

# Veterinary medicine, food security and the global environment

A.M. Kelly & R.R. Marshak

University of Pennsylvania, School of Veterinary Medicine, United States of America

## Summary

The authors focus on the role of veterinary medicine in feeding the nine billion people projected to inhabit the planet by 2050, despite the problems of global warming, political constraints and environmental destruction. Population growth, predominantly urban, will occur mainly in developing countries, at a magnitude comparable to creating a city the size of Los Angeles, the second largest city in the United States of America, every three weeks for the next 40 years. Accompanying this growth will be a greatly increased demand for animal protein. How this burgeoning demand can be met by intensive and extensive systems of animal production is discussed, with particular reference to the immensely important role that the veterinary profession and schools must play.

## Keywords

Animal production – Curriculum – Extensive systems – Farming – Food production – Food security – Food supply – Global warming – Intensive farming – Livestock – Para-professionals – Southeast Asia – Sub-Saharan Africa – Urbanisation.

## Introduction

One of the great challenges of the 21st Century will be to learn how to feed an estimated nine billion people by the year 2050, 40% more than presently inhabit the planet (19), and to do so without destroying the environment. The issue is how to increase the supply of food, particularly food of animal origin, in the face of a relentlessly increasing global demand from predominantly urban populations. Already, more than half of the global population live in urban communities (2). Future growth will accelerate this trend, which is equivalent to creating a city the size of Los Angeles, California (population: 3,834,340), every three weeks for the next 40 years. Demographers project that, in China, an astounding 900 million people will live in cities by 2020 (21). This profound restructuring of Chinese society has created huge challenges, including a revolution in the production, packaging and distribution of food (13). Similar changes are taking place in other countries of Southeast Asia, presenting the veterinary profession with unprecedented opportunities and responsibilities, the scope and breadth of which are still not fully understood or appreciated by leaders of governmental and

international agencies. Moreover, veterinary schools have generally been slow in adjusting their educational programmes and alerting and preparing the profession for the challenges presented by the accelerating crisis in global food production. Students must be made aware of the need to acquire competence in a variety of relevant, non-traditional disciplines, and the profession must more effectively disseminate its message on how the unique contributions of veterinary medicine are essential in achieving the goal of a healthy, hunger-free world.

With growing affluence, the rapidly increasing urban households of middle-income nations are demanding better, more varied diets, including meat, milk and poultry products at levels two to three times higher than in rural households (18). But, because land is in short supply, farmers in China and other countries of Southeast Asia do not have the capacity to provision their large and rapidly expanding urban populations. China, with 20% of the global population, has only 7% of the arable land. Moreover, markets are distant, transportation infrastructures are usually inadequate and, due to insufficient cold chain facilities, spoilage can be as high as 30% (11). These factors have driven large, intensive

livestock and poultry operations to locate in the peri-urban areas, and such operations now account for roughly 80% of the total increase in Asian livestock products since 1990 (14). In the short term, while the urban demand for animal foodstuffs is being met, peri-urban livestock operations have created alarming environmental challenges, particularly related to the disposal of enormous quantities of animal waste.

Embodied in the challenge of feeding a growing world population is the problem of supplying inexpensive food for the millions of urban poor who must pay in cash and risk hunger or starvation when food prices rise. Affordable food supplies are essential for political stability. Food riots have been uncommon for over four decades, due to an era of abundance following the Green Revolution (the transformation of traditional agriculture, which began in about 1945, due to the development of high-yielding crops, irrigation projects, pesticides and the use of nitrogen fertilisers). However, when food prices jumped 85% over the past three years, riots ensued in over 30 countries (4). Additionally, the beneficial impact of the Green Revolution has been compromised severely by:

- rising fuel and fertiliser prices
- climate change
- prolonged droughts in Australia and other parts of the world
- the diversion of grain to bio-fuel production in the United States of America (USA)
- growing affluence and consumption in emerging economies, especially China and India.

To address the growing crisis successfully will require the development of new, efficient, environmentally friendly technologies that can dramatically increase world food supplies. In this essential mission, the veterinary profession can play a pivotal role by applying its special knowledge and skills to increase the productivity, sustainability and safety of food animal agriculture.

