

Food Security: The Contribution of Livestock

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ABSTRACT

Food security is discussed as that basic level of food necessary for survival, and beyond that for basic nutrition. The paper illustrates how livestock continually contribute essentially to both survival and nutritional health. It notes that the major contribution of livestock, apart from luxury animal products consumed by the wealthy middle classes, is through those pastoralists and integrated small farmers that feed themselves and their families and to the urban poor through often compromised products. It is estimated that perhaps 1.5 billion persons that currently benefit from livestock products may be compromised if extant pastoral and in particular small integrated farms are not supported in animal science research and national food security plans.

Key Words: food security, animal science, livestock, nutrition, protein, micronutrients, research

INTRODUCING FOOD SECURITY

Food security is probably the major global issue. Where food is scarce, governance is weak and all security is compromised. This has been the case since Empires and States began and may be traced back into prehistory as the basis of a tribe's or a nation's security. Today, we think we are more sophisticated than that. But we are not – and with a burgeoning population, instant international communication and enhanced means of fleeing from disastrous events, food security is not only the first principle of national security, but also of international security. Migration can undo the best intentions of precarious States while also undermining the lifestyles of protected economies. It is thus a primary responsibility of government and international development to ensure that conflicts and disasters do not threaten access to the most basic forms of food that a population needs to survive. This paper explains how livestock form a key part of such food and national security.

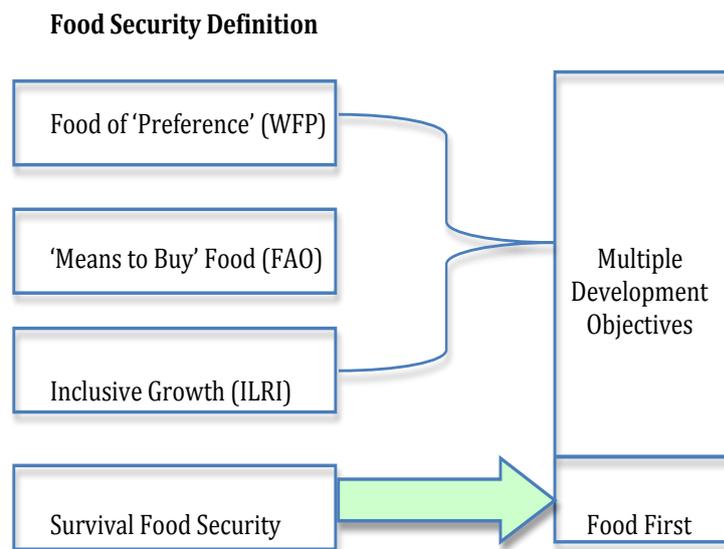
The food security of the 1996 World Food Summit stated that 'food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996).' However, real food security relates to survival. When food is really scarce food preferences mean little, and the world has recently increased that risk where promotion of free trade in food has directed poor country policies away from survival food security planning (Falvey, 2011).

FAO states that 'one of the hardest challenges for food security is ensuring that all who need food have the means to buy it' (FAO, 2011). That is part of food security, but another critical part is the two billion small farmers who feed themselves and their families and are not in the 'buying' economy. In addition, we do well to conceive food security as a psychological state of safety as much as a physical state of eating, and thereby to empathize with those who are in need of food rather than some national average or international benchmark (Falvey, 2001). These are all aspects of real food security.

How do livestock form a critical part of such real food security? They meet multiple development objectives while also contributing to food security, as shown in Figure 1. They also provide multiple outputs, including: high-quality protein; income; draught and traction power for agriculture; nutrient recycling; various edible and non-edible by-products, and they can reproduce themselves.

Figure 1

Livestock Contribute Through all Definitions of Food Security



Livestock are not as important in overall food security as cereals, which are the major human foodstuffs. This may explain why they have been neglected in discussions, and also perhaps because their products are seen as luxury foods. Thus as FAO (2011) has noted ‘although much has been said about livestock’s role in achieving food security, in reality, the subject has been only partially addressed and no current document fully covers the topic’ – their report ‘is an attempt to fill the gap’.

