand in a village compound after spending the day grazing common lands in Lhate village, Chokwe, Mozambique. (photo credit: ILRI/Stevie Mann)

feed, and fuel demands (IAASTD, 2009), which may be possible, but there are questions about the cropland that would be required, and thus there are real potentials to exploit synergies in mixed crop–livestock systems.

Animal-source foods are much more than an expensive and inefficient source of energy. Animals convert low-biological-value protein foods that are less palatable and less nutrient dense to high-biological-value foods that are highly palatable and nutrient dense. This is not conventionally factored into current estimates of the net cost benefit of animal production.

Direct Contributions of Livestock to Nutrition Security

Poor people survive largely on diets based on starchy foods that fail to meet all their nutritional needs. The more people earn, the higher their consumption of nutrient-rich animal-source food. Consumption of meat and milk, driven by population increase, urbanization and rising incomes in developing countries, is forecast to increase faster than that for any crop product (IAASTD, 2009).

Animal-source foods are nutritionally dense sources of energy, protein, and various essential micronutrients. They match particularly well with

the nutrients needed by people to support normal development, physiological functioning, and overall good health. In contrast, plant-based diets tend to be deficient in one or more essential amino acids, especially lysine, methionine, and threonine (Young and Pellett, 1994). Micronutrients (including iron, zinc, vitamin A, and calcium) also tend to be more bioavailable in animal-source foods, and some, such as vitamin B₁₂, are found naturally only in animal-source foods. Animal-source foods provide several micronutrients simultaneously, which can be important in diets lacking more than one nutrient: for example, vitamin A and riboflavin are both needed for iron mobilization and hemoglobin synthesis; supplementation with iron alone may not successfully treat anemia if these other nutrients are deficient (Allen, 2005). Protein-energy malnutrition, iron-deficiency anemia, and vitamin A deficiency, all of which can be prevented if sufficient animal-source foods are included in the diet, have big impacts: these three diseases result in 17.4 million, 15.6 million, and 0.6 million disability-adjusted life years (DALY where one DALY is equal to one year of healthy life lost), respectively (WHO, 2009).

Consumption of even small amounts of animal-source foods has been shown to contribute substantially to ensuring dietary adequacy, preventing under-nutrition and nutritional deficiencies (Neumann et al., 2002), and having positive impacts on growth, cognitive function, and physical activity of children; better pregnancy outcomes; and reduced morbidity from illness (Neumann et al., 2002; Sadler et al., 2012). Consumption of adequate amounts of micronutrients, such as those that can be found in animal-source foods, is associated with more competent immune systems and better immune responses (Keusch and Farthing, 1986).

Modern humans, like their humanoid and early human ancestors, are considered to be naturally omnivorous; although diets have for millennia been dominated by plant-based foods, animal-source foods have also been

