

BACKGROUND READINGS FROM:



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- NEW KIDS, NEW TOOLS, NEW COMMUNITIES
- IMPLOSION OF SAFETY NETS
- EXPANDING SOCIAL ENGAGEMENT
- BIO-DISTRESS AND THE NEW HEALTH COMMONS
- GREAT BIOLOGICAL MIXING BOWL
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*“Never doubt that a small group of thoughtful, committed citizens can change the world.
Indeed, it is the only thing that ever has.”*
- Margaret Mead

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"Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has."

- Margaret Mead

Malaria, eliminated decades ago in the West, kills a child in Africa every 30 seconds. In 2006, Mozambique reported 6.3 million cases of malaria, equal to 32 percent of its population, resulting in more than 5,000 deaths. For those in government and the non-profit sector, bettering civil conditions in Mozambique is a big challenge. The country of more than 800,000 square kilometers, is beset with electrical disruptions, poorly maintained roads, insufficient vaccine supplies, and inadequate immunization logistical support, all of which impact animal and public health.

Enter Erik Charas, investment director for a non-profit organization and an engineer. Assessing the potential use of wireless technology and cell phones, Erik calculated that adding relatively inexpensive boosters to communication towers would increase data transmission to cover 80 percent of the country. To increase timely reporting, decrease errors in tabulating vaccination data, and increase logistical coordination, Erik built input screens into the cell phones of field campaign workers. This allowed workers to enter and transfer data immediately to central headquarters using text messages.

Erik, born in Mozambique, is one of the 'new kids' whose expertise, commitment and creativity are essential to meeting the challenges of vaccination campaigns for public health as well as animal health purposes, where foot-and-mouth disease, exotic Newcastle disease, tick infestations pose major domestic and international challenges. This effort is one example of how applying technology enables societal advancement. In parts of Mozambique, equipping public health workers with better technology has increased the number of children fully immunized each year by 47 percent.

COMPUTER TECHNOLOGY A TOOL FOR GROWTH

Technological growth is one indicator of societal advancement and change. Applied to communications, technology began centuries ago when the Chinese found that pounding linen made paper and facilitated the transfer of accurate historical records to subsequent generations. In 1440, the Gutenberg press was invented and books became accessible to all, facilitating mass education. The first programmable computer, built in 1936, weighed

500 kilograms and could complete a simple multiplication problem in five seconds. The birth of the microprocessor around 1971 began the revolution that has put a supercomputer in every cell phone, PDA and automobile. Since 1945, computational performance has grown at a rate of 45 percent every year. While the price of computer power has fallen 47 percent per year relative to wages. These increases in productivity are far larger than that of any other good or service in the historical record.

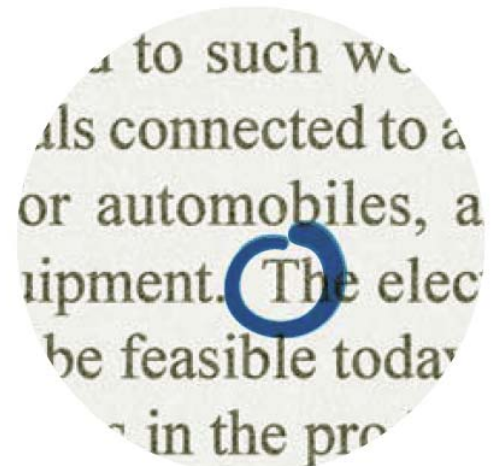
Health and allied professions have benefited immensely from such advances. Practitioners can access medical record databases for more rapid disaster response, there is increased public access to health care information, and the ability to track and mitigate disease outbreaks has expanded.

Microprocessing combining cell phones, wireless technology, and radio frequency identification devices (RFIDs) offer endless possibilities. There are 2.8 billion cell phones in the world with 1.6 million added each day. An estimated 10 billion microprocessors will be sold in 2007. This could mean unprecedented innovation and the ability to track products worldwide. People and animals can be tracked, too, to monitor migration, assess changes in emerging risk factors and help curtail disease spread. Consumers could be empowered in unanticipated ways. For instance, the supermarket of tomorrow could allow shoppers with allergens, dietary or health concerns to scan a food product's RFID to retrieve item information prior to purchase. By some estimates, RFIDs may eventually cost as little as \$.04 (USD).

TECHNOLOGICAL GROWTH

Propelling economic, communication, educational and societal changes

The price per transistor on a computer chip has dropped dramatically since Intel was founded in 1968. Some people estimate that the price of a transistor is now about the same as that of one printed newspaper character. The number of transistors now shipped per year is about 100 times the number of ants estimated to be in the world.



- Intel Corporation, 2005 and 2006

UNANTICIPATED SOCIAL CHANGE

Access to technology allows even the most removed communities to use computers to learn without classrooms and teachers (see insert). The delivery of curricula or information such as ‘health alerts’ via cell phones becomes a viable option. To spur economic growth and entrepreneurialism in some of the poorest countries, the World Bank is exploring the possible use of cell phones providing direct access to banking services.

The 1957 launch of Sputnik was a social and political change milestone that created public impressions that government could be a force for positive social improvement. Twelve years later, Neil Armstrong’s “giant leap for mankind” confirmed an assumption true even today in many countries – that major leaps forward can be planned and accomplished in a decade’s time. The increasingly interdependent global environment is showing us that technology may move society forward at a rate that far exceeds our accustomed planning and action horizons. To address the convergence of animal and public health means harnessing technology for larger and faster “leaps forward.”

TECHNOLOGY FOSTERING “THE COMMONS”

Technology can also alter how public dialogue and policy development occurs. “Smart mobs,” self-structuring social groups that use technology to exchange information and coordinate, can influence public policy and cultural change. This can occur through the Internet via online communities such as “MySpace” and “YouTube.” It can generate complex levels of social coordination around “common themes” of interest in previously unimagined ways unrestricted by geography. It can leverage how a few can alter public discourse and underscores the philosophy of anthropologist Margaret Mead: “Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has.”