The gap is also being addressed by the world’s principal livestock research centre – the International Livestock Research Institute (ILRI). ILRI focuses on food security in combination with such objectives of poverty alleviation, environmental care and health issues across scenarios with the greatest development potential (ILRI, 2012).

- Systems that support inclusive growth, agricultural transition, wellbeing of people now and in the future, supply gap reduction, and environmental and human health challenges.
- Low growth systems in which livestock may benefit from targeted research not conducted by others.
- Growth where livestock’s negative effects on environmental services or human health might be mollified.

This is an important step forward in correctly seeing livestock and the animal science that supports it.

SEEING LIVESTOCK CORRECTLY

Western perspectives view livestock as specific industries rather than as integral to the farming systems of smallholders in poor countries and herders, and in some cases assume these production systems will disappear in time. The assumption is unrealistic at current states of knowledge and development. ‘Global figures indicate that livestock are important in providing some 20 percent of food energy and 30 percent of protein ... these figures mask

their relatively higher value to the poor, in terms of geographical distribution, the excess consumption of animal products in some diets and nutrient deficiencies in others, as well as cultural dietary differences' (CGIAR, 2008).

Livestock associated with the rural poor are not usually those that are criticized among new global concerns; they do not consume much grain, are not the only source of risk of animal-to-human disease transmission, environmental damage or even the largest greenhouse gas emitters. These common criticisms of animal production are more relevant to the industrial systems created to feed cities. And in fact, nomadic or mixed small farming systems are highly evolved efficient systems understood by nomads and farmers in a manner forgotten by narrow conceptions that overlook the role of rabbits, rodents, poultry, native pigs, buffalo, yak, camels, horses, fish, reptiles, insects and native goats, sheep and cattle providing meat, offal, milk, blood and other food products in areas remote from affluent markets.

If we separate animal production into rangeland, integrated farming, intensive production and landless systems, we find that each contributes to food security. From the extensive pastoral systems of Mongolia and Tibetan China, to the mixed crop-and-livestock systems that involve billions across most poor countries, to the intensive production systems that provide low value byproducts to the urban poor especially in China, to the landless dairy herders and milkers of India that ensure their neighbours have regular animal protein in their diets, each system contributes to the food security of the vulnerable poor though not necessarily in market forms recognizable to the global middle classes.

The animal raisers that service such 'markets' differ from those in commercially-linked systems. They view dung not only as manure, but also as a construction material and a cooking fuel, and animals themselves as not only for ploughing but also for traction, packing and working mills while providing a regular small income and nutritional contribution from milk, eggs, hair and blood. They prefer small breeds to large ones because they mitigate the risk of losing an animal, and may view a product such as meat as an end-of-working-life byproduct; they see milk as more than a liquid drink, butter or cheese and more as a storable and transportable product. And they know that the financial value of an animal set by an urban market can as a consequence grossly understate its economic value. Figure 2 summarizes some of the differences.

Figure 2

Why Livestock Owners Persist with Low Financial Returns
(value exceeds financial (monetized) return)

Sources of Financial Returns

- Sales of meat
- Sales of milk
- Sales of hides
- Sale of wool/hair
- Sales of byproducts

Value of Livestock to Owners

- Sales of meat
- Sales of milk
- Sales of hides
- Sale of wool/hair
- Sales of byproducts
- Traction/transport
- Draught power
- Dung: fuel/manure
- Savings
- Risk mitigation
- Status
- Religion/Tradition

Rather than assume that these systems will move towards commercial agriculture, it is appropriate to address the needs and contributions of each animal production system. We have seen the negative environmental effects of naive sedentarization of nomadic herders, for example after 70 years of enforced settlement of Mongolian pastoralists under Russia's governance (Falvey and Leake, 1993). And rather than assume commercial production is the end game, we may do well to see that small subsistence farmers and their animals are providing a great service by feeding up to two billion small-farming families around the world. If those families were to migrate to cities, the consequent increase in food demand would not be met from current levels of production of broadacre agriculture even if it used all the land once tilled by small farmers.

WHO IS FOOD INSECURE?

