Underneath the Livestock Revolution

Achilles Costales, Pierre Gerber and Henning Steinfeld

The sustained rise in demand for food of animal origin, driven by growing populations, increasing consumer affluence, and increasing urbanization, is underpinned by structural changes along the whole animal food supply chain. Distribution, processing and production sites are affected. This "livestock revolution" is characterised by prominence of large retailers, a tendency towards vertical integration and coordination along the food chain, and industrialisation of the production process. Since each of these developments may raise market barriers for small scale operators, sustaining the revolution may not be compatible with sustaining small scale livestock production. Moreover, the structural changes are accompanied by an increasing use of crops for livestock feed, rather than human food, raising questions about food security and poverty. Industrialisation if poorly managed can result in externalities in the form of environmental damages. This paper explores each of these factors and highlights issues that policy makers must take into account when responding to the livestock revolution.

The rise of large retailers

Rising per capita incomes and the urbanizing populations in developing countries have been observed to be leading to the westernization of diets and transformation of food systems (Pingali 2004). Increasingly affluent urban consumers in developing countries are associated with an increase in prominence and reach of large-format retail stores, in particular supermarkets, responding to and perhaps shaping the increasing demand for convenience, variety, and quality assurance. While the main target of the supermarkets in developing countries is the urban middle class, the competition among rival chains brings prices of similar products down, thus also accommodating lower income households in search of opportunities to stretch the purchasing power of their food budget.

The rapid expansion in supermarket penetration in developing countries is a fairly recent phenomenon, notable only over the last 5-10 years, proceeding at different rates and depths in the various regions of the developing world. Reardon and Timmer (2005) describe the diffusion of supermarkets in three successive waves. The first wave covered much of Latin America and East Asia (except China), North-Central Europe and South Africa. While a number of supermarkets already existed in these countries in the 1970s and 80s, they were local firms using local financing, catering to niche markets for the wealthier classes in major cities. Entering the 1990s, these supermarkets accounted for only 5-10% of agri-food retail sales. By 2000, the modern supermarkets had captured 50-60% of the agri-food retail market. The second wave of supermarket diffusion took place in the mid-1990s, covering parts of Central America and Mexico, Southeast Asia, and South-Central Europe, with the share of supermarkets in total food retail reaching about 30-50% by the early 2000s. The take-off of supermarkets in the third wave of diffusion started only in the late 1990s. Countries affected included China, India and Russia, some countries in Central and South America, in Southeast Asia, and some in Africa. By the mid-2000s, supermarket share of food retail had already reached 10-20%.

There are regional differences in the speed at which these transformations are taking place. In general, the diffusion took place a little earlier and has now penetrated deeper in Latin America, followed by East Asia (except China), and then Eastern Europe. Apart from the size and rate of expansion of the economy, urban population, and

the middle class, these developments have been facilitated (or slowed down) by country policies on trade and retail sector liberalization, as well as those relating to foreign direct investment (FDI). The late entry of China and India was related to the remaining policy restrictions on the entry of foreign investments in the food retail sector in the early 1990s.

At the forefront of supermarket diffusion are the large transnational food agribusiness conglomerates. Their spread has been facilitated by full or partial liberalization of the retail sector, inducing FDI in food processing and distribution. Although reinforced by multilateral trade liberalization, the breaking down of quantitative restrictions and lowering of tariffs, and the laying down of rules and standards for food quality and safety (Sanitary and Phytosanitary standards, Codex Alimentarius, private standards), the entry of FDI to the developing regions of the world since 1990 has been more crucial to the take-off of supermarkets.

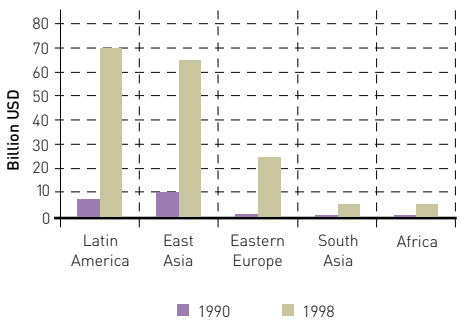
The increase in FDI investments in the agri-food sector by transnationals has been more or less in proportion with expansion in overall FDI (Reardon and Timmer, 2005). Concomitant with the first wave of supermarket diffusion, the leading regions in FDI expansion were also in Latin America and East Asia. In the same way that supermarket diffusion lagged behind in India and Africa, so has the entry of FDI.