## Livestock and poultry production: intensive systems

Strong demand for livestock products in the emerging economies of Southeast Asia is projected to continue for the next three decades and beyond (10). China has little choice but to adopt landless, intensive systems of swine and poultry production that rely on imports of feed grains from overseas. The advantages of intensive systems include:

- efficiencies of scale and in the use of resources
- improvement in feed conversion, management, housing, nutrition, marketing and genetics

- opportunities for research and innovation, for example, in the capture of methane emissions from manure.

However, such intensive systems also bring disadvantages, such as vulnerability to the rapid spread of disease among concentrated animal populations and the potential for environmental damage.

Advances in technology are far more likely to be applied in large, commercialised, intensive systems rather than in small-scale operations. Improved efficiency reduces pressure on resources and fragile ecosystems in the rapidly developing countries of Southeast Asia, as well as in South America, where feed grain production has caused massive deforestation and loss of biodiversity (16). To service large production units, veterinarians must be capable of analysing the economic and herd health, nutritional status and environmental stewardship of entire farming operations. Clinical skills should be coupled with knowledge and competence in:

- food production systems
- epidemiology
- preventive medicine
- biosecurity
- animal welfare
- quantitative measurements of risk assessment
- nutrient management
- animal health economics.

The last three disciplines, well represented in some American veterinary schools, are generally absent from the curricula of most veterinary schools elsewhere in the world.

In China and other countries of Southeast Asia, intensive livestock and poultry operations rely on the importation of large quantities of feed grain from overseas. This has encouraged production systems to locate near ports on the South China Sea, where there are few environmentally friendly ways of managing waste. As a consequence, swine and poultry operations have become major sources of nutrient pollution in the South China Sea. The result has been massive environmental damage and the spread of water-borne diseases in one of the most biologically diverse fishing areas in the world. Huge algae blooms have killed more than 80% of the fish in an area of 155 square kilometres (60 square miles) along the coasts of Hong Kong and southern China (17). Foul odours and swarms of flies from livestock operations in peri-urban areas compound the problems. The World Bank has cautioned that further livestock expansion under present intensive operating conditions is unsustainable (9, 20). Steinfeld *et al.* (16, 17) have stressed the urgency of the situation by stating that, 'the environmental impact per unit of livestock

production must be cut by half, just to avoid increasing the amount of damage beyond its present level'.

To ensure food security for urban populations, investment is needed to build and bolster key infrastructures. Regional planning initiatives must be aimed at moving intensive livestock and poultry operations away from cities to areas where expanded production is a lesser threat to the environment. Such reforms have already been introduced in Bangkok (8). As demand grows, the availability of adequate water and the safe disposal of animal waste will be crucial, but, with large feed grain imports and only 7% of the arable land in the world, it is questionable whether China will have the capacity to absorb so much waste; for environmental reasons, more land is required to absorb animal waste than to grow feed crops. Methane digesters usefully capture energy from manure but nitrogen and phosphorus remain in the effluent and must be handled responsibly. One solution is to move animal industries closer to ample sources of feedstuffs, to Brazil, for example, and then to ship the finished products to distant consumers. While this may have advantages for energy use, governments generally are adverse to the idea for the following reasons:

- the threat to full rural employment
- vulnerability to price fluctuations
- vulnerability to geopolitical crises
- threats to the security of their food supply industries.

Crowding livestock and poultry in intensive production facilities heightens the risk of infectious disease outbreaks and raises consumer concerns about food safety, animal welfare and multi-drug resistant pathogens. Reducing disease risk in concentrated animal feeding operations requires strictly controlled access and rigid enforcement of biosecurity protocols. Evidence suggests that the conversion of H5N1 avian influenza virus from a duck-adapted, low pathogenicity virus to a highly pathogenic avian strain took place in the crowded poultry operations of Southeast Asia (12). The avian influenza epidemic and the 1997 outbreak of Nipah virus infection in Malaysia, which destroyed the Malaysian swine industry and caused a number of human deaths (5), reveal a failure to understand risk and biosecurity enforcement protocols. Since the responsibility for developing protocols, educating herdspeople, conducting surveillance and ensuring enforcement ultimately belongs to the veterinary profession of a country, public and private veterinary services in Asia are under great pressure to adjust their thinking and practices to meet the challenges presented by the rapid consolidation of their livestock and poultry industries. To succeed, food animal veterinarians require new, generally unfamiliar, managerial skills directed towards:

- efficiency of production
- profitability

- disease prevention
- environmental protection
- biosecurity.

