Animal Contributions to Human Health and Well-being

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ABSTRACT: Livestock continue to make a huge and diverse contribution to human health and well-being. About one quarter of the dietary energy and one half of the dietary protein of people in developed countries comes from animal and fish products. Contrary to all the predictions of thirty years ago, animal products are making a larger contribution to feeding people in developing countries than previously. For billions of people, the regular consumption of a range of animal products provides almost complete protection against a variety of nutritional disorders. The three major human nutrition problems that the world still faces are iron deficiency, Vitamin A deficiency and protein-energy malnutrition. An increased consumption of a relatively small amount of animal product in populations at risk would substantially and efficiently ameliorate all three diseases. Animals provide the draught power for about 28% of the world’s arable land, and will be the most economically realistic and socially appropriate technology for many regions of the world into the foreseeable future. Estimates suggest that about 22% of total nitrogen fertilisation and 38% of total phosphate is of animal origin. There is a wide range of other important products from animals; all are now part of highly competitive markets. Quality of the product, from the consumer’s perspective, is a fundamental issue requiring close attention. Animal production systems have contributed significantly to our environments. Properly managed grazing systems are almost certainly our best method to preserve the massive arid and semi-arid eco-systems of the world, whilst utilising their resources for humans. The animals in mixed farming systems contribute to crop production as well as having potentially beneficial environmental effects. Intensive production systems have lowered the real cost of food products and have provided security of food to urban dwellers in developing countries, but have significant environmental and animal welfare problems.

Key Words: Livestock, Nutrition, Environment, Products, Systems

INTRODUCTION

The relationship between animals and humans has been constantly changing.

Ten thousand years ago, all humans were hunter-gatherers. There were no domesticated animals. Hairy-coated sheep freely grazed pastures in south-west Asia. Red Jungle fowl fed in jungles in south-east Asia.

A mere blink of the eye later, in evolutionary terms, and we now have about 13 billion domesticated poultry, about 1.5 billion domesticated cattle and buffalo. We have put hundreds of millions of ruminants on a continent on which none were grazing 250 years ago. We have sheep producing wool with a mean fibre diameter of 12 microns and broilers capable of producing 1kg of meat from 1.8kg of feed. The reverberations of this enormous explosion in numbers and genetic potential of livestock will continue for centuries to come.

During that time, animals have made incredibly diverse contributions to human health and well being. They have been the source of a range of products from violin strings to explosives. They have protected, clothed, fed, transported us and thrilled us in sport. Some of these functions have disappeared, but others are emerging.

And meanwhile change is continuing at an even more rapid pace. The twentieth century saw a series of technological, social, economic and cultural changes that will once again reshape the contribution that animals make to humans.

This paper provides an overview of some of the current contributions of livestock and the livestock industries to human health and well being.

LIVESTOCK AND HUMAN NUTRITION

Livestock have always played a vital role in providing food to humans, both directly through edible animal products, and indirectly by providing draught power and fertiliser to crops.

Meats are excellent sources of protein and essential amino acids, water-soluble vitamins and several minerals. Red meats are an especially good source of iron, with high bio-availability. Dairy products are rich in protein calcium, phosphorus, vitamin A, and B vitamins, especially riboflavin. Eggs, having a nearly perfect balance of nutrients, are excellent dietary sources of protein, major and trace minerals, vitamins A and D, B vitamins and essential fatty acids.

About one-quarter of the dietary energy and one-half of the dietary protein of people in developed countries comes from animal and fish products. In the developing countries, the proportional contribution of animal products to human nutrition is about half of this, but has undergone a remarkable rise in recent years (Delgado, 1999).

Since the 1980’s, meat consumption in developing countries has been growing at about 5% per year whilst milk consumption has been growing at about 3% per year. In some countries, such as China, the growth has been dramatic, where meat and milk consumption has almost doubled during the last ten years. Contrary to all the predictions of thirty years ago, animal products are making a larger contribution to feeding people in developing countries than previously.

A feature of the rise in animal-derived food consumption in developing countries is that it has been demand-driven, and has not been associated with any
particular technological innovations leading to radical changes in supply. We, the scientific community, cannot take much of the credit (or blame) for this shift.

Two factors have driven the growth in demand for animal-derived food consumption. The first is increased disposable income, with real income of consumers in developing countries doubling since the early 1960’s. Worldwide, there is a strong positive relationship between per-capita income and per-capita meat consumption, until a ‘saturation’ point is reached. Per-capita consumption of meat has grown most rapidly in those regions where incomes grew most rapidly.