FAO has collated the various UN approaches to food security into the four aspects of: food availability; access to food (during conflicts and crises also); reliability of supply, and sound food safety and nutrition (FAO, 2011). A food system that meets all four aspects simultaneously is considered to be 'sustainable and resilient' (Harding, 2010). It is an ideal, for it seeks production of adequate food, its transportation with minimum waste and sale at affordable prices, and then adds other ideals such as monetized environmental and public nutritional education costs. It assumes free movement of food across the world and that it is possible to plan systems that are resilient to wars, economic crashes, disease and natural disasters. Nevertheless the approach is useful to define in gross terms who is food insecure. But it cannot ethically be imposed it on food-vulnerable persons unless accompanied by a guarantee of food security.

Undernourishment decreased by about five percent in the actual numbers of persons, which with rising world population represents a decrease in the percentage of undernourishment in the world from the 1980 figure of 28 percent to 13 percent in 2007 (16 percent for developing countries) (FAO, 2008a). Such arithmetic is based on food calorific intake as in Table 1, which omits consideration of nutritional quality and continues to affect the health of some two billion persons. This leads to such estimates as 146 million children being underweight, of which 31 percent are stunted (UN, 2010). It is in these areas that animal products make a specific contribution.

Table 1
Dietary Protein and Energy, and Undernourishment per Region (FAOSTAT, 2014)

Region	Protein	Energy	Calorie Deficit (%)
World	76	2,780	13
Developed countries	102	3,420	<5
Developing countries	70	2,630	16
Asia (incl. Oceania)	70	2,610	16

ANIMAL PRODUCTS IN FOOD SECURITY

Average world consumption of food products derived from livestock totals about 13 percent in calorific terms and 28 percent in terms of protein in meat, milk, eggs and offal. Table 2 presents the change in average output of selected global animal products per person over 40 years. Increased availability on a global basis does not mean that the diet of marginalized persons has improved. Where they can access these products, nutrients deficient in many diets may be reduced, particularly protein (including amino acids not readily accessible from plant foods) and micronutrients (such as iron, zinc, vitamin A, vitamin B12 and calcium) in diets of children and reproducing women. While there are no agreed nutritional scales that recommend the amounts of livestock products for different categories of persons, it is suggested that regionally gross protein consumption levels exceed the minimums except in sub-Saharan Africa.

Table 2**Increases in Average Global Animal Product Output per Person (FAOSTAT, 2014)**

Product	1967 (kg)	2007 (kg)	Increase (%)
Milk	110	102	-8
Beef (incl. buffalo)	11	10	-7
Pork	10	15	52
Eggs	5	10	83
Poultry	4	13	269
Sheep/goat meat	2	2	5

In poor countries with significant parts of the population existing on marginal diets, means of augmenting amino acid and micronutrient deficiencies is accomplished most easily through the incorporation of animal products. Benefits accrue from small amounts of animal products, for example from meat that provides zinc and iron as well as increasing absorption of iron from plants (Bender, 1992), and both meat and milk that provide vitamin B12, riboflavin and vitamin A, and milk that provides calcium. With iron deficiency affecting some 1.6 billion people (DeBenoist et al., 2008), impairing mental development of 40–60 percent of children in developing countries and implicated in 20 percent of maternal deaths each year (UNICEF, 2007), ensuring reliable access to small amounts of animal products remains key to food security. And with meat consumption projected to rise more in developing than developed countries, as indicated in Table 3, it is impossible to ignore the potential role of animal food products in the diets of even the urban poor.

Table 3**Projected Rise in Meat and Dairy Product Consumption (FAO, 2011)**

Product	World Consumption (t x10 ⁶)			Developing Countries (t x10 ⁶)		
	2010	2050	% Rise	2010	2050	% Rise
All meat	269	464	173	158	330	209
Dairy (not butter)	657	1,038	158	296	641	216

Average national food consumption figures suggest an increase in animal food products in diets with rises in income (Delgado, 2003). However, national figures hide within-country variations, and simple correlations of income and animal product consumption can miss cultural taboos such as pig meat consumption in Muslim communities or social changes such as in Thailand where a traditionally non-milk-drinking society changed to one with school milk representing 25 percent of national milk consumption compared to between one and nine percent elsewhere in the country (Griffin, 2004).