Veterinary school curricula and professional standards should be refocused to emphasise these generally under-developed or neglected fields.

## Livestock and poultry production: extensive systems

Today, over half the population in the world exists on less than US\$2.50 a day (15). The situation is most dire in sub-Saharan Africa, where half the people, with livestock as their principal source of food and income, live in abject poverty (6). 'Stuck' on the 'bottom rung of the economic ladder', poorer than they were 40 years ago, and most vulnerable to the effects of global warming on food production and the spread of disease, they have been hurt rather than helped by globalisation (3). Knowing how to help is difficult. Educational programmes have not been well adapted to the needs of nomadic people (7) and many African countries suffer from corrupt leadership, ethnic hatreds and ruinous civil wars (4). Present models suggest that the global climate will become drier and more unpredictable, decreasing the capacity of the land to sustain present livestock densities and increasing the problems of overgrazing and soil erosion. To combat this trend, grasses, corn and other crops must be made more drought- and insect-resistant (4). Regrettably, with the exception of South Africa, countries throughout Africa, influenced by the European ban, refuse to sow genetically modified crops. Unless this reluctance is overcome, it is hard to see how farmers, including the cattle, sheep and goat farmers of Africa, can survive, let alone feed their growing and increasingly urban population.

Veterinary medicine has a vital role to play in addressing the global crisis of hunger, poverty and disease, but surveillance and control programmes and other veterinary health services are difficult to deliver to poor pastoral people on a regular basis. Moreover, sub-Saharan African veterinary public health and extension services have suffered from years of under-funding and neglect. While private veterinary practices have been successful in some urban and peri-urban areas, financial considerations limit the delivery of services to more remote sites (20). To address this problem, a number of mainly donor-funded, independent, community-based projects, employing local animal health workers and veterinary para-professionals, have been established in under-served rural areas. Although these projects may not be supported by licensed veterinarians, and lack legal status, studies show that such initiatives in Kenya, Tanzania, Sudan and the Philippines

have reduced disease-related losses in livestock and improved local living standards (7). Nevertheless, there are reservations about these initiatives for the following reasons:

- quality of service
- accuracy of diagnoses
- drug distribution and the possibility of drug residues
- advice received
- availability of assistance from licensed veterinarians.

Despite these reservations, a number of studies have concluded that the involvement of community-based, veterinary para-professionals offers a viable alternative to overstretched and underfunded Veterinary Services in developing countries (1).

Mali stands as an example. Here, a donor-funded programme supports livestock extension services through a network of private veterinarians and para-professionals, with strong participation by producers and regional agricultural chambers. Over 100 veterinarians and para-professionals provide training in 4,500 villages on animal health management, vaccination programmes and range and water management. Success is based on strong participation by the herders in selecting priorities and by rapid, tangible effects, such as decreased mortality rates (7). Continued aid from international agencies is essential for maintaining such initiatives, as is support from veterinary institutions in the developed world, charged with providing accurate diagnostic services and consultation on effective disease control programmes. Determining whether or not a given system satisfies local needs while, at the same time, promoting sustainability is of equal importance.

Developing viable livestock and poultry industries is crucial for the pastoral peoples of sub-Saharan Africa and other severely under-developed regions, for many, improved animal health and productivity is the only way out of poverty. In addition, the desire for dietary animal protein by impoverished people has, for centuries, been satisfied by consuming bushmeat. Now their fragile resource is being devastated by population growth, drought, overgrazing and the illegal trade in wildlife.