The second driving force towards greater animal intake is urbanisation. About 45% of the world’s population now live in cities and 80% of the world’s population growth is occurring in the cities of developing countries. Consumers in urban areas are more likely to diversify their diets into meat and milk. Urban food consumers have greater food choices and more diverse dietary and cultural influences than those typically found in rural areas.

For many of the lucky, then, in both developed and developing countries, the regular consumption of a range of animal products provides almost complete protection against a variety of nutritional deficiencies. But not everyone is that fortunate. The three major human nutrition problems that the world still faces are iron deficiency, Vitamin A deficiency and protein-energy malnutrition. An increased consumption of a relatively small amount of animal product in populations at risk would substantially ameliorate all three diseases.

Iron deficiency is the most common nutritional disorder in the world, with over 2 billion people affected. The deficiency results from consuming diets with insufficient iron, reduced dietary iron availability, increased iron requirements to meet reproductive demands and losses due to parasitic infections; these factors often operate concurrently. Iron deficiency is associated with about 50% of maternal deaths and is wholly blamed for up to 20%. Red meat is one of the richest sources of iron, and increasing meat consumption is a general recommendation to avoid iron deficiency. Iron tablets are a low-cost alternative, but their regular consumption often meets with poor compliance. Fortification of wheat flour with iron has also occurred in several developing countries, but this cannot replace direct supplementation.

Vitamin A deficiency is a moderate-to-serious public health problem in about 76 countries in the world, affecting about 250 million people. About half a million children each year develop total or partial blindness because of it, and about half of these die within a few months. These devastating problems could be easily overcome by promoting the consumption of foods rich in vitamin A, or by supplementing children’s diets with vitamin A capsules. Eggs, butter, whole milk and liver are the richest sources of vitamin A.

Protein-energy malnutrition generally refers to under-nutrition in young children, although older children and adults can also suffer from it. In 1995, 167 million children under five years of age, mostly between the ages of six months to two years, were affected. It is associated with more than half of all deaths of children worldwide, and leads to severe long-term disabilities in those that survive. As we start the new millennium, protein-energy malnutrition is possibly the most serious cause of human suffering and the greatest violation of human rights on earth.

With this background, it is not surprising that repeated concerns have been raised about ‘competition’ between livestock and man for food. It is of particular concern that humans consume only two thirds of the world’s total grain production. The rest goes down the throat of pigs (12%), dairy cows (9%), beef cattle (5%), meat chickens (5%) and laying hens (4%) (CAST, 1999). The fact that about one-third of the world’s grain harvest ends up being fed to livestock is often considered to be both irrational and unethical.

This issue has been discussed at numerous forums, but five main points require re-iteration:

1. Calculations of the net cost or benefit of animal production efficiency should be based on realistic estimates of the efficiency with which various feed sources are converted into food by various species in various systems. Current average conversion rates of feed grain to human food have been calculated from global data on food production and feed grain use (Table 1) (CAST 1999). Comparable results were obtained from more detailed estimates of conversion efficiencies in specific livestock systems in a variety of countries. These indicate that sheep, goats, dairy cattle and beef cattle in developing countries produce more than one kilo of food for every kilo of grain consumed. The same is true for sheep and dairy cattle in the developed countries (Table 1). Estimates of protein conversion indicate that, overall, animals produce about one kilo of human food protein for each 1.4 kilo of human edible protein consumed. Since the biological value of proteins from animals is about 1.4 times that of proteins from plants, there is no net protein wastage. Thus, on a global basis, with the current balance of animal production systems, animal production is far more efficient than often stated.

Table 1. Estimates of the average conversion rates of grain to human food (kg grain/kg product) for various foods in developed and developing countries (adapted from CAST 1999).

<table>
<thead>
<tr>
<th>Food</th>
<th>Developed Countries</th>
<th>Developing Countries</th>
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</thead>
<tbody>
<tr>
<td>Beef</td>
<td>2.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Pork</td>
<td>3.7</td>
<td>1.8</td>
</tr>
<tr>
<td>Sheep and goat</td>
<td>0.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Poultry</td>
<td>2.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Milk</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Eggs</td>
<td>2.2</td>
<td>1.6</td>
</tr>
</tbody>
</table>