The swell in the popularity of different food systems such as organically-produced food products or “buy local” food, the push toward “greener” modes of transportation, the growing public sentiment around animal welfare, the use of antibiotics in animal production, and substandard agricultural health practices are all examples of societal-driven agendas beginning to challenge and influence organized government.

TECHNOLOGY AS A FOE?

Technology can also be a double-edged sword, fostering disruptive change. British physicist Stephan Hawking, one of this century’s premier thinkers stated, “The greatest threats this world faces are a result of advances in science and technology.”

Globally, change is unevenly distributed as some countries, lacking basic infrastructure, struggle to

meet the adoption of new requirements by more advanced countries, and struggle to develop the technology needed as developed countries more closely scrutinize their source of food and animal products. The addition of new equipment or laboratories means maintaining such investments.

Animals and products that feed global food supply chains that serve economic and political needs can be moved over longer distances over shorter periods of time. Hence, geographical barriers that may have once prevented the onset and spread of disease are becoming more common due to advancing transportation technology.

Advances in science and access to information can enable factions of society to create fear, death and economic upheaval through chemical, biological or radiological means that undermine the confidence in food, food systems and the supporting institutions.

SUMMARY

Prior generations have grown accustomed to incremental change. ‘New kids’ with new tools, however, are changing society more rapidly than ever before. Globalization and technological advancements that are pushing these changes can be both positive and negative. A greater number of options lets individuals unite for common good or to undermine society. Access to information may open up ways to overcome obstacles, while also giving voice to grassroots efforts. The actions of establishments must take on a greater transparency than ever before. For public and animal health, the changes brought by technology will revolutionize the safekeeping of humankind in new and unanticipated ways.

ONE LAPTOP PER CHILD TO ADVANCE HUMAN CONDITIONS IN MOST REMOTE AREAS

A computer for every child and learning for all. The One Laptop per Child (OLPC) Foundation, the brainchild of Nicholas Negroponte, is on a mission to put laptops in the hands of children in developing countries. Like a “Johnny Appleseed of the digital era,” OLPC seeks to give children, their families and their communities a gateway to the world, the chance to learn and learn about learning, and the creation of economic opportunities, enhanced public health infrastructures, and improved animal health practices. Priced at \$100(USD), the OLPC’s “XO” laptop is a durable, power-efficient machine conceived of in the Media Lab of MIT. To date, OLPC, has garnered partners such as AMD, Intel, Google, and the world’s largest maker of laptops, Quanta. OLPC has also earned purchase commitments from countries including Brazil, Nigeria, Libya, Uruguay, and Rwanda, among others.



“Every step by which an individual substitutes concerted action for isolated action results in an immediate and recognizable improvement in his conditions.”

- Ludwig von Mises, economist and social philosopher

GROWING CHALLENGES

In 2001, an outbreak of foot-and-mouth disease (FMD) in the United Kingdom spread quickly between farms before animal movement restrictions could be enforced. Immediate actions included the closure of meat and animal export markets and the eventual sacrifice of more than 6.5 million animals.

Longer-term effects included countless farming operation closures despite more than \$2 billion (USD) in government compensation to more than 9,000 farms, and losses estimated to be as much as \$12 billion (USD) in the tourism sector. In rural areas, the suicide rate rose markedly, directly attributable to the event.

Before the outbreak, the U.K.’s chief veterinary officer warned of the potential for a disease incursion, highlighting shortcomings in the infrastructure needed to combat disease. Between 1991 and 2001, one-half of the regional animal health offices and 20 percent of the veterinarian positions assigned to those offices were eliminated, along with a decrease in the number of laboratories available for disease testing.

These reductions, on the heels of the U.K.’s experience with bovine spongiform encephalopathy or “mad cow disease,” limited the ability to detect the emergence of diseases such as FMD. The 2001 outbreak illustrates the growing challenges and vital need to maintain an adequate animal health infrastructure in order to operate in a global environment.

RECOGNIZING THE IMPORTANCE OF ANIMAL HEALTH INFRASTRUCTURE

Global trade, stimulated by economic and population growth, is growing. Agricultural production to serve consumers is also expanding to meet increasing demand. Meat and animal product consumption in developing countries alone is expected to increase by at least 50 percent by 2020. Intensive animal production in many developing countries has, in response, increased significantly to meet domestic needs and to realize comparative trade advantages in a global marketplace.

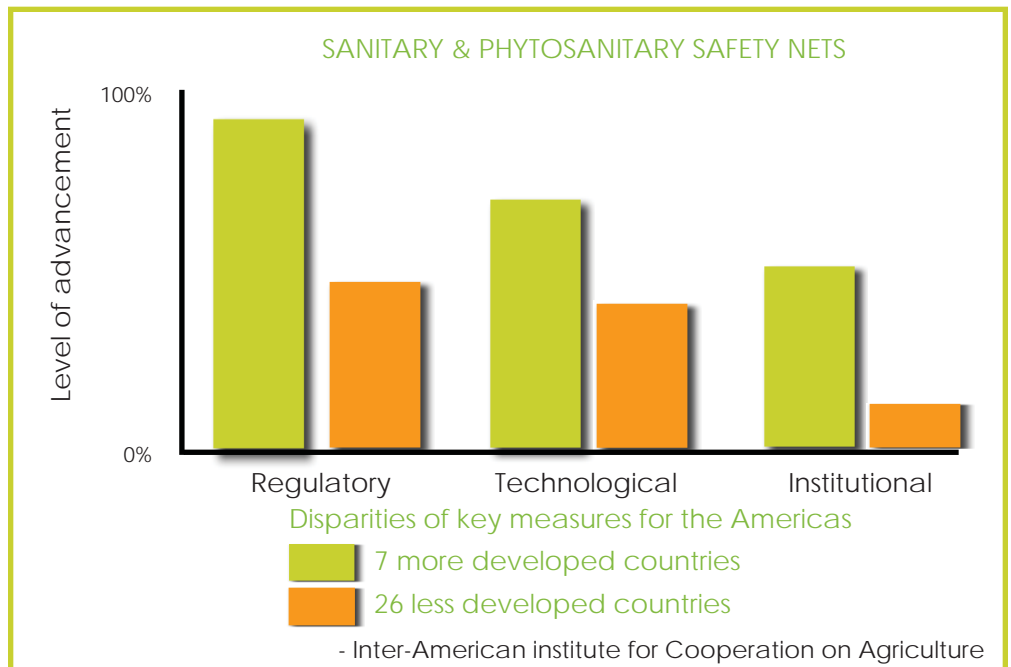
Beneficiaries of animal production technology, economies of scale and a relatively inexpensive labor force include Asian countries.