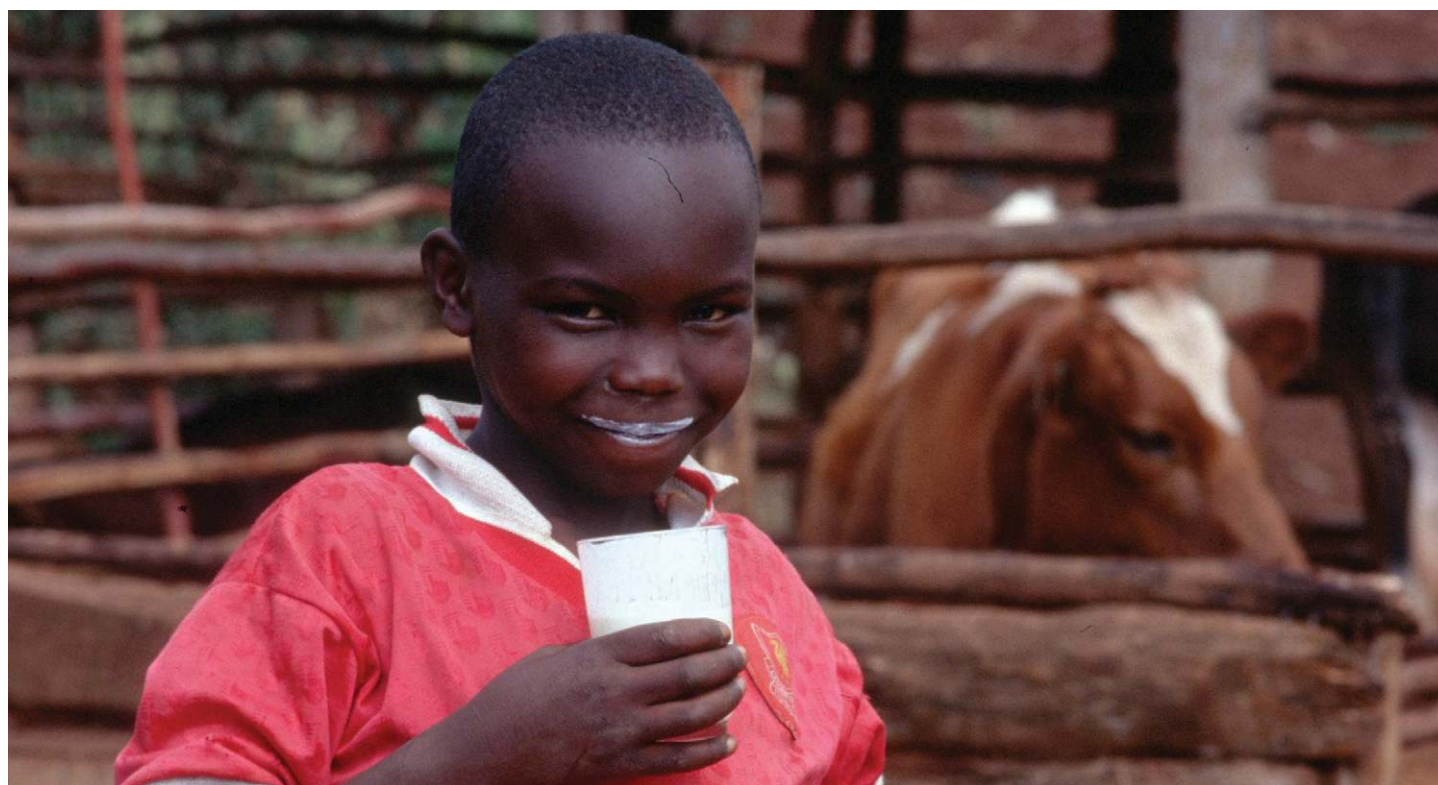
featured (Smil, 2002). The levels of protein and animal-source foods seen in Paleolithic and hunter-gatherer diets were considerably greater than the current recommended levels of daily energy intake: 19 to 35% came from protein, 22 to 40% from carbohydrates, and 28 to 50% from fat (Eaton et al., 1997; Cordain et al., 2000), suggesting that humans are well adapted to consuming animal and fish proteins and fat.

With close to one billion of the world's poorest people relying on livestock for their livelihoods (FAO, 2012), it is tempting to assume that livestock-keeping households consume the animal-source foods they produce and that increasing productivity of livestock would impact positively on household nutrition. For both livestock and other agricultural enterprises, such connections are notoriously difficult to prove (Masset et al., 2011). A range of projects aiming to introduce or improve animal production suggest that livestock and their products are more likely to be sold for income than consumed by poor households (Scoones, 1992). Nevertheless, most trade in animal products occurs locally due to their perishable nature, so that the benefits of their consumption are at least distributed in nearby areas.

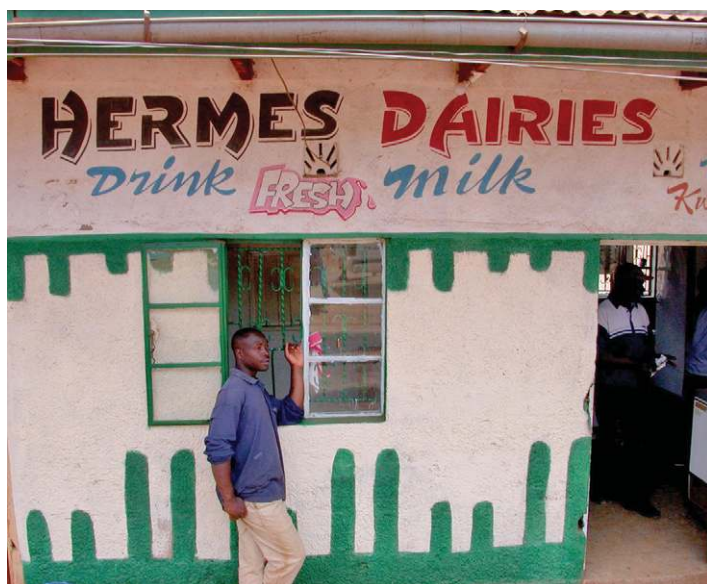
Greater emphasis on dairy production can, however, decrease time available for child care and lead to children being weaned too early because cow milk is available and convenient.