2. There is a wide range in the efficiencies of both animal and crop production. Many types of crops grown around the world are relatively inefficient
in producing utilisable energy and proteins for humans, given the inputs that they receive. The most efficient food sources on energy grounds would not be a large mix of crops alone, but a mix of a very few extremely high-yielding crops combined with animal products derived from grazing and mixed-farming systems, that convert mainly non-edible matter into high-quality human food. But obviously a wider variety of crop and animal products than this is desirable for many reasons. Grains fed to animals are usually very high yielding, and it would do little to replace them with lower yielding crops for human consumption. For instance, corn is often grown in regions that produce wheat, and produces twice the yields. Since the most important animal feed grain is corn, a shift from corn production for animal feed to wheat production for human consumption would about halve the expected benefit to human nutrition. Similarly, a crop such as irrigated lucerne yields much more than any food crop that might replace it. It has been estimated that more human food energy per hectare is obtained by growing lucerne and feeding it to dairy cows than by growing wheat. Tomatoes and grapes, two high-value crops more likely than wheat to be grown on land suitable for lucerne, produce a small fraction of the food energy or protein of lucerne (CAST 1999).

3. Feed grains for animals do get diverted to humans in times of shortage. In fact, a recent study concluded that the pools of grains normally fed to animals act as an important global buffer against temporary food grain shortages, such as occurred in 1974/75, and thereby help stabilise availability of food to humans.

4. Estimates of food conversion efficiencies of animals make no allowance for the multiple roles that animals fulfil. For the millions of rural people in developing countries, arguments about energy efficiencies of grain versus animals are largely irrelevant. For them, animals are a source of draught power and fertiliser; they provide employment and help generate cash income to permit purchase of grains.

5. Finally and importantly, focusing solely on issues such as the efficiency of energy conversion of various foodstuffs trivialises the real issues associated with protein-energy malnutrition. Protein-energy malnutrition is a disease of children. The fact is that a young child requires very little energy. For example, a child whose daily requirement is 1000 kilocalories may be suffering from energy malnutrition because of an intake of only 700 kilocalories. That 300 kilocalories deficiency is only about 2% of the 12,000 kilocalories that the average poor family consumes each day (Ramalingaswami et al., 1996).

Protein-energy malnutrition is a disease of the overcrowded poor, where maintaining hygiene is virtually impossible. It is a disease of those denied a basic education; of those who do not know the importance of breast feeding and early weaning nutrition – the importance of giving the right food at the right time and in the right way for normal child growth. It is a disease of the subordinated. Women who have no autonomy to act in their own or their child’s best interest have little chance to properly care for their child, no matter how much they love them. The basic determinants of protein-energy malnutrition are the resources available to a community and a host of political, cultural and social factors that affect their utilisation. It is these determinants that are being addressed in the global programs designed to reduce the number of suffering children in the world.

Although a broad combination of crop-based nutrients can provide a balanced diet, securing such a balance throughout the year with vegetable matter alone is not easy, especially for the rural poor. On the other hand, increased consumption of even a relatively small amount of additional meat and milk would supply the necessary protein and micronutrients and a fair share of additional calories, and would do so with a much less varied vegetable matter diet than using crops alone. The great majority of poor in the world want reasonable access to animal-derived foods not only to improve their health, but for cultural reasons and for the plain enjoyment of it. The question is not how we should deny them this, but how to help deliver this.

At the other end of the scale, it is a sobering fact that one of the most important nutrition problems facing people in developing countries is an excessive intake of energy, leading to obesity and a series of related health problems such as heart disease and atherosclerosis. Although excess total energy intake is the basic problem, there is epidemiological evidence that over-consumption of saturated fats in ruminant meat is particularly undesirable. This, along with other factors, has probably led to the decline in red meat consumption in many developed countries, and, in the long term, will probably provide a cap for maximal intake of red meat per head.

In summary, at the low levels of intake that currently exists in most developing countries, an increase in consumption of animal-derived foods is known to be nutritionally highly beneficial, especially for young children. These benefits result from the higher content and availability of essential amino acids, of iron and Vitamin A and of energy. In developed countries, on the other hand, intakes of energy, in particular saturated fats, are often excessive and could be reduced to improve the heath of these populations.

**LIVESTOCK AS A SOURCE OF POWER**

Draught and transport animals have played an extremely important role in shaping human civilisation. Civilisations that had technological advantages in the use of animal power were able to dominate those that did not. For example, in the second millennium BC, the horse and chariot revolutionised warfare in the ancient world by providing armies with unprecedented mobility. The horse and chariot laid the foundations for...
the empires of the Hyskos in Egypt, the Hittites in Anatolia and the Arians in northern India. The enormous expansion of the Mongol Empire in the 13th century was largely based on their armies of mounted archers who possessed great speed and mobility.