In the last 20 years, Asia has become the top poultry production region in the world. For many countries, the absence of disease, investments in animal health infrastructure often go unrewarded.

Competitiveness is the primary goal toward which the agricultural infrastructure of most countries is aimed. Yet, competitive market conditions such as live animal auctions are highly efficient means of dispersing pathogens. International trade can transcend geographical barriers that may have naturally slowed the spread of diseases in the past. The market economy does not necessarily reward additional resources to enhance animal health infrastructure or encourage surveillance to track changing risk factors that might signal the possibility of disease.

Maintaining adequate national animal health infrastructures to serve domestic and global demand is a constant challenge. Currently, the vulnerability of the sanitary conditions of countries exporting animal products and countries receiving those products may go unrecognized in the absence of a full-fledged disease outbreak or threat of a potential pandemic.

The adequacy of preventative measures is of concern to animal health and human health. By some estimates, more than 75 percent of the diseases that threaten human health originate in the animal population. While these diseases, termed zoonoses, have always threatened human health to some degree, it is believed that animal-borne diseases are responsible for 11 of the last 12 significant human health epidemics including the most recent Asian strain of highly pathogenic avian influenza H5N1.



Projected to become the world's most populated regions by 2050, Africa and Asia typify the growing intersection of animal agriculture and the human population. Domestic and global demand fueled by the simplicity and speed with which meat and animal products transcend seemingly "borderless" trade routes have all converged and animal health operations, both intensive and extensive, now reside in close proximity to human populations and compete for available natural resources.

LINKING ANIMAL AND PUBLIC HEALTH

The 2002 outbreak of severe acute respiratory syndrome (SARS) illustrates the precarious link between animal and human health. SARS first emerged in China, the likely result of overcrowding and species mixing in live animal markets. By 2003, it had spread to Hong Kong and Toronto, Ontario, and recurred in China in 2004. SARS has sickened more than 8,000 people and killed 10 percent of those infected. Infrastructural failures such as understanding the risks of disease between animal and public health, inadequate public health systems, a lack of clear and effective treatment, and inaccurate diagnoses contributed to this "super spread."

Bracing for the next SARS, whether it is a recognized or new emergent pathogen, requires the consideration of our global, interdependent health. Prioritization and investments in health infrastructures that recognize the importance of animal health on public health may pay dividends in improving global health and strengthening the global economy.

Rooted in this challenge is growing health infrastructures to adequately address disparities based on income, gender, race or social class. This applies to animal agriculture and public health.

Extensive animal agriculture remains an important source of food and income, especially in lesser developing countries. Animal disease occurrence can have a disproportionate affect on family income and other measures such as education and health-care. In the face of already limited animal health infrastructure, the cost of disease in these areas receives little attention.

Simultaneously, public health infrastructures are at odds with growing regional human populations. One can derive that investments in public health can be overlooked in the face of an overabundant pool of labor wanting to work irregardless of risks and levels of health support.

RESOURCES, PRIORITIES AND PARTNERSHIPS

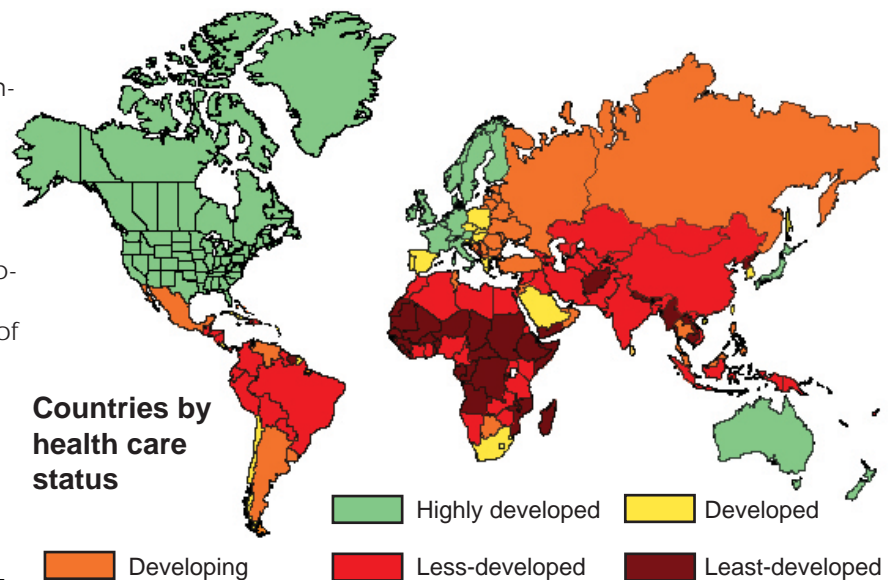
Building the infrastructure that protects a growing human population and sustains agricultural growth at a domestic and global

scale in light of limited resources and competing priorities is no small task. It requires investments of economic and social capital. Unfortunately, there is a growing gap between the expectations placed upon governments and their capabilities to deliver as evidenced by governments' inadequate response to outbreaks and failure to address more sustainable preventative strategies. In the Americas, for example, an estimated five percent of total government expenditures are in agriculture. Just five to 10 percent of this total goes to animal and plant health programs. The average term of office of a minister of agriculture is just 1.5 years.

Countries lacking the technical expertise, infrastructure or resources to prevent and respond to outbreaks may view Non-Governmental Organizations (NGOs) as a more viable or immediate funding source than their own treasuries, the private sector, or international banks and donors. NGOs, including international organizations, have limited resources and operate within the bounds prescribed by governments.