Even within households, significant variation in the quality of animal products consumed occurs: women tend to consume more low-value offal than men in Nigeria and Somalia (Grace et al., 2012a).

Anecdotal evidence suggests that livestock production, sales, and income have to rise beyond a certain threshold before livestock keeping significantly benefits household nutrition security. This is an area that demands further research.



A boy drinks milk in Kenya, one of the largest milk-consuming countries in the world (photo credit: ILRI/David Elsworth).



Left: One of Kenya's many milk bars. Right: Women daily sell and buy unpasteurized milk in Nairobi's informal Dagoretti Market. (photo credit: ILRI/Dave Elsworth and ILRI/Brad Collis)

Indirect Effects of Livestock on Food Security

Income Generation

By generating cash incomes from the sales of animals, their products, or services, or through employment along animal-source food value chains, livestock in poor countries contribute to food security by providing income that can be used to purchase staple food.

It is estimated that livestock production and marketing are currently essential to the livelihoods of more than one billion poor people in Africa and Asia: one-seventh of humanity. Almost two-thirds of poor livestock keepers are rural women (Staal et al., 2009). Herrero et al. (2013) found that beef production and marketing in West Africa supports 70 million people; dairy supports 124 million people in South Asia and 24 million in East Africa; while small ruminants support 81 million people in West Africa and an additional 28 million in southern Africa (Staal et al., 2009). Others have estimated that more than 80% of poor Africans and up to 66% of poor people in India and Bangladesh keep livestock (FAO, 2009). The contribution of livestock to household income ranges widely, from 2% to more than 33% in a number of developing countries (Staal et al., 2009; Pica-Ciamarra et al., 2011).

The massive increase in demand for livestock products witnessed over the past few decades has created equally significant opportunities for smallholders who raise animals to meet that demand and to benefit as a result (Herrero et al., 2010). The role that smallholder livestock keepers play, however, has been shown to vary depending on the stage of development in different countries, on the livestock commodity concerned, and a host of other local, regional, and global influences. So for example, in urbanized economies, there may be less opportunities for smallholder provision of livestock commodities; but this also varies, with smallholders being far more competitive, for example, in the dairy sector, but far less likely to prosper for monogastric production (Tarawali et al., 2011).

In addition to directly providing cash-generating opportunities for livestock keepers, farm animals also create significant numbers of jobs and small business opportunities, many of them in rural areas where other

income opportunities are limited. Livestock value chains represent a large and growing employment sector. They include farm-level production, input, and service industries to farmers; transportation of livestock and their products; and processing and marketing. In some developing countries, the livestock sector contributes as much as 40% of agricultural GDP.

In Kenya, it is estimated that 600,000 dairy households have created 365,000 waged jobs in addition to family labor. There are also an estimated 40,000 jobs in milk processing and marketing as well as an unquantified number in a wide range of input and service functions related to dairying (see <http://mahider.ilri.org/bitstream/handle/10568/1701/SDP%20Brief%202.pdf?sequence=1>).

Livestock Underpinning Smallholder Agriculture

In addition to the direct production of much of the world's red meat and milk, mixed crop–livestock systems produce 50% of cereals (Herrero et al., 2010). Livestock contribute to this staple food production by providing manure, contributing to land preparation, and providing ready cash to buy planting materials or fertilizer or to hire labor for planting, weeding, or harvesting. Livestock contributions can thus increase the area of land cultivated, the yields and productivity achieved, the feed produced from crop residues, and, through enhanced nutrient recycling, the sustainability of those farming systems.