Horses were also used as the main source of power to open up the vast agricultural potential of North America and Australia. But in all developed countries, mechanised agriculture is now the dominant technology. The continuing importance of draught animals in developing countries is not widely recognised. Consequently, on a world scale, draught animals are often incorrectly considered to be a redundant technology.

About 16 species of animals are used in developing countries as draught, pack and riding animals. Animals still provide the draught power for about 28% of the world’s arable land, or about half the total cropping area in developing countries, directly or indirectly serving about 2 billion people. To replace this with mechanical power would cost hundreds of billions of dollars in capital machinery, plus billions of dollars in annual fuels costs. It has been estimated that in India draught animals provide more power than the hydroelectric and fossil fuel stations in that country (Starkey 1991).

Draught animal power is one option in a spectrum of technologies, ranging from the use of hand power to the use of sophisticated motorised power, that are now available for use by farmers.

The preferred technology for a farmer depends upon many highly specific social and economic factors. Draught animals are generally part of highly integrated small-holder farming systems, in which they have a range of different technical, economic and social functions. The use of draught power is slowly increasing in Africa, where 80% of cultivated land is currently prepared by hand power, but is declining in importance in eastern Asia as mechanisation takes place.

Highly mechanised agriculture seems to be a universal aspiration of governments, and numerous efforts have been made to introduce mechanisation into farming practices through government subsidies and extension programs. Many of these have met with limited success and some with complete failure, particularly those attempting to go straight from hand to tractor cultivation.

Mechanisation should not be viewed as an end in itself. Generally, mechanisation alone does not lead to increased yields. The principle benefit of mechanisation relates to labour. The labour requirements when using a tractor with a plough are less than one twelfth of the labour requirements of preparing one hectare of land using draught animal power. Consequently, mechanisation is particularly advantageous to communities in which the opportunity cost of labour is high or to communities with the ability to increase the area of land under crop. However, in regions with general unemployment and no opportunity to increase area of land under production, mechanisation can bring social disruption.

Mechanisation does not necessarily result in improvements in crop preparation. For example, Cambodian farmers with access to tractors still consider that animals are better for second ploughing and harrowing of rice crops. Degradation of soil resources and increased soil erosion may occur with a shift to motorised tillage, particularly in the many regions of the developing world with fragile soil.

Complex and expensive machinery cannot be successfully introduced into rural communities unless there is proper infrastructure support. Availability of credit to allow purchase of machinery, proper technical support to keep the machinery repaired, and availability of spare parts are just some of the infrastructure elements that need to be in place if mechanisation is to occur successfully, even in those communities where the potential benefits from mechanisation may be great.

Far from being redundant, in many regions of the developing world, draught animals still represent the most economically realistic and socially appropriate technology, and probably will continue to do so in the foreseeable future.

Sadly, during the last century, the scientific community has contributed little to improving the efficiency of draught power. Implements used with draught animals such as ploughs, harnesses and carts are often made with materials and designs that have been used for generations. There is a dearth of practical information on nutrition, management and breeding systems for draught animals. Given the likely importance of draught animals for generations to come, it would be wise to reverse this situation.

**LIVESTOCK AS A SOURCE OF FERTILISER**

Animal manure has been an important source of nutrients and crops for centuries. The use of inorganic forms of fertiliser has only risen rapidly following the Second World War, lessening the relative contribution of animal manure as fertiliser, especially in developed countries. Nevertheless, estimates suggest that about 20 million tonnes or 22 percent of total nitrogen fertilisation and 11 million tonnes or 38% of phosphate is still of animal origin, representing about US$1.5 billion worth of commercial fertiliser (de Haan et al., 1997).

Both the organic properties and the nutrient content of manures are useful for soil fertility, and manures have been shown to improve soil tilth, increase water holding capacity, improve aeration, promote soil microbial activity and act as a source of nutrients.

Crop response to manure varies according to plant and soil types, agro-ecological zones and manure quality, but in general, the response can be very similar to those obtained from inorganic fertilisers. Comparisons of the effect of manure and inorganic fertilisers on yields of corn showed that manure
increased yields similarly to the best chemical fertiliser treatment on two of three soil types, and that on all three soil types highest yields were obtained from a chemical/manure mixture.

**LIVESTOCK AS A SOURCE OF CASH**

Although their cash and insurance functions are slowly being replaced by financial institutions, cattle and buffalo remain as an efficient storage of both cash and energy for many rural poor. Their long productive life means they maintain value well. They can lose weight during periods of poor feed supply and gain again during good times without serious penalty to their own well-being, as long as there is no severe feed shortage when they are very young.