And while an outbreak can provide governments with a previously unavailable influx of external resources, a delicate problem is created. NGO support may contain conditions and limitations as NGOs can be fiercely competitive to ensure their own survival. In addition, external resources may reduce elected officials' need to re-prioritize domestic spending to improve the animal and public health infrastructure within a country's national agenda.

The relief of the immediate pressure to pursue longer-term national solutions fosters an oft-seen scenario whereby the eventual withdrawal of external resources results in a regression of the infrastructure. At risk is the perpetuity of a dangerous cycle of animal agriculture disease emergence that goes unnoticed until the next crisis and potential threat to human health on a national or international scale.





"Culture is like the sum of special knowledge that accumulates in any large united family and is the common property of all its members."

- Aldous Huxley

In parts of Nepal, man-made canal systems are essential for crop irrigation. Farmer-owned and managed, these systems can be rudimentary, built with mud and stones and requiring constant upkeep.

In the Dang valley region, the U.S. Agency for International Development and the Nepal Department of Irrigation funded the construction of a modern system of concrete and steel to replace five farmer-owned systems. Canal management was now in the hands of a central authority using modern construction techniques versus local knowledge of soil conditions, mud run-off or community norms and practices.

Since its operation, water delivery has been inconsistent, and agricultural output is now less than it was under the previous and more rudimentary farmer-owned systems.

This example shows the result of issues management from a purely technical perspective without consideration for seemingly less tangible aspects; in this case, the critical role of the community's knowledge, norms and behaviors.

Addressing the convergence of animal and public health also requires recognizing multiple factors that may be difficult to quantify yet have significant impact upon the eventual success or failure of an initiative.

Listed below are a series of considerations when addressing health convergence.

SOCIAL DILEMMAS

Individuals, organizations and governments may pursue activities that are logical and rational from their standpoint, yet for greater society, may lead to less than desirable outcomes. This can create tension and lead to "social dilemmas."

Social dilemmas can manifest at many different levels. In some countries, an insufficient investment in animal health infrastructure puts neighboring countries at greater risk of a disease outbreak. Despite this, policymakers may still see animal health as a low priority, rationalizing that the international community would step up to provide resources and assistance should a disease outbreak occur.

Some producers may oppose broader initiatives (such as vaccination programs) for a variety of reasons even though at a regional or national level, a successful campaign could elevate the sanitary status of the country and lead to increased commerce and income. Despite this, some producers may forego vaccination or skirt controls if the costs outweigh the

benefits. Ignoring social dilemmas in the pursuit of 'greater benefits for greater society' does not necessarily ensure success.

Such social dilemmas often reflect the shared beliefs of a culture, community or organization. A population's deep-rooted cultural practices can also be a basis for action that makes sense from a variety of perspectives yet could have harmful consequences.

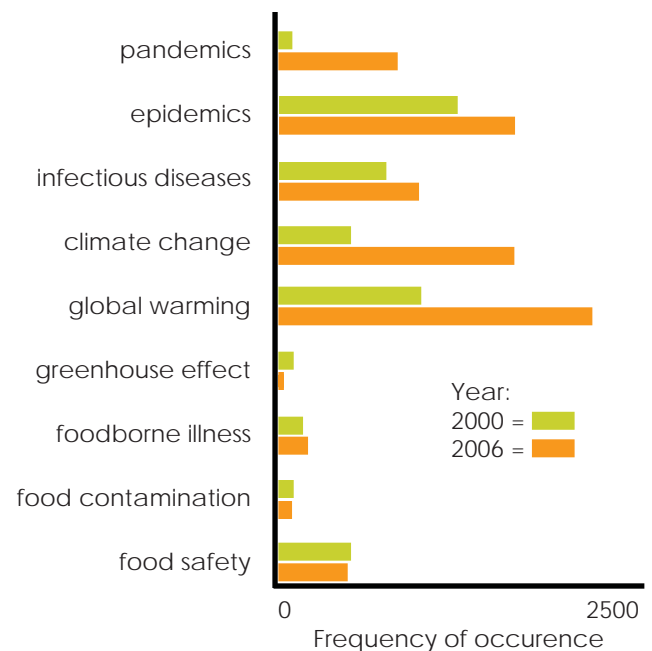
COMMUNITY BELIEFS

Social dilemmas can stem from a population or community's core set of shared beliefs. These can have long-standing religious or social bases, or be rooted in business and production beliefs passed on for generations. These beliefs may be rational for that community, yet may conflict with scientific knowledge and lead to devastating results.

Some populations or communities believe it important to inspect live animals prior to purchase and consumption.

SHIFTING ATTITUDES AND PRIORITIES

Frequency in the use of words in major international mass media print publications.



New technologies give greater access to information affecting our attitudes and priorities, increasing our ability to interpret and act upon societal signals.

- Lexis-Nexis search (2007), and Michigan State University Libraries

Live animal markets in many countries cater to this practice and may congregate many different species in close proximity -- an undesirable practice that can encourage disease transmission. Such was the case in China in 2002 resulting in the outbreak of severe acute respiratory syndrome (SARS) that quickly became a global public health issue.

CULTURAL PRACTICES

Long-standing cultural practices can supersede technological advances laws or changing population demographics such as increased urbanization. Household pets, including exotic species, are increasingly common. Cats can be a reservoir for rabies or Gambian rats may introduce diseases such as monkey pox. In some cultures, backyard chickens are a meat source but may also be used for other purposes such as cock fighting. Backyard flocks may exist in relative proximity to intensive agricultural production operations. In some countries and societies, animals and people live in the same premise where the animals roam free. All can facilitate animal-to-animal and animal-to-human disease transfer.

Eradicating backyard flocks is seen as one possible measure to halt the spread of avian influenza H5N1. However, such actions may produce other undesirable outcomes. For example, in the late '70's and early 80's, all of the pigs on the island of Hispaniola (Dominican Republic and Haiti) were eradicated to control African swine fever. The disease was successfully eliminated, yet replacement pigs from North America adapted poorly. Notable impacts included a 50 percent drop in school enrollment, as the role of the pig in society was not fully understood.