It is estimated that globally livestock manure supplies up to 12% of gross nitrogen input for cropping and up to 23% in mixed crop–livestock systems in developing countries (Liu et al., 2010). Inorganic fertilizer use is especially low in Africa: on average, African farmers apply just 9 kg ha⁻¹ yr⁻¹ of commercially produced fertilizer, and application of manure can improve the efficiency of inorganic fertilizers (Tittonell et al., 2008). In some systems, manure is highly valued: it may be bartered for grain or transported large distances; some cattle keepers value manure as much as milk. Use of manure is, however, influenced by economics, logistics, and regulations (FAO, 2011a), and there may be competition with other demands, such as for fuel. In contrast, in intensified, industrial livestock systems, where crop and livestock production enterprises are geographi-



Typical mixed crop–livestock farming in western Kenya (photo credit: ILRI/Pye-Smith).

cally separated, manure can become more of a liability than an asset (Gerber et al., 2005).

Although on aggregate, draft power use is decreasing globally, in some regions, notably sub-Saharan Africa, it continues to contribute significantly to food production, and in this region, the number of draft animals is increasing. It enables more land to be cultivated; allows people, especially women, to escape the drudgery of manual tillage; permits land to be cultivated before the rains have softened the soil, thereby increasing timeliness of farming operations; can generate greater yields as a result of better weed control and more timely operations; and facilitates adoption of improved soil practices, such as the use of ridges, which can reduce erosion and enhance water retention (FAO, 2011a).

In most mixed crop–livestock systems, the main animal feed consists of crop residues (Blummel, 2010). This enables animal-source foods to be produced without competing with people for food. Use of crop residues as animal feed can, however, lead to hard-to-reconcile trade-offs. For example, an important component of conservation agriculture is the practice of returning crop residues to the soil. Further research is needed into the relative benefits of feeding crop residues to animals and using their manure versus direct use of crop residues as sources of organic matter to improve soils (Valbuena et al., 2012). More research is also needed to determine the most effective and efficient ways of using crop residues in terms of class of livestock and how they are combined with other feed sources (Capper, 2011). And there are opportunities to reconcile the demand for developing crops that prioritize only grain production on the one hand and production of more and better quality crop residues as well as grain (referred to as food-feed crops) on the other.

Livestock are often the most important asset in poor rural households. Access to and control and ownership of assets are regarded as being critical aspects of well-being (Sherraden, 1991). Accumulation of livestock has been identified in some studies as the tipping point that allows poor

households to invest in land or small businesses, diversify their incomes, and become less poor and vulnerable, all of which tend to enhance food and nutritional security (Ellis and Freeman, 2004). Furthermore, livestock assets are generally more equitably distributed between men and women than are other assets, such as land (Flintan, 2008). Livestock, which can be moved, can also provide a buffer in times when harvests fail or other disasters strike, thus smoothing out food availability: refugees on the move frequently take their cattle, small ruminants, and even poultry with them.

In many societies, poultry and small ruminants are often owned by women, who may also control any income obtained from their sale; this is more likely to be spent on their children or family's nutrition than if this income is controlled by men. Recent results show that improving women's access to inputs and services has the potential to reduce the number of malnourished people in the world by 100 to 150 million (FAO, 2011b).

Zoonotic Diseases and Food Safety

Livestock can also impact food security by transmitting diseases to people via vectors such as biting flies and through contaminated animal-source foods; these diseases limit productivity of people by reducing their ability to produce food themselves or to work to earn income to purchase food. With 13 major zoonotic diseases causing some 2.2 million deaths a year, mostly among poor and middle-income populations (Grace et al., 2012b), the harm livestock cause to the nutrition and health of people is significant. Implementing risk-based assessments that seek practical solutions to human health threats from livestock in developing countries, without excluding small-scale producers from their source of income, demands new kinds of collaborations between veterinary and public health researchers and officials as well as imaginative new institutional arrangements (Randolph et al., 2007).