Livestock are frequently sold by poor people to purchase food in times of stress, such as crop failure. Draught animals can be a continuous cash generator by being hired out or used for contract work.

**LIVESTOCK AS A SOURCE OF FIBRE AND FABRIC**

A range of livestock products, such as mohair, cashmere, rabbit and camel hair, are used for clothing and furnishing, but wool and leather are by far the two most important.

About 950 million kg of wool and 3,000 million kg of leather are consumed annually throughout the world. Both are high cost compared to competing products and so tend to be used in the manufacture of higher value garments. Wool consistently commands about 3-to 4 times the price of competing fibres such as cotton.

Wool now has about 4% of the total textile market and holds a dominant position in the formal-wear segment. But its position is under threat, both from changes in consumer preferences and heavy competition from competing fibres, especially synthetics.

The casual/leisure wear segment is the fastest growing segment of the clothing industry, and wool has little share of it. Consumers are demanding a higher level of specified product attributes from fibres, fabrics and coatings. Easy care, and close-to-the-skin comfort are probably the two most important that require attention from the wool industry.

Synthetic and man-made fibre companies have responded to this consumer pull with heavy research and development expenditure and increasing branding of their particular fibre. Wool is more limited in its ability to alter the basic structure of fibre and is reliant on growers to move to finer micron sheep if it is to meet the movement in consumer demand. Improvements in wool-processing costs are essential to bring wool into a broader competitive arena. Blends, short-staple spinning and non-wovens are all possibilities that need to be explored. All of these areas require more research.

**LIVESTOCK AS A SOURCE OF OTHER PRODUCTS AND SERVICES**

“We use all of the pig except its squeal” was the proud claim of the Chicago slaughterhouses in the 1920’s. Since those days, less of the animal is used for food and many of the by-products have vanished, but there is still a formidable list of by-products from animal production. Animal glands for hormones, intestines for specialised strings and sutures, fats for cosmetics, soaps and oils, bristles for brushes, scraps for meat meal … the list goes on and on. However, virtually all of these products have suffered severe market shrinkage from new competing products with cost advantage or superior properties.

Some of the other long-standing traditional contributions of animals to humans are still very significant today. Animals are important cultural and religious icons in many societies. In fact, the current distribution of animals in the world has been strongly shaped by cultural and religious preferences. Likewise, the role of animals in entertainment and sport is obvious and substantial.

A relatively new and major contribution that animals have made to human health and well-being is as models for comparative and biomedical research; a potential contribution that is just crystallising is to use genetically engineered, cloned animals to produce extremely high-value pharmaceutical products for humans.

One of the consequences of a more urbanised world is that many people have little or no contact with agricultural animals or farming systems. The continued reliance of man on animals is easily overlooked in air-conditioned rooms in major cities where milk comes from cartons rather than cows, where meat comes wrapped in vacuum-sealed plastic and polystyrene containers, and cheese is often a rubbery, synthetically-coloured, foil covered, processed abomination with all the flavour of solidified floor wax. We have created environments in which our reliance on animals is hidden, is abstract and is easily lost from thought. Targeted education in urban regions is required to address this problem.

For urban dweller, pets are usually their only obvious connection with animals. Pet animals are an integral part of the social and environmental milieu of most urban societies. For example, about 60% of all households in the USA have a companion animal. The many roles that pets play in human health are not well understood, but recent medical epidemiological studies indicate that pet animals positively impact on human health. Pet animals also offer very important services. Seeing-eye dogs, hearing and service dogs, facilitated-therapy dogs, resident pets in nursing homes, and therapeutic horseback riding for people with special needs are just some of the roles pet animals perform; studies have shown that providing trained service dogs for people with physical disabilities result in significant
improvements in mental health and well being in a cost-effective manner.

**LIVESTOCK PRODUCTS – THE BIG CHANGE**

One hundred years ago, animal products and services held a dominant, unquestioned role as the preferred and often the only source of food, fibre, transport and a host of other uses. Competing products and technologies developed in the intervening period have irreversibly changed that position. All animal products and services, including food, are now part of competitive market place; they need to preferentially attract potential customers in order to maintain market share. The ability of livestock industries to respond to the requirements of the consumer will largely determine their future.