The main markets of these large-format retail units are the domestic urban consumers, whose growth in demand for higher-value fresh and processed agri-food products has been expanding. The entry of FDI allowed transnational food retailing companies to bring with them their state-of-the-art technology in product specification, quality control, labeling and packaging, as well as in logistics and accompanying infrastructure in procurement and distribution. From these investments are built the economies of scale and the capacity to meet competitively price and quality standards in both international and domestic markets (Berdegué and van de Kop, 2005).

The emergence of supermarkets in developing countries reflects a structural change that alters the way in which meat and dairy products are assembled, inspected, processed, packaged, and supplied to consumers. It is a change that has deep impacts on livestock and milk producers, particularly on who can and who cannot participate in the mainstream supply chains. A segmentation of markets can be seen, between the 'formal' and the 'informal' supply chains, and between the 'wet' markets for fresh and warm meat and the supermarket outlets of processed, frozen, packaged and branded meat. The relative significance of each market segment is tied to the level of economic development. It is closely linked to the purchasing power of households and individuals, their demand for leisure, their preferences with respect to the form and texture of meat upon purchase, and the relative value they give to notions of food that is 'safe'.

While the informal supply chains for livestock and raw milk, and the wet markets for meat, still constitute the dominant segments in developing countries, with the expansion of their economies, the large scale retail sector is growing. The rapid expansion of large retailers in Latin America, East Asia and the Near East has been accompanied by a relative decline of traditional wholesale

GROWTH IN FDI IN DEVELOPING COUNTRIES, 1990 AND 1998



Source: Reardon and Timmer (2005)

markets in regions where the restructuring of the agri-food markets and industries have been most dynamic. With the expansion of the formal supply chains and the displacement of the chains leading to the traditional wholesale markets, comes a contraction in the productive activity that supplied these traditional markets as well.

In regions where economic growth has been relatively slow, such as Sub-Saharan Africa, the informal and traditional markets for livestock products remain dominant and production for home consumption is still very important. In Ethiopia, for example, only about 20% of total milk output reaches the market, either through informal or formal links. In the capital Addis Ababa, where market transactions take place, the share of the informal market is estimated to be around 70%, consisting of traditional raw milk and traditional butter (Jabbar *et al.*, 2005). Even in Kenya where the government has poured significant investments into the establishment of modern dairy processing plants, the formal dairy sector has collapsed, and the informal market chains, which took 70% of the market in the 1980s, increased their share up to 90% by 2003, mainly by exploiting local tastes and preferences for traditional milk and dairy products (Omiti *et al.*, 2005).

Apart from South Africa where supermarkets have become a significant force, and to some extent Kenya, Zambia and Zimbabwe, most of Sub-Saharan Africa has not yet experienced a substantial takeoff of supermarket diffusion. Particularly the very poor countries such as Ethiopia, Sudan, Burkina Faso and Mali, are unlikely, even in decades, to witness the growth of supermarkets. It will require a critical mass of urban consumers, purchasing power, improved farm-to-market infrastructure, better FDI investment climate, and political stability (Reardon and Timmer, 2005).

The resilience of informal markets is apparently providing relief to small livestock producers supplying informal markets in the rural as well as urban areas on the basis of strong consumer preferences for traditional products. There are, however, no guarantees that these markets will continue to be the locus of economic opportunities for smallholders in the longer run. While consumption patterns and habits appear to be embedded in tradition, the power of structural change in modern market chains to overcome seemingly immutable hurdles cannot be underestimated.

Vertical coordination and integration along the food chain

The entry of transnationals into the agri-food chain, particularly in the retail and processing sectors in developing countries, has transformed the manner in which agri-food products are purchased from suppliers, transformed into differentiated products, and distributed to consumers. As these new distribution and large retail units have to compete for market share, between themselves and even with traditional suppliers and traditional wholesalers in the domestic market, they must offer competitive prices. They can only maintain and/or expand market share by cutting costs.

At the same time they must compete in delivering consistent product quality that is demanded by their main market. The concept of 'quality' from the producers' perspective is complex, and its attributes evolve over time. Its definition varies according to suppliers' strategies on the one hand, and to cultural influences on the other. It includes food safety, nutrition and attributes related to the commercial differentiation of the products (Reardon, *et al.*, 2005). Large retailers require a reliable supply of agricultural products from their suppliers (producers) with consistency in volume and in quality.