Supplying some 13 percent of global calorific intake and perhaps 28 percent of protein, livestock products are significant. Misconceptions of vegetarianism in India, for example, commonly omit the country's role as the world's leading dairy product producer and consumer (Falvey and Chantalakhana, 1999). Table 4 presents the rankings of consumption levels for major foodstuffs of some animal products in developing and low-income countries compared to world averages. It shows the importance of animal products.

Table 4**Calorie Consumption Ranking of Animal Products (adapted from IFPRI, 2010)**

Product	World	Developing Nations	Low-Income Nations
Milk	6	7	9
Pork	7	6	13
Beef	14	16	17
Poultry	12	17	19
Eggs	17	18	22
Lamb	23	23	20

ANIMAL PRODUCTION IN A FOOD-INSECURE WORLD

Livestock production has increased markedly in East and Southeast Asia in recent decades while in sub-Saharan Africa production has lagged. Intensive production systems are responsible for most of the increase. China produces about 70 million tons of eggs and 15 million tons of poultry meat compared to India's 3 million and 0.6 million. Nevertheless, poultry production in India is rising fast and consumption rose from around 22 percent in 1985 to some 50 percent of livestock protein consumed per person in 2003 (Pica-Ciamarra and Otte, 2009). As in Thailand, Vietnam increased dairy product consumption by 300 percent between 1996 and 2002 (Garcia et al., 2006). The traditional dairy country of India has increased consumption from 178 grams per day in 1992 to 258 in 2009 (NDDDB, 2010). While such trends are less evident in poorer Asian countries like Bangladesh (Halderman, 2005), the increased production and consumption of animal products in Asia is a significant development phenomenon.

Some Asian nations are major exporters – Thailand is a case in point as home to one of the world's multinational agribusinesses, Charoen Pokphand (CP). But this does not add much to basic survival food security for such product mainly serves wealthy markets. The response is not to seek a means of directing exported product to the hungry poor but to see the international food trade as business – and to separately see national food security in food-insecure countries as essential to good governance. However, policies for animal production in food-insecure countries are often similar to those in food exporting nations, which can increase the risk of food shortages and malnutrition. For example, Western approaches to monogastric and feedlot ruminant diets compete with humans for grain.

While it is logical that ruminants should be raised on extensive non-arable lands utilizing plants inedible to humans, dietary preferences override such an ethic in rich market-driven production systems. Even when one country is in food deficit, another country's decision to continue feeding grain to livestock is usually based on price signals. Such reliance on market signals to provide needed food can work under conditions of surplus and when the hungry in the deficit country have purchasing power – but not if either one of these factors fails. In any case, totally grazing-based ruminant production accounts for only about 12 and nine percent of world milk and meat respectively. More important is the system of mixed grazing and crop residues occasionally supplemented with concentrates, which produces some 88 percent of world milk, but only six percent of meat (FAO, 2011).

These contributions are reduced in situations where animal production diverts feed from humans. An attempt to quantify this by FAO (2011) based on trade, animal feed and crop statistics standardized by protein content indicated 'a tendency for countries with intensive livestock systems to consume more human-edible protein than they provide compared to countries with extensive ruminant systems that augment overall supply of protein'. In confirming accepted viewpoints, such work leads some to recommend reductions of intensive animal production and expansion of mixed systems of ruminant grazing or animal consumption of biological waste products. But this is unlikely to occur since demand for grain-fed livestock – both monogastrics and ruminants – is correlated with rising affluence. A more practical recommendation in such situations is to address the options available for the nutritionally marginalized proportion of the population.