Quality of product, from the consumer’s perspective, is a fundamental issue that has received closer scientific attention during the last thirty years. Quality of product is now being described, objectively measured and improved. Research has shown that many important quality attributes, such as the flavour of a steak or the comfort factor of a suit, are strongly influenced by farm-management practices, especially animal-breeding programs. This indicates that the entire supply chain must have a unified and coordinated approach in order to deliver products that are consistently fit for purpose. In some supply chains, such as wool, this is currently lacking.

Consumers, not unreasonably, expect safety in their products, especially food. Microbial contamination and chemical contamination of animal products are of particular concern and are receiving considerable attention through the introduction of more sophisticated food quality assurance systems globally. The recent BSE disaster in Britain highlights the complex nature of potential zoonoses in animal systems and how easily an industry can be brought to its knees by human health concerns.

Consumers make purchasing decisions not just on the nature of the product itself but also on an ethical judgement of the nature of the production system. Animal welfare and ecological sustainability issues are particularly important. Was this product made in an environmentally friendly way? Were the animals treated properly?

Animal welfare and sustainability issues challenge our traditional view of animals and set new limits for their management, but at the same time offer new exciting opportunities for sound progress in animal agriculture. A positive and creative attitude to them, avoiding both unjustified fear and suspicions, will strengthen the ethical framework of societies, enhance professional esteem of producers and benefit marketability of products in the future.

**LIVESTOCK SYSTEMS AS PRESERVERS OF ECOSYSTEMS**

Nearly half the world’s land area is used by grazing livestock alone or by livestock as part of a mixed farming system. This presents an enormous responsibility to livestock managers to ensure that the resource base is preserved for future generations. Animal agriculture is frequently blamed for adverse environmental effects, but the positive role of animals in conservation is rarely emphasised. For much of the globe, properly managed grazing livestock systems are our best method to preserve important ecosystems whilst utilising their resources for humans.

Broadly, there are three main livestock production systems: grazing, mixed farming and industrial (Table 2). Grazing systems are mainly based on native grasslands and have little or no integration with crops. They rarely involve imported inputs and generally have low output per hectare. Mixed farming systems are those in which livestock and crop activities are integrated. Industrial systems, such as intensive poultry production, are land-detached in terms of feed supply and waste disposal.

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**Table 2.** Quantity (1,000 t) and percent of global livestock food products produced by the three main production systems (from Sere and Steinfeld, 1996).

<table>
<thead>
<tr>
<th></th>
<th>Grazing</th>
<th>Mixed</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>12,289 (23%)</td>
<td>34,249 (65%)</td>
<td>6,055 (12%)</td>
</tr>
<tr>
<td>Buffaloes</td>
<td>0</td>
<td>2,652 (100%)</td>
<td>0</td>
</tr>
<tr>
<td>Sheep and Goats</td>
<td>2,981 (30%)</td>
<td>6,860 (69%)</td>
<td>100 (1%)</td>
</tr>
<tr>
<td>Pig meat</td>
<td>685 (1%)</td>
<td>42,821 (60%)</td>
<td>28,163 (39%)</td>
</tr>
<tr>
<td>Poultry meat</td>
<td>796 (2%)</td>
<td>10,469 (24%)</td>
<td>31,969 (74%)</td>
</tr>
<tr>
<td>Eggs</td>
<td>524 (1%)</td>
<td>12,289 (31%)</td>
<td>27,071 (68%)</td>
</tr>
<tr>
<td>Dairy milk</td>
<td>38,775 (8%)</td>
<td>434,332 (92%)</td>
<td>0</td>
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</table>

**Grazing systems**

About 3.4 billion ha of land, or 26% of the world’s land area is used for grazing livestock. Ruminants are the dominant types of animal, involving about 360 million cattle and 600 million sheep and goats. Grazing animals directly supply about 23% of the world production of beef and about 30% of sheep and goat meat (Table 2). In addition to this direct contribution, they also complement other livestock production systems, such as stratified beef feedlot
systems, which rely on a supply of calves coming from herds maintained on grazed lands. Grazing livestock is probably the only feasible source of livelihood for about 200 million people living in arid and semi-arid regions of the world.

There is a general perception that grazing livestock have caused destruction of the environment. That perception is incorrect. Humans are the source of any destruction, not the livestock. Humans control where livestock move, whether they breed, whether they live. How we choose to control them determines whether the livestock has a negative, positive or neutral impact on the environment.

In all grazing systems, the primary factor that determines the impact of livestock on the environment is stocking rate. If stocking rates are relatively low compared to the long-term sustainable carrying capacity, then it is likely that environmental impacts will be minimal, regardless of the grazing strategies and management tactics that are employed. As stocking rates increase towards capacity, the need for close monitoring and high level control of the livestock increases.