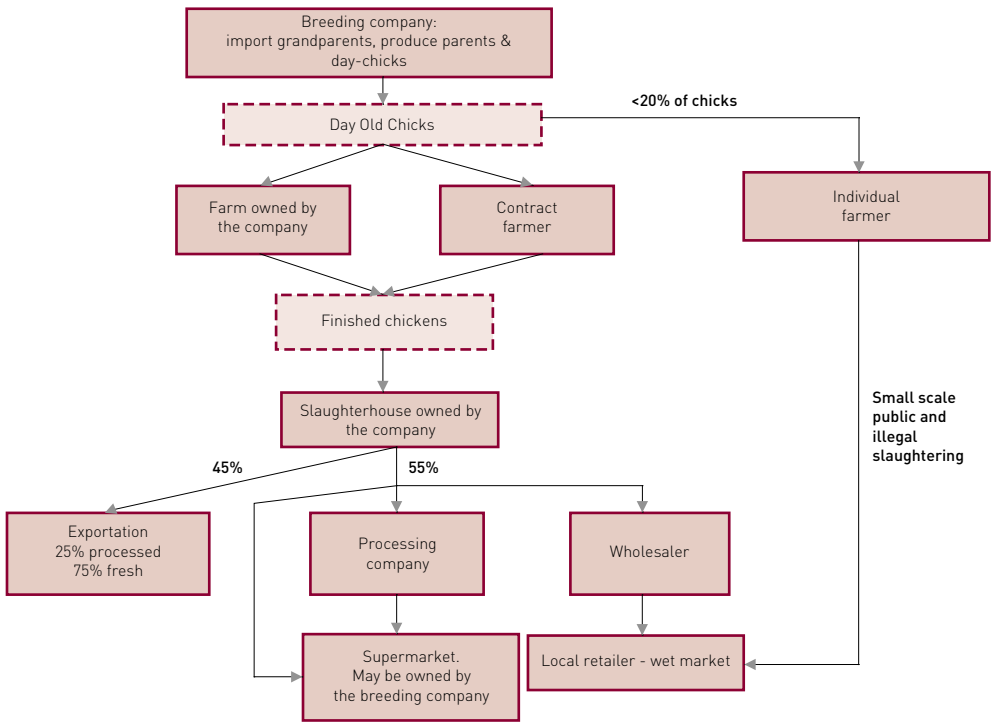
Vertical coordination presents the opportunity to keep control of operating and transaction costs while at the same time meeting high standards for food safety. It demands organizational and institutional changes in the relationship between the primary producer and the agri-food processor or supermarket distributor, giving rise to either various forms of vertically coordinated transac-

tions (the retailer contracts suppliers and/or processors), or in the extreme form, fully integrated systems (all units in the food chain owned by one company). Large retailers in developing countries are increasingly tending towards vertical coordination, although vertically coordinated chains may interact with informal markets by supplying inputs of live animals or products.

Several studies (Weatherspoon and Reardon, 2003; Reardon *et al.* 2003) indicate that supermarkets' procurement systems involve purchase consolidation, a preference for specialised wholesalers, and tough private quality and safety standards. The introduction of clearly specified quality and safety standards and contractual production arrangements reduce transaction costs associated with information asymmetry, but require investment in physical and human capacity. Through vertical coordination and governance at each stage in the chain, production efficiency as well as product quality can be monitored, and standards imposed. Vertical coordination not only allows gains from economies of scale, but it also secures benefits from market ownership and control over product quality and safety by controlling the technical inputs and processes at all levels. Large multinational firms have strength in achieving economies of size and scope, and by sourcing supplies at different levels and across national boundaries.