ANIMAL PRODUCTION SYSTEMS

Animal production systems can be presented conventionally as in Table 5, but may more usefully here be presented as social segments that rely on specific production systems, namely:

1. Livestock-dependent societies
2. Small mixed farmers
3. Urban populations

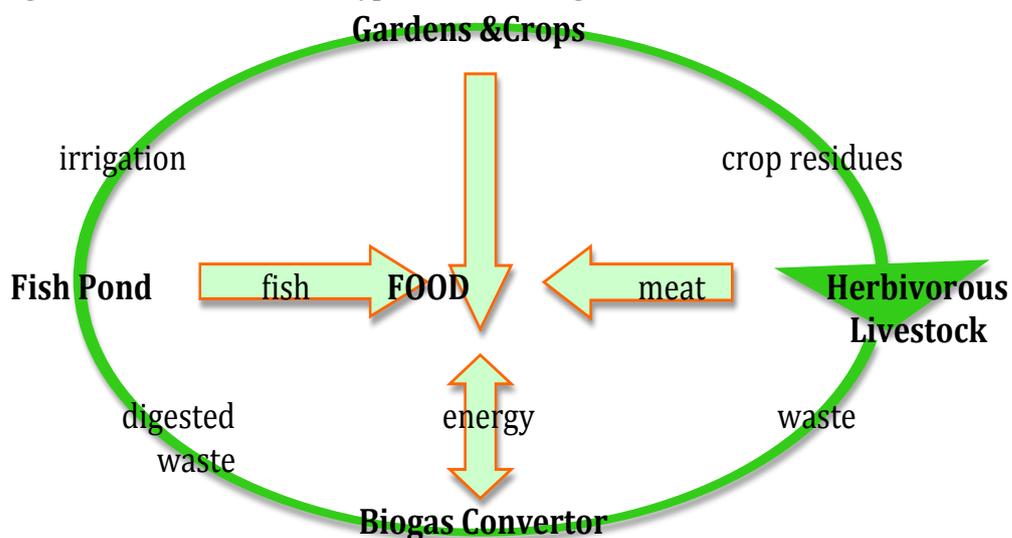
Table 5 World Animal Production (mill. t.) by Production System (FAO, 2011)

	Grazing	Mixed Rainfed	Mixed Irrigated	Industrial	Total
Milk	72	319	203	?	594
Pork	1	13	29	52	95
Poultry	1	8	12	53	74
Beef	15	29	13	4	61
Eggs	1	6	17	36	59
Sheep meat	4	4	4	?	59

1. Livestock-dependent societies: Comprising some 120 million people who raise mainly ruminants on uncultivated and usually non-arable areas, such societies may derive 90 percent of total farm production from livestock (Sere and Steinfeld, 1996). Including both pastoralists and ranchers, these systems are said to produce about 19 percent of world meat production and about 12 percent of milk. On the margins of Asia, such systems in Australia make it the world's largest exporter with some 45 percent of production (MLA, 2011). Likewise in Mongolia, extensive livestock production contributes some 30 percent of GDP and 20 percent of export earnings. These represent highly evolved interactions with otherwise uninhabitable landscapes. While it may seem that their numbers are declining, persons from livestock dependant societies need not be forced into cities, which would increase the overall demand for food of such persons by at least 30 percent above current consumption levels. Thus it might simplistically be estimated that by not migrating to cities – that is, by continuing in their extensive lifestyles – their animal products contribute directly to food security to the extent of about 160 million persons.

2. Small mixed farmers: Defining a mixed farm as one where more than 10 percent of animal feed is from agricultural by-products or more than 10 percent of the farm production value is from other agricultural enterprises (Sere and Steinfeld, 1996) leads to a wide range of animal production systems. It is these rain-fed mixed systems that produce much of world meat and milk – 48 percent of beef, 53 percent of milk and 33 percent of mutton. Often such farms are subject to single-product analyses of efficiency, which can grossly underestimate draught and traction functions and other products of large animals. For this reason it may be more constructive to use the Asian integrated farming system as the basis for small-scale mixed farms rather than the more generalized global definitions. One of their myriad forms is presented in Figure 3.

Figure 3 Schematic of one Type of Asian Integrated Farm



In such farms, animals perform a range of functions in addition to the usual food products, including waste usage, provision of fertilizer and insect pest control (Devendra and Leng, 2011). Small breeds are more efficient in such systems as numbers can be varied more easily across seasons and conditions, and allow a more regular source of protein in diets. An important consideration in such farms is that they follow the same systems that have evolved through trial and error over millennia. China moving to food exports when mass starvation was predicted has relied on small-scale farms integrated with small animals.