Globally, during the last century, there has been a massive increase in stocking rates of grazing lands, often without the required increase in monitoring or high-level control of livestock. There are very few regions of the world producing potentially grazable forage that is not utilised by grazing livestock (an interesting exception is the forage that grows under estate tree crops such as rubber and oil palm). Some regions of the world are carrying stock beyond the long-term sustainable capacity, and severe degradation is inevitable. For instance, it has been estimated that some of the arid regions of Australia are about 30% overstocked.

The huge advantage of grazing animals in the arid and semi-arid regions is that they are by far the most efficient method of collecting, converting and concentrating the sparsely scattered herbage into a useable diet for humans. The sustainability of grazing livestock in the arid and semi-arid regions of the world has been challenged, based on the argument that livestock inevitably cause destruction to these fragile environments. However, recent studies indicate that most of the world’s arid rangelands, many of which have been grazed for centuries, are highly resilient ecosystems and in better condition than previously realised (de Haan et al., 1997).

A key to long-term sustainable use of arid grazing regions is flexibility in grazing patterns. The arid rangelands are subject to highly variable rainfall, and consequently highly variable feed availability. Low rainfall periods are a fundamental critical control point that livestock owners need to manage. Most changes and loss of flora are a result of drought periods. Generally, as long as the region is rested during these periods, the original flora returns, because of the high resilience of the ecosystem. In most regions of the world, mobility of animals has been the traditional method to achieve flexibility in grazing patterns. Consequently, wherever mobility is impaired and customary practice impeded, degradation often occurs.

Changes in land ownership, such as policies to settle pastoralists, can critically reduce flexibility of grazing pressure and consequently lead to local land degradation. Similarly, the development of water points for livestock in arid regions may change traditional seasonal grazing patterns into continuous grazing patterns and consequently cause degradation (de Haan et al., 1997). Governmental polices to support livestock owners in arid regions need to be more cognisant of long-term issues in order to provide real benefits to those they are trying to help.

In the semi-arid regions, particularly in parts of Africa and India, degradation is more severe. The degradation is directly linked to increased populations in these regions. However, shifting from grazing livestock production to other uses of the land, such as crop production in these regions will not ameliorate degradation problems in these regions. In fact, inappropriate crop production in marginal semi-arid regions is one of the most serious causes of severe degradation. For instance, in northern China, the cultivation of land previously devoted to livestock grazing reduced the area available to feed livestock. When the crop failed, severe land erosion followed and viable rangeland was lost, for many years to come.

Temperate grazing systems are found in China, Mongolia, Northern America, Australia, New Zealand, Argentina, Chile and substantial parts of Europe, accounting for about 10% of the world’s sheep and goats and about 2.5% of the cattle population. Those temperate grazing regions that are blessed with stable cultures and economies, such as those in the prairies of Canada and United States, have probably experienced the least negative environmental impact of any farming ecosystem in the world. According to some reports, rangelands in western North America are in better ecological condition today than at any other time during the last century (Connor et al., 1998). Some of these regions, such as in Australia, New Zealand and Europe, have a very high proportion of derived temperate pastures, and are probably capable of both further intensification and further crop production. But for much of the world’s temperate grasslands, crop production would cause more environmental damage than properly managed grazing livestock. For instance, conversion of productive rangeland to cropland in Inner Mongolia led to serious degradation through soil loss from wind and water erosion.

Properly managed grazing livestock systems are almost certainly our best method to preserve the massive arid and semi-arid ecosystems, and large parts of the temperate zone grasslands, whilst utilising their resources for humans. That is a huge, continuing contribution that livestock make to humans. To correct the imbalances in grazing systems that we currently have in these regions will not be simple. It will require economic, social and cultural change. It will also require a new focus and new knowledge. An ecosystem approach should underpin rangeland research and management. A greater understanding of plant responses to grazing is required, particularly during critical events in the life of a plant species. Threshold indicators of site degradation are required for various
ecosystems so that managers can monitor and respond appropriately to them. There is a need to develop specific management strategies for different range types, taking into account not only the environmental issues but also any animal production and economic issues. Because of the low potential to intensify production in much of arid and semi-arid regions, technologies that increase productivity per head will be particularly appropriate. Each animal in the herd or flock must contribute to the total. Control of disease, effective genetic improvement programs, efficient reproductive performance, and efficient flock and herd structure will be increasingly required to secure the financial stability of these arid and semi-arid grazing systems into the future. Many of these elements are currently lacking.