## Education

At present, particularly in developed societies, an increasingly clinically sophisticated veterinary profession generally continues to be focused on the traditional delivery of care to the common domestic species. The profession seems largely unaware of and unprepared for the immense challenges and opportunities to contribute in the rapidly changing global landscape, where population growth, poverty, hunger and disease, environmental

degradation and loss of biodiversity threaten to overwhelm the ability of nations to find timely solutions. Fortunately, many contemporary veterinary educators and students are increasingly concerned about the world they live in, and increasingly conscious of issues including:

- environmental protection
- food safety
- drug resistance
- the rapidly changing nature of agriculture
- animal welfare
- population growth
- poverty and hunger
- the new and re-emerging diseases that afflict both animals and humans.

Such sorely needed teachers and students are promoting and considering careers in veterinary public health, epidemiology and food supply/production medicine. Indeed, a majority of American veterinary schools now offer degree programmes in public health, epidemiology, ecosystem health and management and animal welfare.

In addition, because of the involvement of the profession in on-farm disease control, and as world trade in foods of animal origin is changing rapidly, veterinary public health curricula should include introductions to production medicine, nutrition and business administration. Veterinary programmes should aim to produce graduates who are not only clinically competent but intellectually curious, entrepreneurial and, most importantly, who have the confidence to lead. At present, few veterinarians hold leadership positions in the national and international organisations and agencies responsible for developing policies on foreign animal disease surveillance and control, food safety and environmental conservation. Yet the richness and breadth of veterinary education provides a unique foundation for this work. Despite different cultures, religions and priorities in food production, disease control and the preservation of biodiversity, developing countries are generally open to assistance from the USA and other wealthy nations. To succeed will require knowledge of how to move into the worlds of other people, patience in understanding the dimensions of their problems and an appreciation of how to work with and lead among health professionals and scientists in a variety of regulatory agencies and disciplines.

Of particular relevance are externship programmes. In developing countries, they introduce students to other cultures. At the Centers for Disease Control (CDC), the United States Department of Agriculture, the World Organisation for Animal Health (OIE), the Food and Agriculture Organization of the United Nations and the World Health Organization, students are exposed to comprehensive scientific and regulatory programmes. In

2008, for example, over 400 veterinary students from across the USA attended CDC Day at the Communicable Disease Center in Atlanta, Georgia, to learn about career opportunities in public health.

In developing countries, veterinary students interested in food animal medicine need an educational system that confers the knowledge and skills required to confront the challenges presented by disease control and efficient food production. American and European veterinary schools should be encouraged to create training opportunities for veterinarians in developing countries aimed at improving disease surveillance and control, with the goal of decreasing losses in livestock production. This, however, is not enough; they should also provide instruction in increasing the productivity and profitability of livestock operations in developing countries by focusing on topics such as:

- managerial efficiency
- reproductive efficiency
- nutrition
- forage quality
- water quality
- animal welfare
- communications
- disease prevention.

Information technologies, which are constantly advancing, should be enlisted to deliver inexpensive but increasingly effective distance education programmes. This is especially relevant for sub-Saharan Africa, where agriculture is the primary source of income for over 70% of the population and accounts for 40% of the total exports of the region (2). If this part of Africa is to be lifted out of poverty, it will be imperative to support veterinary public health programmes aimed at achieving acceptable standards of disease control, productivity and food safety.

## International good will

An adequate food supply, disease control and environmental protection are fundamental to the survival and peaceful growth of developing nations. Moreover, these objectives have a broad impact well beyond the immediate interests of veterinary medicine. Helping to improve the economic, educational and health status of people around the world generates priceless good will that serves as a powerful antidote to widespread suspicion of American purposes and intentions. Indeed, such initiatives can only make America more secure.



## La médecine vétérinaire, la sécurité alimentaire et l'environnement mondial

A.M. Kelly & R.R. Marshak

### Résumé

Les auteurs analysent la contribution de la médecine vétérinaire à l'objectif de nourrir les neuf milliards d'habitants que comptera la planète en 2050, dans un contexte caractérisé par le réchauffement climatique, par des tensions politiques et par la destruction de l'environnement. C'est surtout les pays en développement qui connaîtront une croissance démographique impressionnante, essentiellement urbaine, dont le rythme équivalra à la création d'une ville de la taille de Los Angeles (deuxième ville des États-Unis d'Amérique) chaque semaine pendant les quarante prochaines années. Cette croissance s'accompagnera d'une augmentation de la demande en protéines animales. L'article décrit comment les systèmes extensifs et intensifs de production animale pourront répondre à cette demande en plein essor et met l'accent sur le rôle de premier plan qui sera dévolu à la médecine vétérinaire et aux facultés vétérinaires.