SHIFTING ATTITUDES AND PRIORITIES

The beliefs and practices of a culture or organization are influenced by information as reflected in shifting attitudes and priorities. The advent of the information age has brought about a world where change occurs more rapidly than ever before. There is more information in a weekly edition of the New York Times than the average 18th century citizen in the U.S. came across in a lifetime.

New technologies, changing demographics, globalization and access to unprecedented amounts of information all converge and can influence how we view the world and possible opportunities and solutions. This ultimately affects our attitudes and priorities, increasing the importance of our ability to interpret and act upon societal signals. Climate change is one example of an issue that has come to the forefront of public consciousness over a relatively short period of time (See figure on front page).

RECOGNITION OF COMMON GROUND

Establishing common ground is one avenue to channel changing priorities and attitudes that reaches across different cultural practices, attitudes and beliefs.

A common ground vantage point can accommodate non-quantifiable factors and encourages broad support across seemingly diverse individuals or communities. Pulitzer Prize winner and Harvard scientist E.O. Wilson embodies this approach. His concern that current resource use and practices threaten the future sustainability of the planet has brought him to the forefront of environmental activism. Seeking to combine efforts toward greater stewardship, Wilson is enjoining scientific and religious leaders to meet "on the near side of the metaphysical" and to stimulate change.

SUSTAINED VISION AND COMMITMENT

Building common ground and pursuing actions that address societal problems and dilemmas requires sustained vision and commitment over time. In Costa Rica, the National Biodiversity Institute (InBio) is a source of national pride. Early on, InBio, a non-profit NGO, received no government funding and struggled financially. One day it received a \$1 million check from a pharmaceutical company. Honoring its founding vision, InBio's board wrote on the back of the check "Some things are more important than money" and sent it back. As it turned out, InBio's sustained commitment to its long term vision would lead to a stable path for future growth and national and international recognition.

SOCIAL CAPITAL

The aforementioned factors recognize that increased interdependence is a reality as countries and communities become less self-sufficient in meeting all essential needs. Effective interdependence assumes a level of trust and confidence, or "social capital." When a farmer sends to market sick birds enabling a disease of local origin to morph into a global health concern, social capital is eroded. The same occurs when a business person intentionally adulterates feed ingredients intended for export, leading to adverse health consequences in importing countries who then question the integrity of the entire food or ingredient supply chain.

SUMMARY

Civil society will play an increasingly larger role in shaping the debate. This will be manifest in ways that include reexamining beliefs and practices, shifting priorities and sustained commitment. These seemingly less tangible factors will grow in importance just as the interactions leading to the convergence of animal and public health will also increase in complexity.



"Infectious disease is one of the few genuine adventures left in the world. The dragons are all dead and the lance grows rusty in the chimney corner."

- Hans Zesser ("Rats, Lice and History," 1935)

In 1998, in northern Malaysia, a new biological threat was born. Pig farmers were suddenly becoming ill with flu-like symptoms. Unsuccessfully treated as Japanese encephalitis, the outbreak signaled the emergence of a previously unknown virus, now named Nipah.

The Nipah virus spread through peninsular Malaysia. By the next year it had sickened 265 pig farmers, killed 105 more, and led to the slaughter of more than 1 million pigs. Animals and humans in Bangladesh and India were also infected – the result of pigs imported from Malaysia – causing encephalitis, or brain inflammation. Nipah killed up to 70 percent of patients – a danger level equal to the Ebola virus.

An investigation of the Malaysian pig farms exposed an overlap between fruit bat habitats and the farms. Attracted to the area due to nearby fruit orchards, spillage from the bats' feces, urine and from partially eaten fruit infected the pigs, then the humans.

Like other recent viruses such as SARS and Ebola, Nipah is a "zoonotic" disease as it can transfer between animals and from animals to humans. Zoonotic diseases evolve from a convergence of species such as bats and humans, sometimes involving intermediary hosts such as pigs. Environmental changes such as the encroachment of humans into animals' territory and animals' relocation due to changes in food availability and a loss of habitat increase the potential for disease transfer.

Humans' role as stewards of the Earth, as well as beneficiaries of its resources, has created a symbiosis between humans, animals, environmental conditions and disease. Scientific revelations of the delicate balance of this relationship recognize rising "bio-distress." In the balance hangs the impact of the outcomes of biodistress upon humans by self-created rapid urbanization and population growth, extreme climate variability, a declining species biodiversity, and the consequent ability for "super diseases" to start local and go global.

POPULATION AND URBANIZATION

Around the time of Columbus' arrival in the new world, the global population totaled 500 million. It now tops 6.6 billion with the greatest increase coming after World War II. By 2050, more than 9 billion humans will inhabit the Earth, drawing upon its water and food

supplies. Countries least able to support this growth – those facing political, economic and environmental crisis – will host 80 percent of the 9 billion. The United Nations Population Division reports that by 2050, nearly half of the world's population will reside in nine countries. Only one (U.S.) is in the developed world.

The number of us living in cities is growing. As of 2007, more than half the world's population live in cities – a figure that will reach 60 percent by 2030. The rise in urban populations is impacting the Earth in ways that defy simple measures or models, adding to changes in the planet's surface and atmosphere thermal properties. In addition, though cities in the developed world may hold conveniences, 40 percent of urban dwellers are in the developing world, many in packed conditions, lacking clean water and adequate sanitation.

The interplay of population and urban growth and rising standards of living in heavily populated countries such as India and China is creating a depletion of resources never before seen. Water will become one of the most critically sought-after resources by 2025, impacting four billion people in an estimated 54 countries who will face serious water shortages. A lack of safe water could claim more lives than the HIV/AIDS pandemic. Water is also a needed component for food and animal production, and its scarcity and quality will weigh heavily upon expanding current food production.