Overconsumption of Animal-Source Foods

Overconsumption of animal-source foods can harm human health and well-being, impacting whole societies as well as individual households. Overconsumption of fatty red meats and hard cheeses, which have increased concentrations of saturated fats, can lead to cardiovascular disease, while overconsumption of processed meats, such as bacon and ham, has been associated with some cancers (Larsson and Wolk, 2012). Increased consumption of energy-dense meat, milk, and eggs also contributes to the global obesity epidemic. This is not an issue confined to developed countries, and it is multi-faceted, with differences within a single household, and a diversity of views on “how much is too much” and how to influence the trajectory of rising consumption in many emerging economies.

Livestock and Climate Change

In the longer term, livestock production can impact negatively on food security through production of greenhouse gases that contribute to climate change. In tropical regions, climate change is expected to result in significant yield reductions, although in temperate regions, the impacts might be beneficial in places (Nelson et al., 2009).

Estimates of the current contribution of livestock to anthropogenic climate change, expressed in carbon dioxide equivalents, range from 8.5 to 18% (O'Mara, 2011). This includes carbon dioxide itself, mainly due to land use changes; methane emissions through enteric fermentation by ruminants; and nitrous oxide emissions, mostly from manure-handling practices. Total emissions of all three greenhouse gases are likely to increase in the coming decades: it has been estimated that emissions of methane due to livestock and nitrogen dioxide due to agriculture will increase by up to 60% by 2030: East Asia and sub-Saharan Africa are expected to increase steeply, driven by increasing numbers of ruminants (Thornton and Herrero, 2009). In response, there will be increased pressure to increase efficiency of livestock production: more milk, meat, and eggs with fewer inputs and decreased greenhouse gas emissions per unit of production. Shifting to fewer, more productive animals of more productive breeds

is one way to do this although doing so would require enhanced access to breeding, animal health and feed services, and inputs to keep these less hardy animals alive and productive (Tarawali et al., 2011). Such an approach also provides an opportunity for “triple-win solutions” as described by Moran and Wall (2011), with synergies among productivity gains, environmental conservation, and poverty alleviation.

Livestock, Food, and Nutritional Security: Future Prospects

Over the coming decades, population growth, urbanization, and income growth, especially in developing countries, will result in huge increases in demand for milk, meat, and eggs. Meeting that demand will place enormous pressure on the global food system.

This has led some authorities to call for a global rebalancing: those who eat too little animal-source foods should eat more; those who eat too much should eat less. A figure of 90 g of meat person⁻¹ • day⁻¹ (32.8 kg per year) has been proposed, with not more than one-half of this coming from red meat (McMichael et al., 2007). Agreeing on the “right” amount, as well as the practicalities and fine tuning of implementing such recommendations, is a significant challenge for the future (Westhoek et al., 2011). While the idea may gain some traction among the “worried well” in the West as a healthy lifestyle choice, it is likely to be a hard sell in the developing world; as people emerge from absolute poverty, dietary diversification, including increased consumption of milk, meat, and eggs, tends to be one of the first manifestations of their increased spending power. Meeting the proposed target would require some big changes to be made: data for 2009 show that, on average, Africans would need to double their consumption while North Americans would need to reduce their consumption to almost a quarter of the 117.6 kg per year consumed today (see <http://faostat.fao.org/>).

Mixed crop–livestock farming systems currently produce most of the world's meat, milk, and staple crops. A major question for the future is

whether smallholder agriculture can remain competitive. Addressing the role of mixed crop–livestock systems in the future, including issues such as efficiency of production as well as the complexities of market engagement, is crucial to address whatever trajectory of change these systems undergo in the coming decades if they are to contribute to food security in a way that is equitable, environmentally sustainable, economically viable (Capper, 2011), and good for human health.

Many poor livestock keepers report that a key motivation for keeping livestock is to earn income so their children can attend school and, perhaps, go on to benefit from further education. By providing essential nutrients, especially in the first critical 1,000 days from conception, animal-source foods can help ensure normal physical and cognitive development. The combined impacts of meeting nutritional needs and providing income make livestock a powerful force for the poor. Well-nourished and well-educated youngsters can grow up to be healthy young adults who are able to realize their full potential and earn higher incomes, in the process enhancing the well-being of their families, communities, and society. The impact of this on food and nutrition security at household, national, and global levels cannot be overstated and demands innovative research, development, and policy approaches.

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