Mixed farming systems

Mixed crop-livestock systems utilise about 2.5 billion ha of land, involving ruminants, pigs and poultry. This type of system is the largest producer of animal product and is growing, especially in humid regions of Asia. About half of the world’s meat and the majority of its milk is from mixed system farming.

Most mixed-farming systems make very efficient use of natural resources, and use the synergies that exist between livestock and crops. Crop residues feed the animals and animal manure fertilises the soil. Since mixed-farming systems generally have a negative nutrient balance, the transfer of nutrients from grazing land to crop land through animal manure is particularly important. Crop rotations involving a pasture phase grazed by herbivores can be highly efficient in generating nitrogen, whilst helping control disease of crops.

Mixed-farming systems can also add to soil biodiversity, and animals are often the justification for agro-forestry inputs such as fodder trees (de Haan et al., 1997).

Mixed farming provides a way for farmers to diversify risk and also to alter production in response to changes in markets and other factors. For instance, farmers in the wheat/sheep region of Australia have been continuously shifting the proportion of livestock to crop in response to grain, wool and meat market outlooks.

With the growth of human population, and greater need for both cropping and livestock production, the need for integration of both systems will increase rather than decrease. The basis of animal husbandry in this context must be to efficiently utilise the crop, animal and urban by-products and residues, combined with the weeds, grasses or occasional crop surpluses that may be periodically available. Research needs to address problems related to this general circumstance.

Industrial systems

During the last fifty years the greatest change in livestock production has been the growth of industrial systems of production. In Europe and America as late as 1940, the great majority of poultry were kept in small flocks as a sideline, an unimportant and insignificant source of revenue. Today, about three-quarters of the world’s poultry meat, two-thirds of the world’s eggs and 40% of pork is produced in industrial systems (Table 2). In beef production, industrial systems are often the final component of a stratified system in which livestock are finished to market requirements before slaughter.

During a period of relentless population growth, industrial systems have made a major contribution to the security of the world’s food supply and the affordability of food. Industrial systems are able to lower the cost of production through economies of scale. For instance, the labour efficiencies can be remarkable. One experienced person, for example, may be able to manage about 40,000 caged layers in an intensive system.

In developed countries, industrial systems combined with other technological advances in poultry production have led to a profound decrease in the real cost of poultry products. This technologically driven supply shift has been a main reason for a steady increase in the consumption of poultry meat in the developed world, mainly at the expense of red meats. For instance, poultry meat consumption in Australia, historically a country with a voracious appetite for red meat, is poised to surpass beef consumption.

Industrial systems drive trade in feed grains and other feed resources, providing an opportunity for crop farmers to diversify and gain additional income.

Industrial systems of production are relatively transportable, since they do not require highly specific geographic or climatological conditions; the use of controlled environment buildings has enabled production in a range of hostile climates around the globe. Industrial production of pigs and poultry products is by far the fastest growing form of livestock activity, growing at about twice the rate of mixed farming systems and more than six times the rate of grazing systems production (Sere and Steinfeld, 1996). In developing countries this has led to an important shift towards pig and poultry meat production. In 1970, ruminant meat production accounted for about 50% of total meat production in developing countries; now it accounts for about one third. Industrial production is therefore now making a huge contribution to the food security and quality of life of the largest and most rapidly growing population group in the world – the urban dwellers in developing countries.

This contribution does not come without costs. Industrial production is generally capital intensive and highly labour efficient. This causes problems in the many developing countries that have a shortage of capital and a surplus of labour. There are substantial environmental concerns about industrial systems, particularly relating to the concentration of large amounts of manure and urine in small areas. The problem is exacerbated in developing countries because production tends to be situated near large cities to enable good market access. Animal health problems are a constant threat in intensive production systems, and the mixing of high densities of animals with high-density human populations substantially increases the risk of zoonoses.
Consumers in the developed countries, who have been longer-term beneficiaries of the low cost and security of supply of industrial production, are questioning the ethical position of industrial animal production and are increasingly willing to pay more for similar products produced in a manner which they believe is ethically preferable. Animal welfare and environmental issues are particularly important and are re-shaping the nature of these industrial systems.

The demands that are being placed on animal systems can be summarised succinctly. Society wants a secure supply of high quality, safe food and product, and evidence that the system is ecologically sustainable. Livestock owners want a fair income for their work and investment. Animals deserve a good quality of life. Livestock systems that operate where there is conjunction of these desires will be assured of a future.

REFERENCES