MICROBES AND CLIMATE CHANGE

Microbes reflect the environmental niches where they reside. Warmer conditions, unhealthy water supplies, and growing and more transient populations upon which germs can hitchhike all foster the conditions for a "disease perfect storm" – a public health, animal health and emerging disease convergence.

MIGRATION OF SPECIES TO NEW PLACES

Animal and plant species not previously seen in northern climates are becoming evident in increasing numbers.

Originally from South America, the nine-banded armadillo is common in Mexico and the southern United States. More recently, however, armadillos have been spotted moving north toward Canada through states in which they are had not previously appeared. Researchers believe this is a pre-cursor to the animals' movement further north. Some believe that the northeastern and northwestern U.S. coasts are its next destinations as winter weather conditions throughout the U.S. become more mild.



- Journal of Biogeography
- National Wildlife Federation

Fear is growing of the potential for a warmer and more populous Earth to cause tropical diseases such as malaria to invade temperate zones. This fear is supported by the recording of 3,000 cases of infections in Russia in April 2007 caused by hantavirus. Responsible for hemorrhagic fever and renal syndrome, the virus typically dies off in Russia's consistent below-zero temperatures. Temperatures in the winter of 2006, however, were well above normal, marked by a record 46 degree F day in Moscow on December 7th. It was comparable to a warm spell in 1997 when 20,000 cases of hantavirus were recorded.

Seen as a growing problem in historically colder climates, hantavirus is transmitted to humans through the air from the droppings of infected mice. Their survival requires warmer winters, and Russia's current rodent population is 10 times as high in 2007 as in previous years. One of every three mice infected with the virus. With changing climates and the emergence of food sources such as specific trees and flowers in northern regions, the impact could be hantavirus cases that reach into the tens of thousands.

INTERDISCIPLINARY SOLUTIONS FOR COMPLEX CHALLENGES

Recognizing mechanisms underlying emerging and reemerging infectious diseases is vital to protecting animal and public health. Knowledge gaps exist for even the most studied diseases, reflected by a currently simplistic view of pathogens as disconnected from social and ecological contexts.

The reality is that the ecosystem shared by humans, animals and emerging infectious diseases undergoes natural environmental change, such as seasonality or meteorological events. Man-made changes, however, are creating events spawning a unique era of emerging infectious diseases. It demands an unprecedented approach for understanding and solutions.

The notion of biocomplexity offers a holistic and realistic view. The complex interplay of life and environment is sustained, affected and modified by living organisms' behavioral and social, biological and chemical, and physical interactions. Biocomplexity captures this depth and richness of the interactions of human and natural systems.

Employing the biocomplexity paradigm can enhance the understanding of infectious diseases, yet requires a synthesis of interdisciplinary perspectives. It sparks the need to view biological processes from molecular levels up through communities and regions, linking public health infrastructure with an understanding of the impact of climate conditions.

This effort must work at the convergence of human, animal and ecological health to achieve healthier people, places and a healthier world. Health is now an outcome shaped by a wide range of social, economic, natural and political factors. This forms a

complex and ever-changing dynamic that needs to be reflected by new scientific, medical, and research teams.

This view also suggests that people and citizens not previously involved in science and from a much wider array of disciplines can help frame our agricultural and biomedical agendas and become more influential in determining future agendas. The task is addressing the complex, contemporary microbial threats and their ecologies.

Dr. Rita Colwell, past director of the National Science Foundation stated, "Public health is no longer the domain of any one boundary or discipline; instead it is the work of clinicians, epidemiologists, climate scientists, oceanographers, and even space scientists working together to provide a new perspective using many tools, including remote sensing. Tracking, treating and preventing disease are truly global in their scope and require the richness of interdisciplinary research."

SUMMARY

The agent - host - environment relationship is changing in ways never before seen. Rising human, animal and exotic species populations, packed into concentrated geographic settings, contribute to externalities such as the depletion of resources. In a complexity and magnitude yet to be fully understood, the rearrangement of these components can facilitate a greater spread of disease marking the need for new approaches and thinking in the realm of animal and public health.

MAN-MADE BIODISTRESS THREATENS ANIMAL AND PUBLIC HEALTH IN SOUTHERN CHINA

Man-made biodistress is also playing out at southern China's Dongting lake. An operation that began in 1994 and completed in 2006, the construction of the Three Gorges Dam across the Yangtze River is changing the ecology of the Dongting. One of its native species is the zoonotic parasitic disease, *Schistosomiasis japonica*. It infects freshwater snails and can be transmitted to other mammals, notably water buffaloes, when they are exposed to infected water.

Schistosomiasis is a major health risk. A consequence of the Three Gorges project is the relocation of 2 million persons and domestic animals. Not only are population movements linked to extreme vulnerability to disease due to malnutrition and lack of clean water and appropriate sanitation, but officials also warn that these water management projects will aid the transmission of Schistosomiasis as the range of snail habitats will be extended. Around Dongting, occupational groups, notably, farmers and fishermen are at risk thus having substantial effects on the local economy and agricultural development of the area.



"As the HIV disease pandemic surely should have taught us, in the context of infectious diseases, there is nowhere in the world from which we are remote and no one from whom we are disconnected." - Institute of Medicine, the National Academies of Science

Yellow fever results in more than 30,000 deaths annually, infecting more than 200,000 people living in tropical areas of Africa and the Americas. Symptoms range from a mild flu to severe illness, including jaundice from which yellow fever gets its name.

Mosquitoes are a natural source of yellow fever. It has been present in Africa and the Americas since the 1500s, can easily transmit from infected mosquitoes to humans, and has been detected in other countries carried by returning travelers.

Although an effective vaccine does exist, the number of yellow fever cases is growing worldwide due to humankind's manipulation of the world's ecology. Deforestation, which claims an estimated 13 million hectares of forest annually, and urbanization, the migration of humans to urban settings, contribute to mosquito contact and aid viral spread.