Small-integrated farms that support some two billion persons are a major contributor to food security because they allow that third of humanity to continue feeding themselves in rural settings and so not add to the major food security issue that has arisen in cities. The food security benefit of such small farmers can be roughly estimated as higher (say 20 percent) potential yields of small farmers plus the 30+ percent extra production required for food to reach urban dwellers. This would make the total food security contribution equivalent to one billion persons.

3. Urban populations: With more than half of the world's population now living in cities, supply of food to cities is a rising aspect of food security. With 300 million urban dwellers considered to be extremely poor and the majority of these in Asia (Ahmed et al., 2007), food security related to severe undernourishment and precarious access to food is a major issue. Animal products are highly accessible to the urban middle classes, but much less so to the price sensitive poor, who are in turn subject to risks of unsafe products resulting from poor hygiene, poor refrigeration and unregulated toxin and residue levels. Having no viable connections to agriculture, the urban poor do not have the nutritional buffer of animal products or any protein reserve and are thus the most vulnerable to disease and early death. Similarly, the usual animal products do not readily lend themselves to the trend for urban households to hoard food when prices become volatile. For example, the food crisis of 2007–08 led to poor households in urban Bangladesh limiting their purchases of meat, fish and eggs (Cohen and Garrett, 2010).

Urban-based livestock production is now being reduced out as priority is allocated zoonotic disease risk mitigation above food security for the poorest persons. For example, a constant population of more than 200,000 poultry was raised within Jakarta in 2003 and was increasing until such production was banned in the Avian Influenza programs of 2008 (FAO/ICASEPS, 2008); in Thailand tax incentives were provided to urban livestock producers to move out of Bangkok (Costales et al., 2006). China located farms around cities and placed them within the urban governance ambit. Beijing is said to supply 70 percent of vegetables and milk internally (Jianming, 2003) and Shanghai meets at least milk and egg demand from within city limits by governance of an area that elsewhere would be defined as 87 percent rural (Yi-Zhong and Zhangen, 2000). While such periurban agriculture has long been the major source of food for most cities – estimated to supply 34 percent of meat and 70 percent of egg production worldwide in the late 1990s (FAO, 2011) - the important difference is that urban food needs are managed as a priority by the city administration in China. And the system includes huge livestock production.

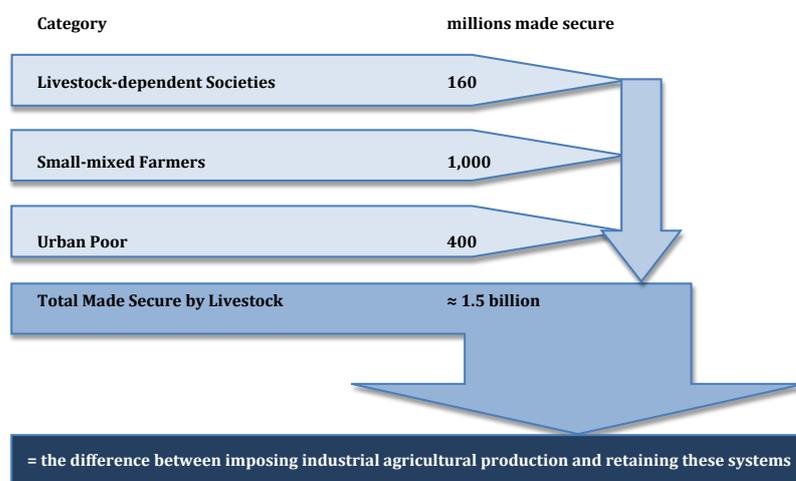
Estimating the number of persons kept productively alive by animal products meeting the increased demand in cities is more difficult than for pastoral (160 million) and small mixed farms (maybe one billion). If it is accepted that the situation is grave for about 30 percent of urban inhabitants of third-world cities, the usual figure of about one billion food insecure persons globally emerges. Assuming the same figure of 30 percent for highly urbanized China, then perhaps some 200 million persons otherwise food insecure are rendered food secure by such urban policies as China's. Add this to elements of such policies in other nations and the figure might double to some 400 million.

The sum of livestock's contribution to food security might then be as shown in the following

Figure 4.