The move toward non-market transactions (e.g. contract farming, dedicated suppliers) within a

COMMERCIAL CHICKEN PRODUCTION AND SUPPLY CHAIN IN THAILAND IN 2003



Source: Department of Livestock Development, personal communication.

framework of vertical coordination has profound economic and social implications for rural and peri-urban livestock producers in developing countries. To meet quality requirements by agri-food processors, producers have to make investments and adopt new practices. In this situation, there are both challenges and opportunities. Where there are many large producers to choose from, who can make the necessary investments to still operate profitably, large agri-food processors will find little incentive to source supply from small producers. Under these circumstances, the burden is entirely put on the smallholders to make the investments. If they are unable to do so, they are taken out of the market chain loop, as in the case of the small dairy farmers in Brazil (Farina, 2002), in Argentina (Gutman, 2002) and Chile (Dirven 2001). The move towards non-market transactions, however, does not automatically mean the demise of smallholders under all circumstances. Where there are few alternative large suppliers, and smallholders have the human capacity to meet product quality requirements, and incentives exist for the agri-food processor/distributor to make profits from such capacity, interlinked financing contracts and technical assistance are often provided in exchange for adjusted payment schemes on the output side, as in the case of smallholder dairy farmers in Poland (Dries and Swinnen, 2004).

While many farmers recognize the opportunities presented by consumer-driven agriculture, great challenges remain for small scale farmers in developing countries. The large number of small scale farms makes it difficult to organize, monitor and standardize the quality of products. Further downstream, the ability of the traditional wholesale market systems to meet demands by modern procurement systems is low. For example, Ahold company in Thailand has limited ability to meet large retailer requirements in the supply of fresh fruits and vegetables (Boselie, 2002). Fresh products marketing is characterized by poor infrastructural and institutional support. Risks and uncertainties are high. This can only be compensated by costly investments in an alternative system (Reardon and Timmer, 2005).

Under conditions of high risk and uncertainty of output and input markets, where guaranteed product quality is required (e.g., absence of avian influenza disease), vertical integration is a well known strategy to resist shocks in input and output prices, especially for small producers operating in a market subject to high price volatility. It is also an efficient way to provide technical assistance to the producers and to diffuse new technologies. For example, the Charoen Pokphand Group has been promoting new housing and manure management systems over the last 5 years in Thailand, resulting in drastic shifts among its contract farmers.

These challenges for smallholders, however, are not insurmountable. It is rather the approach to integrating them into the more dynamic and dominantly private-sector business transactions that needs to be explored. This may require different methods to the conventional technology upgrading and skills transfer programmes and strategies to small producers provided by the public sector.

Under marketing environments where volume or/and quality assurance is important, a major incentive for some form of coordination or another is a wish to limit transaction costs. Even in traditional marketing, these are often prohibitively high for small-scale producers because of the small quantities of marketable product produced and the absence of adequate physical and market infrastructure in remoter areas. Transaction costs are also increased where producers lack negotiating power or access to market information and remain dependent on middlemen. Moreover, the lack of facilities for the formation of producers associations, or other partnership arrangements, makes it more difficult for smallholder producers to reduce transaction costs through economies of scale. Economic forces towards vertical coordination are sometimes further strengthened

STANDARDS IN THE LIVESTOCK MARKET AND IMPLICATIONS FOR SMALL SCALE PRODUCERS

	Positive factors	Negative factors
Process standards		
UHT treatment of milk, government requirement.	Clearly specified process	Administration costs of inspection. Investment in equipment and training may exclude smallholders.
HACCP in abattoir, required by importers and supermarkets.	Clearly specified process	Probably neutral for small producers
Organic produce, standards set by certifying bodies.	Premium price. Can be carried out on small scale (e.g. honey production in Chile). Favours labour-intensive systems	Several certifying bodies, harder to achieve in developing countries. Costs of certification. Achievable by smallholders working in co-operatives.
Performance standards		
Salmonella levels in meat, with financial penalty for poor performance.		Standards usually set to stringent developed country consumer requirements. No guaranteed method to meet required standard. Cost of tests may be prohibitive unless subsidized by government.
Combined standards		
Contract farming requirements for timing of activities and quality of product.	Premium price. Some support with investment and cash flow. May be supported to overcome risk e.g. restocking after HPAI outbreaks. Technical support Reduce risks related to variations in input and output prices	Risk of total market loss if fail to produce required quality. Not all producers meet requirements. Social stigma if fail to "make the grade".

if governments tax market transactions for, e.g. feed, as described by Delgado and Narrod (2002) for the case of poultry producers in Andhra Pradesh (India). The combined effect of economic gains from lowering transaction costs by vertical integration, and favourable tax regimes, may severely disadvantage independent and small scale producers.