Yellow fever is an example of an existing microbe that has adapted, crossed species lines or relocated to new geographic or new niche settings. Humans' modification of the environments in which microbes live and thrive has formed new pathways for the evolution and spread of current and emerging infectious diseases. The creation is a biological mixing bowl with a "survival of the fittest" theme, pitting man against animal against pathogen.

MICROBES MOVING ALONG NETWORKS

A new era of infectious disease is at hand, with the reemergence of old diseases and emergence of new ones. The extreme growth of the world's population, changing environmental factors such as deforestation and the depletion of natural resources, urbanization, and the establishment of concentrated animal production systems all contribute to a convergence of human, animal and microbial health. As human populations increasingly share a closer physical commons among themselves and with domestic and wild animal species, the risk for infectious diseases to cross from one species to another has increased.

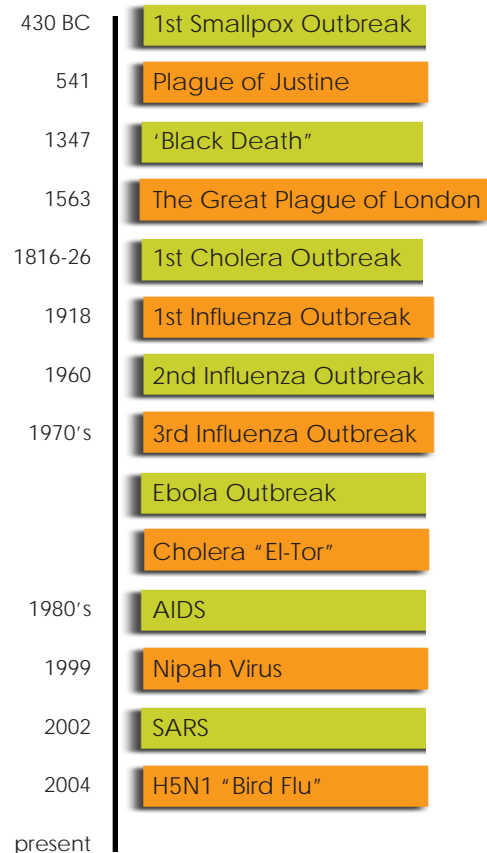
Evidence of this interdependence of humans, animals and microbes is seen within animal production. Growing global wealth is generating a demand for meat and animal products. To answer demand, industrial animal production systems are now dominant in developed societies. Characterized by large numbers of animals of similar genotype being raised, predominantly in confinement, such systems may place less emphasis on bioexclusion and biocontainment measures resulting in an increased animal and public health risks. The emergence of new, more virulent

and more resistant microbes is one of these risks.

Swine influenza, a disease that is endemic in pigs and carries a subtype that can cross over to humans, is a product of highly-dense animal production. More became known about "swine flu" in the early part of the 20th century, as it caused the Spanish Flu pandemic of 1918 to 1920 and killed upwards of 20 million people. The Flu emerged again in 1976 in the U.S., promoting public health officials to announce a nationwide vaccination program. Public relations problems and delays led to the cancellation of the program, but not before 24 percent of all U.S. citizens had received the vaccine and the government had spent \$400 million on the effort. Epidemics of swine flu still occur regularly in North America and Europe, and are seen in other parts of the world.

Food-animal production systems in developing countries also figure heavily into potential epidemics. According to the FAO, by 2020 there will be a 50 percent increase in foods of animal-origin, especially in developing countries. In concentrating upon demand, production systems based in developing countries may lessen the attention

A HISTORY OF MAJOR EPIDEMICS



- Natural Health Publications Limited

put upon risk management. Coupled with already poor public and animal health infrastructures, this presents a dire prospect for those concerned with diseases such as avian influenza and the potential for disease outbreaks affecting human health.

The rise in the populations of food-producing animals to meet demand is one ingredient in this emerging mixing bowl of human, animal and microbes. An added element is the movement of production toward major population centers in order to reduce the costs of the transportation of goods and other food products. Coupled with environmental stresses, resource over-use, and inadequate service and social infrastructures, these areas may very well become the infectious disease “hot spots” of tomorrow.

TOOLS AND TECHNOLOGIES HOLD PROMISE

To promote and protect public health in our own nations and contribute to improving the health of others around the world, we must change the paradigm that has driven how we traditionally approach public health and disease control.

Jared Diamond’s book, “Guns, Germs and Steel,” discusses an era some 8,000 to 10,000 years ago when human populations became stable and communities emerged due to the advent of agriculture. New diagnostics, social networking technologies and the semantic Web are creating a new social order in this era and ways in which we can fight disease. The latest tools and technologies offer hope. Bottom-up approaches to outbreak reporting and communication made possible through technology-based networks enable collaboration to halt outbreaks while also forming a new health commons.

A victim of the devastating tsunami in December 2004, the southeastern Indian state of Tamil Nadu felt its effects long after the event. Amidst decreased sanitary conditions and contaminated water supplies, the transmission of disease was a serious concern. Health officials were desperate for a surveillance network that would allow disease monitoring in real time in order to prevent and mitigate the further spread of pathogens within Tamil Nadu and into other states.

In 2005, Voxiva, an international information management provider, launched Tamil Nadu Health Watch. Now health workers even in remote areas could immediately report disease incidence data to health managers to initiate an informed response. The phone and Web-based system has already reduced incidences of disease, mitigating the potential spread within and beyond the borders of India.

One lesson reinforced by the Voxiva example is that infectious disease does not need to pose a direct health threat to a country or region in order to have a profound impact on that nation’s well being. As the threat of avian influenza crosses borders to find new hosts, the reality of the ability of infectious diseases to

move from local origins to global destinations becomes clear, as well as the need for tools and technologies to facilitate a bottom-up approach to disease surveillance.