### Mots-clés

Afrique subsaharienne – Approvisionnement de produits alimentaires – Asie du Sud-Est – Bétail – Élevage – Élevage extensif – Para-professionnel – Production alimentaire – Production animale – Programme d'enseignement – Réchauffement climatique – Sécurité alimentaire – Urbanisation.



## Medicina veterinaria, seguridad alimentaria y medio ambiente mundial

A.M. Kelly & R.R. Marshak

### Resumen

Los autores analizan el papel de la medicina veterinaria a la hora de alimentar a los 9 000 millones de personas que, según las previsiones, vivirán en el planeta para el año 2050, y ello a pesar de los problemas ligados al calentamiento planetario, las dificultades políticas y la destrucción del medio ambiente. En los próximos cuarenta años, el crecimiento de la población, principalmente la urbana, tendrá lugar sobre todo en los países en desarrollo y revestirá una magnitud comparable a la creación cada semana de una ciudad del tamaño de Los Angeles, que es la segunda más grande ciudad de los Estados Unidos de América. Este crecimiento se acompañará de una mayor demanda de proteínas de origen animal. Los autores examinan la manera en que cabe satisfacer esta vertiginosa demanda mediante sistemas intensivos y extensivos de producción animal, refiriéndose especialmente a la función capital que incumbe a la medicina y las facultades veterinarias.

### Palabras clave

África subsahariana – Asia sudoriental – Calentamiento planetario – Ganado – Para-profesional – Planes de estudios – Producción agropecuaria – Producción agropecuaria intensiva – Producción de alimentos – Producción animal – Seguridad alimentaria – Sistema extensivo – Suministro de alimentos – Urbanización.

## References

1. Catley A., Leyland T., Mariner J.C., Akabwai D.M.O., Admassu B., Asfaw W., Bekele G. & Hassan H.Sh. (2004). – Para-veterinary professionals and the development of quality, self-sustaining community-based services. *In* Veterinary institutions in the developing world: current status and future needs (C. de Haan, ed.). *Rev. sci. tech. Off. int. Epiz.*, **23** (1), 225-252.
2. Cheneau Y., El Idrissi A.H. & Ward D. (2004). – Current veterinary systems in the developing world. *In* Veterinary institutions in the developing world: current status and future needs (C. de Haan, ed.). *Rev. sci. tech. Off. int. Epiz.*, **23** (1), 351-359.
3. Collier P. (2007). – The bottom billion: why the poorest countries are failing and what can be done about it. Oxford University Press, New York, Oxford.
4. Collier P. (2008). – The politics of hunger: how illusion and greed fan the food crisis. *Foreign Affairs*, **3** (91), 67-79. Available at: [www.foreignaffairs.com/articles/64607/paul-collier/the-politics-of-hunger](http://www.foreignaffairs.com/articles/64607/paul-collier/the-politics-of-hunger) (accessed on 14 July 2009).
5. Daniels P.W., Shahirudin S., Aziz A.J. & Ong B.L. (2004). – Nipah virus disease. *In* Infectious diseases of livestock (J.A.W. Coetzer & R.C. Tustin). Oxford University Press, New York, Oxford.
6. De Haan C. (2004). – Introduction: the provision of animal health services in a changing world. *In* Veterinary institutions in the developing world: current status and future needs (C. de Haan, ed.). *Rev. sci. tech. Off. int. Epiz.*, **23** (1), 15-19.
7. De Haan C., Schillhorn van Veen T., Brandenburg B., Gauthier J., LeGall F., Mearns R. & Simeon M. (eds) (2001). – Livestock development: implications for rural poverty, the environment, and global food security. World Bank, Washington, DC.
8. Food and Agriculture Organization of the United Nations (FAO) (2005). – Livestock policy brief 02: pollution from industrialized livestock production. FAO, Rome. Available at: <ftp://ftp.fao.org/docrep/fao/010/a0261e/a0261e00.pdf> (accessed on 24 June 2009).
9. Food and Agriculture Organization of the United Nations (FAO) (2007). – LEAD approach to addressing land, water and air pollution by industrial livestock production. Protecting the environment from the impact of the growing industrialization of livestock production in East Asia. Available at: <http://lead.virtualcentre.org/en/res/gef.htm> (accessed on 7 February 2007).