Industrialization of production

Livestock sector industrialization can be a natural consequence of vertically integrated food chains and supply to large retailers; it can also happen independently. Scaling up, regional concentration and intensification each represent a form of industrialization.

Scaling up

Economies of scale (cost reductions realized through expanding the scale of operations) at various stages of the production process trigger the creation of large production units. As a result, the number of producers rapidly diminishes even though the sector as a whole may expand. In many rapidly growing economies, the average size of operations is rapidly increasing and the numbers of livestock producers are in rapid decline. In Brazil, between 1985 to 1996, the two largest categories of pig farms increased their proportion of the total number of farms (De Camargo Barros *et al.*, 2003).

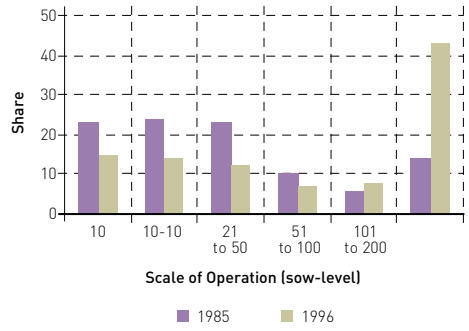
Similarly in Thailand, only the largest category of farms grew in number (Poapongsakorn *et al.*, 2003). In Southern Luzon region of the Philippines, one of the main pig producing regions, while smallholders as a whole still exhibited growth in pig numbers from 1980 to 2000, the pig numbers in commercial farms exhibited phenomenal growth (Costales *et al.*, 2003).

Smallholders can stay in business by providing their labour input to their own farms at below market price, which works well in countries where there are limited employment opportunities in other sectors. But as soon as employment opportunities in other sectors rise, many smallholder producers opt out.

Different commodities and different stages in the production process reveal different potential for economies of scale. They tend to be high in the post harvest sectors (slaughterhouse, dairy plants). In commodity production, poultry is most easily mechanised and shows a trend towards industrial forms of production even in least developed countries.

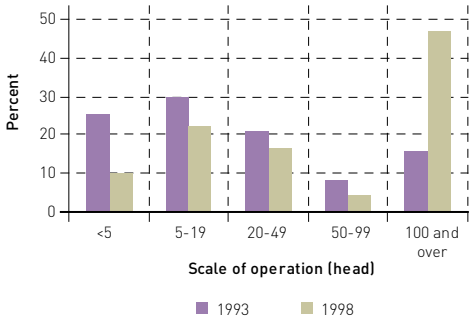
In pig production in Asia, the potentials for scale economies depend on the type of activity and final output. In finished pig production, where investments in breeds, programmed nutrition, and animal health have significant impacts on productivity gains (reflected in better feed conversion ratios and premium prices for output due to perceived quality differences), larger farm size is an advantage. In piglet production for sale to finished pig producers, size is not the main factor in generating higher profits per unit of output, because caring for piglets up to weaning and sale both require intensive labour, but at the same time a critical mass in terms of scale is needed to exploit the advantages of technology (Poapongsakorn, *et al.*, 2003). Dairy production also has high labour requirements, and farm-level production costs on small farms are often comparable with those of large scale enterprises, usually resulting from the provision of family labour below the level

CHANGES IN THE SIZE DISTRIBUTION OF PIG FARMS IN BRAZIL, 1985 AND 1996



Source: De Camargo Barros *et al.* (2003)

CHANGES IN SHARE OF PIG HOLDINGS BY SCALE OF PRODUCTION, THAILAND, 1993 AND 1998



Source: Poapongsakorn *et al.* (2003)

of minimum wages. As a result, dairy production continues to be dominated by family-based production. However, the expansion of smallholder production beyond a semi-subsistence level is constrained by a number of barriers, lack of competitiveness and risk factors.

Recent studies (Delgado and Narrod, 2002) confirm the substantial impact of hidden and overt subsidies that facilitate the supply of cheap animal products to the cities, to the disadvantage of small-scale rural producers. There is often no public support for the adaptation or dissemination of new technologies for small-scale use. Production costs other than labour are higher for smallholders because of both market and production risks. Smallholders have fewer assets and strategies than large scale producers to cope with market risks such as price fluctuations for inputs and products, or production risks related to resource degradation and control, climatic variations such as drought and floods, and infectious diseases.