Figure 4

Livestock's Indicative Contribution to the Most Marginal Food Insecure



The sum of animal products to absolute food security from these three livestock systems – pastoral, small farms and urban livestock – might therefore be some 1.5 billion persons. This means that these 1.5 billion persons could otherwise be subject to health-debilitating diseases if animal protein had not been included in their diet. But an estimate is gross at best, and overlap with the one billion chronically food insecure persons whose primary need is not necessarily animal protein.

From this current basis of livestock supporting food security in often forgotten ways, some discussion of the possible future for animal production is warranted to provide the overall context of livestock.

THE FUTURE

Demand for animal products by the middle class will rise with wealth and population increase – both of which are increasingly urban and Asian phenomena. By 2050, poultry meat demand is estimated to be 230 percent of that in 2005 and other livestock products about 160 percent (FAO, 2011). Requirements for about double the current animal product consumption with at least some increase in price represents another future food security impost on the urban poor. We know that production systems can be increased in efficiency, and that wastage can be reduced, but these do not obviously lead to a doubling of availability of animal food products. The only other path for either increased availability or decreased price is technological innovation, and with declines in investment in agricultural research, large breakthroughs are no longer predicted. That is, except where research investment has been maintained or increased, and again China stands out as the leader.

Another factor is a change in focus from the same old animals to embrace those most suited to the production environment, which remains one of the fundamental tenets of the science of animal production. For example, one field of animal production that may provide needed animal protein is aquaculture. Having increased from about 40 to 52 billion tons between 2002 and 2006, with more than 60 percent of production being in China (FAO, 2008b), aquaculture now represents about half of global fish consumption (FAO, 2010). The high feed conversion rates of some farmed species, and their adaptability to small production facilities, make this form of animal production of increasing importance in food security. Other more remote possibilities include: household fish, rodents and rabbit production; farmed insect and larvae protein; laboratory/factory produced meat-type protein products (Datar and Betti,

2010), and factory-produced ‘protein biscuits’ from treated animal and other wastes. In the meantime, increased efficiency of use of byproducts and waste resources remains an essential component.

Small mixed farmers feed agricultural byproducts, food waste and small animals including insects to livestock foraging near fields and houses. They also cut and carry forage for ruminants in systems that are extremely efficient compared to large-scale commercial and intensive production systems. With adequate disease control and remediation of nutrient deficiencies these systems based on indigenous breeds can show production levels similar to higher-cost commercial systems using exotic breeds. But production efficiencies do not necessarily translate into meeting the needs of the urban poor since most infrastructure to deliver food to cities is based on capturing profits along the supply chain, and greater profits may be gained from supplying middle and upper class demand.

CONCLUSION

While extensive ruminant grazing systems and small mixed farms are the most efficient production systems, the vast majority of animal products that can be delivered to cities is and will be from specialized intensive production, particularly for poultry and pigs. The trend is already well established. Asian production systems that utilize agro-industrial and other wastes already demonstrate greater resource efficiencies than Western-style production systems. Under this scenario, the urban poor may access livestock products that the wealthy classes reject – offal in some markets, suspect-quality meat or milk in others. It sounds inequitable, but it is consistent with historical precedents, and survival ranks above ideology in such matters.

A range of simple urban and home-based animal protein production systems may better serve food security for the urban poor. And we may note that food reserves against poor seasons and disasters need to be reintroduced regardless of trade-based arguments for food security (Von Braun and Torero, 2009). For animal foods such reserves include a wide range of traditional preserved products, animals that graze and scavenge by themselves and urban animal production including home-based production systems. That is why they are called ‘live’-stock. Complementing these are the small mixed farmers and pastoralists in poor countries that are both producers and consumers of livestock products and whose livestock food security maintains healthy persons outside cities.

Research to increase the efficiency of the livestock production systems that meet each of the needs of pastoralists, small mixed farms and urban consumers is a primary responsibility of future animal science. Each requires a multidisciplinary approach. With rates of return to public investment of 40–50 percent from agricultural research this makes financial sense, but the approach conceives livestock as a source of high value traded food, contributing to food security only through trade. In fact, returns to small-farm research may be even higher (ACIAR, 2006).

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