10. HENDY C.R.C., KLEIH U., CRAWSHAW R. & PHILLIPS M. (2009). – Livestock and the environment: finding a balance. Interactions between livestock production systems and the environment. Impact domain: concentrate feed demand. Food and Agriculture Organization of the United Nations (FAO), Rome. Available at: [www.fao.org/wairdocs/lead/x6123e/x6123e00.HTM](http://www.fao.org/wairdocs/lead/x6123e/x6123e00.HTM) (accessed on 3 March 2009).
  11. KELLY A.M. & MARSHAK R.R. (2007). – Veterinary medicine, global health. *JAVMA*, **231** (12), 1806-1808.
  12. MARTIN V. (2006). – Avian influenza and wild birds. In Proc. Scientific seminar on avian influenza, the environment and migratory birds, 10-11 April, Nairobi, Kenya. *Avian Influenza wild Birds Bull.*, **123** (1). Available at: [www.iisd.ca/yimb/ais/](http://www.iisd.ca/yimb/ais/) (accessed on 7 February 2007).
  13. PINGALI P.L. (1997). – From subsistence to commercial production systems: the transformation of Asian agriculture. *Am. J. agric. Econ.*, **79**, 628-630.
  14. REARDON T. & TIMMER C.P. (2005). – Transformation of markets for agricultural output in developing countries since 1950: how has thinking changed? In *Handbook of agricultural economics*, 3: agricultural development – farmers, farm production and farm markets (R. Evenson & P. Pingali, eds). Elsevier, Amsterdam.
  15. SHAH A. (2009). – Poverty facts and stats. In *Global issues: social, political, economic and environmental issues that affect us all*. Available at: [www.globalissues.org/article/26/poverty-facts-and-stats](http://www.globalissues.org/article/26/poverty-facts-and-stats) (accessed on 3 March 2009).
  16. STEINFELD H. (2004). – The livestock revolution – a global veterinary mission. *Vet. Parasitol.*, **125** (1-2), 19-41.
  17. STEINFELD H., GERBER P., WASSENAAR T., CASTLE V., ROSALES M. & DE HAAN C. (2006). – Livestock's long shadow: environmental issues and options. Food and Agriculture Organization of the United Nations, Rome. Available at: [www.fao.org/docrep/010/a0701e/a0701e00.HTM](http://www.fao.org/docrep/010/a0701e/a0701e00.HTM) (accessed on 25 March 2009).
  18. STEINFELD H., WASSENAAR T. & JUTZI S. (2006). – Livestock production systems in developing countries: status, drivers, trends. In *Animal production: food safety challenges in global markets* (S.A. Slorach, ed.). *Rev. sci. tech. Off. int. Epiz.*, **25** (2), 505-514.
  19. UNITED NATIONS INFORMATION SERVICE (2004). – UN report says world urban population of 3 billion today expected to reach 5 billion by 2030. Available at: [www.unis.unvienna.org/unis/pressrels/2004/pop899.html](http://www.unis.unvienna.org/unis/pressrels/2004/pop899.html) (accessed on 3 March 2009).
  20. WORLD BANK GROUP (2007). – Rural development and natural resources – East Asia and Pacific Region. China, Thailand, and Vietnam – livestock waste management in East Asia project. World Bank, Washington, DC. Available at: <http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P079610> (accessed on 24 June 2009).
  21. ZIJUN L. (2006). – Rapid growth of China's cities challenges urban planners, migrant families. Worldwatch Institute, Washington, DC. Available at: [www.worldwatch.org/node/4148](http://www.worldwatch.org/node/4148) (accessed on 3 March 2009).
-