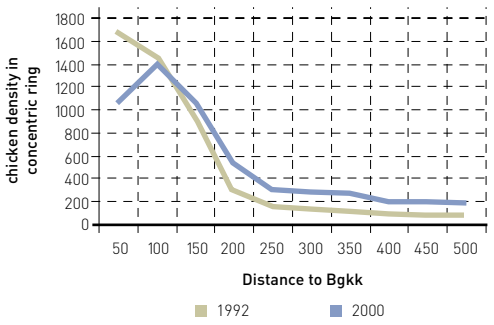
Regional concentration

As countries industrialise, they follow a pattern in relocating livestock production. Traditionally, livestock production is based on locally available feed resources, particularly those of limited or no other value, such as natural pasture and crop residues. The distribution of ruminant livestock can be explained by the availability of such resources, while the distribution of pigs and poultry follows closely that of humans, because of their role as waste converters. For example, in Vietnam, a country that can be considered to be in its early stages of industrialization, 90 % of the poultry distribution pattern can be explained by the distribution of the human population (Gerber *et al.*, 2005).

As soon as urbanization and economic growth translate rising incomes into "bulk" demand for animal food products, large scale operators emerge that, at the initial stage, are located close to towns and cities. Livestock products are among the most perishable products, and their conservation without chilling and processing poses serious problems. Therefore, livestock have to be produced in the vicinity of demand.

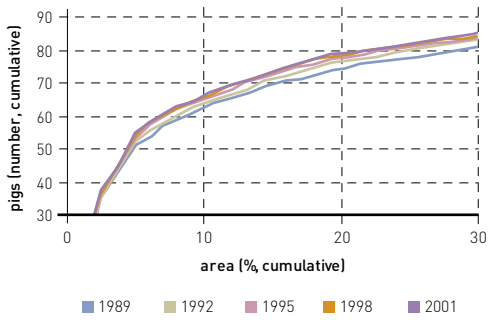
In a subsequent phase, infrastructure and technology develop sufficiently to make it possible to keep livestock further away from people, and livestock production shifts further away from demand centres, driven by a series of factors such as lower land and labour prices, access to feed, lower environmental standards, tax incen-

GEOGRAPHICAL CONCENTRATION OF POULTRY AROUND BANGKOK, 1992 AND 2000



Source: Gerber (2004)

INTENSIFICATION OF PIG PRODUCTION, FRANCE



Source: Gerber (2004)

tives, and fewer disease problems. The poultry density in areas less than 100 km from Bangkok decreased between 1992 and 2000, with the largest decrease (40%) in the areas close to the city (less than 50 km). It increased in all areas further away than 100 km. These trends were encouraged by tax incentives. In developed as well as developing economies, increased concentration of pig and poultry production continues. The pig populations in France, Brazil and Thailand continue to concentrate in fewer, larger units (Gerber, 2004).

The geographical concentration of livestock in areas with little or no agricultural land leads to high impacts on the environment, which are mainly related to manure and waste water mismanagement, although air pollution and loss of biodiversity can also be undesirable results. Nutrient overloads can result from several forms of mismanagement amongst which are overfertilisation of crops, over feeding of fish ponds, and improper waste disposal of agricultural (e.g. livestock) or industrial wastes. Nutrient overloads in the crop-livestock systems mainly occur when the nutrients present in manure are not properly removed or recycled. Phosphate (P_2O_5) overload is a concern in almost a fifth of cropland in South, East and South East Asia (Gerber *et al.*, 2005).

The concentration of livestock production and processing in peri-urban areas undermines the possibility for the rural poor to benefit from new market opportunities. While cheap animal protein favours poor consumers, the poverty and equity effects, of industrial livestock production, are on balance largely negative (De Haan *et al.*, 2001). There are also a number of animal diseases associated with increasing intensity of production and concentration of animals in limited space, and many of them pose a threat to human health (zoonotic diseases). Industrial and intensive forms of animal production may be a breeding ground for emerging diseases (Nipah virus, Bovine Spongiform Encephalopathy, Avian Flu), with public health consequences.

Intensification

Intensification of livestock production is taking place with regard to most of the inputs. In particular, feed efficiency has been greatly improved over the last decades. While large parts of the developing world are moving up the food chain, enjoying a richer and more diverse diet, so are livestock; traditional fibrous and energy-rich feed stuffs are in relative decline, and protein-rich together with sophisticated additives that enhance feed conversion are on the rise.

Traditionally, livestock production used to be based on locally available feed resources, including local fodder, crop residues, and unconsumed portions of household food. Feed had no value as food. Traditionally, natural pastures were the venue of livestock production. In recent times, however, most pasture land in developing countries is situated in areas which are unfit or marginal for cropping. Often, degraded crop land is converted into pastures. On balance, pasture land productivity has lagged far behind that of cultivated areas, although detailed estimates are difficult to make. A number of factors contribute to this trend. First, intensification of the areas classified as pastures is often technically difficult and unprofitable. Constraints to productivity of pastures most commonly relate to climatic features, topography, poor soil quality, and disease pressure, among others. The difficult conditions of these pasture lands is exemplified by the pastoralist and agro-pastoralist areas in arid and semi-arid lands in Sub-Saharan Africa. These constraints can be overcome only with massive investments to address them on various fronts, otherwise, piecemeal interventions will have no effect. Additionally, in much of Africa and Asia, most pastures are under common property which further complicates their intensification. Without firm institutional arrangements, private investments into these areas are difficult to organize as returns accrue to individuals, proportional to their livestock number on communal land. Lack

of infrastructure in these remote areas further contribute to the difficulty in obtaining successes in productivity improvements through individual investments.

As livestock production grows and intensifies, it depends less and less on locally available feed resources but increasingly on feed concentrates that are traded domestically and internationally. In 2004, a total of 690 million tonnes of cereals were fed to livestock (34 % of the global cereal harvest) and another 18 million tons of oilseeds (mainly soya). In addition, 295 million tons of protein-rich processing by-products were used as feed (mainly bran, oilcakes and fish meal).

Species that can profitably make use of such concentrate feed (pigs and poultry) have an advantage over those that do not (cattle, sheep, goats). Among the monogastrics, it is poultry that show the highest growth rates and lowest costs per unit of output, mainly because of favourable feed conversion. Where the use of concentrate feed for ruminants is observed, it is limited to countries with high meant/grain price ratios. Where these ratios are low, typically in grain- or cereal-deficit developing countries, grain feeding to ruminants is not profitable.

What is driving the increasing use of feed grains? First, there is a decline in grain prices, a trend that is basically unchanged since the 1950s. Despite growing demand over that period, supply has not lagged behind. On the contrary total supply of cereals increased by 46% over the last 24 years (1980 to 2004). In real (constant USD terms) international prices for grains have halved since 1961. Expanding supply at declining prices has been brought about predominantly by intensification of existing cropped area and to a lesser extent by area expansion (globally, cereal harvested area shrank by 5.2% over the same period). Intensification is a result of technological advances and higher input use in crop production. In contrast to developed countries, expansion of area dedicated to cereals has been an important contributor to growing supplies in the developing countries between 1980 and 2004, with rates highest in Sub-Saharan Africa (64.0%) and East and South East Asia (15.2%). In Latin America, expansion of the area dedicated to cereal production has been slower (3.9%) however, the area for oil crops rose by 97%. Some countries have seen a particularly strong expansion of cropped area, most of it at the expense of previous forest (Brazil and other Latin America countries). Large parts of this area expansion are on account of concentrate feed production, notably soya and maize (FAO, 2005).

Intensification draws on other technical improvements, such as genetics, health, and farm management that have contributed to raising natural resource use efficiency and output per animal. Between 1980 and 2004, the pig meat, chicken and milk offtake per unit of stock has increased by 61%, 32% and 21% respectively (FAO, 2005). These new possibilities, however, have to be transformed into techniques that can be adapted to local conditions, for their profitable adoption to be likely. These technical advances are supported by increasing use of external service providers and by the specialisation of production, with a substantial shift from backyard and mixed systems to commercial, single product operations.

Conclusions

The rapid expansion in demand for meat and milk in developing countries, and the increasing demand for differentiated and higher-value products of livestock origin, are transforming the livestock industries in these countries. Following the trends in the growth and modernization of global agri-food systems, so too are the livestock production patterns in developing countries being transformed, toward larger, more industrialized, and more vertically coordinated organization. The speed of change is highly variable among countries, depending on the levels of economic development and the socio-political conditions. The pace quickens where there is sufficiently

high demand, to reach a critical mass to exploit economies of scale, and accelerates where there is entry of significant foreign direct investment (FDI) to complement or compete with local investments. The speed of change also varies among livestock species, with the activity being most dynamic in the monogastrics (pigs and chicken).

The trends, from a system of livestock production that mainly converts waste and organic material of low value to meat and milk, to one that is based on sophisticated breeding, animal health care, and livestock nutrition, and from a livestock marketing and distribution system that follows informal chains and traditional wholesale markets to one that has to compete with modern agri-food value-chains, have a number of policy implications.

In countries where transformations have been most notable, there has been a shift towards fewer and larger farms, towards the employment of contracts or other agreements between distributors and producers, and increasing formal investment and employment, particularly in the processing of livestock products. Taking control on the processing and distribution side of the industry, while allowing the modern agri-food industries to rapidly respond to consumer preferences, also provides them leverage to exercise pressure on producer-suppliers. The exercise of private standards by modern agri-food chains is not scale neutral, and can result in easing out of smaller scale producers. Even policies to introduce public standards defining the minimum requirements of food quality and safety for participants in formal markets may have the impact of raising barriers to market participation. It is important to examine policies and measures that support and provide subsidy to capital investment and employment of labour, in order to ensure that the privileges and incentives extended do not unduly favour large business institutions. As markets transform and the informal markets shrink, policies and strategies are needed to raise the capabilities of small scale operators who have the potential to meet the volume and quality demands of the formal markets. At the same time, exit strategies should be designed for those who are unable to cope.

The livestock sector has become the engine of growth for a large part of the crop sector, making demands on land and associated commercial inputs. The sometimes popular view, that the world hunger problem could be resolved by simply curtailing demand for meat and other livestock products, and thereby releasing grain used as feed for human consumption, is flawed. In the absence of demand for feed grains, less would be produced, and the hungry would still go hungry. This underlines the notion that world hunger is a demand (income) problem rather than a supply problem. However, it is clear that the growing livestock sector demand for feed grains and other feed ingredients raises the price of these and other similar commodities to higher levels than would otherwise be the case. This makes grains and other staples less accessible to the poor who have to buy them. On the other hand, producers, many of whom are small-scale and poor, stand to earn higher income from higher prices. The balance between winners and losers, when looking at poor households, as well, is not clear cut, and differs from country to country. Yet it is also clear that the more income opportunities are created among rural households, whether in staples, feedgrains, livestock production, or from employment along the agri-food processing and distribution chains linking rural to urban areas, the greater is the likelihood of reducing hunger and poverty. Response to the demands of future generations for rich and diverse diets depends as much on crop research and technology, including associated input use and natural resource management, as it does on pushing productivity in the livestock sector in the strict sense.

Care needs to be taken that policies do not lead to the proliferation of intensive livestock production activities close to demand centres in

developing countries, with serious environmental impacts, and health consequences on the urban and peri-urban population. There is a strong case for policies and public investments that create incentives for formal livestock production activities and supporting agri-food processing and distribution chains to locate and spread out in the rural areas of developing countries. As access to markets for inputs and outputs are a critical element of the incentive for industry to invest in such areas, the development of infrastructure must be such that even over large distances, production areas, processing plants, and demand centres can be efficiently linked. The ruralisation of the animal products food chain has the potential to considerably reduce the negative externalities that emanate from the concentration of unregulated peri-urban animal production, while at the same time creating new employment and income opportunities among the rural communities. Policy instruments can take the form of public investments in functional rural-to-urban transport and communications infrastructure, and time-bound tax breaks, covering the investment phase and early operations period. Moreover, incentives may be designed such that they are linked to measurable parameters such as land-livestock balances achieved on an area-wide framework, to discourage the build up of clusters or high concentrations of livestock. Similarly, training and organisation of rural communities is required to ensure their capacity to contribute to the livestock supply in different capacities along the agri-food market chains.

At the same time, there is high potential for better integration of livestock and crop activities. Livestock waste management can be improved by effective policy frameworks, clearly linking specific environmental concerns to the operational aspects associated with livestock production technologies and practices. Strategies should be designed for capacity building at the national and local government levels for the strict enforcement of the existing environmental and zoning regulations, and for a broad-based education and information on the public health risks and cumulative environmental impacts associated with inadequately regulated and poorly managed livestock waste disposal.

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