SUMMARY

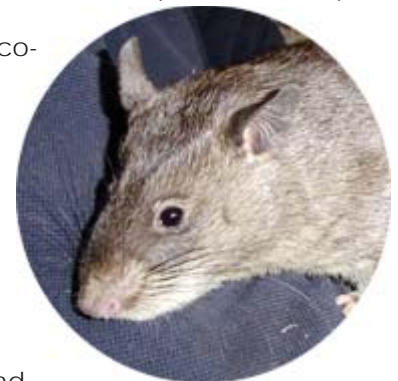
Individual health is influenced by the people and animals around us, as well as the environment in which we all live. To best contribute to improving the health of others around the world, we must change the paradigm that has driven how we traditionally approach the intersection of animal and public health and disease.

Such new challenges call for leaders to adopt a new paradigm for addressing infectious disease in this complex, interconnected world. Building on the successes of the past and learning from more recent experiences, we need to realign ourselves and our partnerships in ways that will improve our ability to protect the health of the country and the world.

To effectively address the new and changing health challenges of today, we must shift from thinking in terms of “interdependence”; we must recognize and work within the context of our being a part of a larger biologic system that links all of these components together.

MONKEY BUSINESS: WHO IS IN CHARGE?

On April 9, 2003, a shipment of 762 exotic rodents originating in Accra, Ghana, reached the United States. That shipment contained giant Gambian pouched rats (50 animals), rope squirrels (53), brushtail porcupines (2), tree squirrels (47), striped mice (100), and dormice (510). Accompanying these animals to Texas was an unexpected virus that eventually found its way into at least two other animal species in the United States (prairie dogs and humans) and spread to at least six other



Gambian pouched rat

unexpected agent, previously unseen in the United States, was a member of the orthopoxvirus group known as monkeypox (CDC, 2003b). It brought a scare to a public health and homeland security infrastructure, already in a state of heightened awareness for smallpox, and challenged the ability to address an emergent health threat in the United States that did not conveniently fall under the domain of any single federal agency.



"Globalization is a fact of life. But I believe we have underestimated its fragility."
- Kofi Annan

In 1996 and 1997, more than 1,000 U.S. and Canadian consumers became ill after eating fresh raspberries imported from Guatemala. The cause was cyclospora – a parasite spread through the ingestion of contaminated water or food.

In response, the Guatemalan berry industry implemented improved on-farm water quality and sanitation systems. Nevertheless, the U.S. Food and Drug Administration banned imports of Guatemalan berries in the 1998 season. The effects were immediate, as 80 percent of all Guatemalan raspberries were bound for the U.S. market. Losses in 1997 and 1998 totaled more than \$13 million (USD).

Agriculture generates about 25 percent of Guatemala's \$61 billion GDP and employs half of its labor force. Guatemala's ability to compete globally without restrictions, a tarnished reputation and damaged trust is critical to its economy and its citizens' well-being.

The raspberry outbreak and similar episodes show that local populations are increasingly vulnerable to events that occur thousand of miles away. Advances in transportation permit the rapid movement of humans, animals and products, as well as the spread of pathogens and disease farther and faster than ever before. It creates a dangerous convergence within a global marketplace dire to meet consumer demand for food at cheap prices in any season from around the world.

TRANSFORMING THE GLOBAL MARKETPLACE

For centuries, trade between countries has been a hallmark of the growth of human civilization. A supply chain infrastructure that accommodates differing climates and land resources, as well as patterns of settlement and colonization, has more recently been transformed by advances in transportation, trade liberalization, and "just-in-time" delivery. Transnational corporations and global distribution systems now provide developed countries with a buffet of global food choices. For instance, the average number of products carried by a typical supermarket in a developed country has grown from 15,000 to 50,000 since 1980.

Such advents let countries and regions leverage competitive advantages such as natural resources and labor pools, permitting them to do what they do best, whether

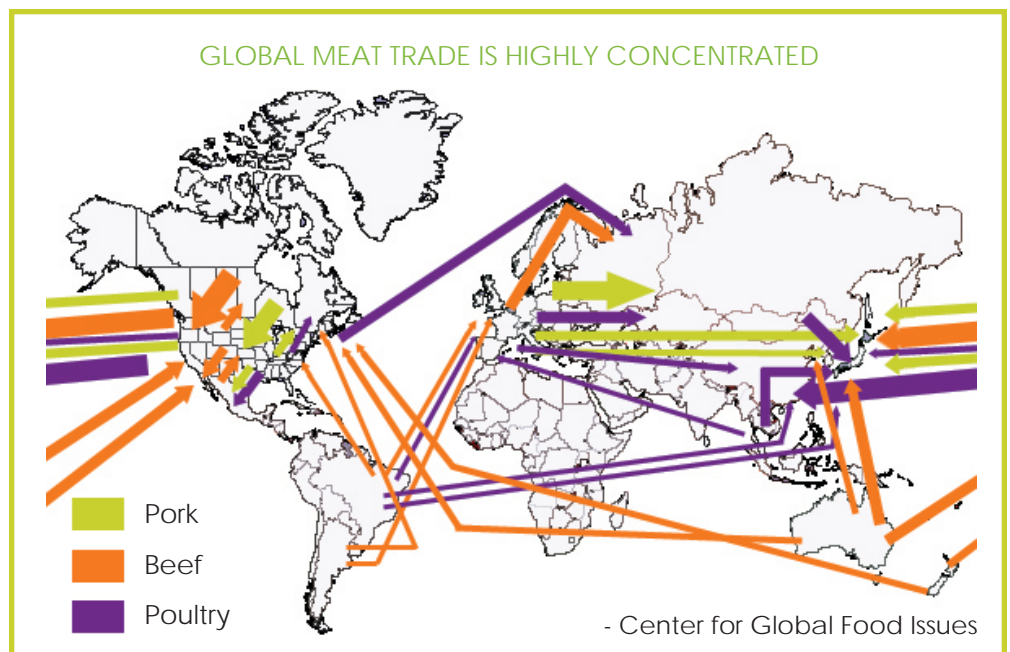
that is agriculture, electronics, heavy manufacturing, or services. The call center in India, soybean production in Brazil, and chemical industries in China are a global complement to fine cheeses and wine of Europe and the quick-service businesses of the U.S.

The food system relies upon this interdependence, with production concentrated in geographic areas with adequate soil nutrients and fresh water, processing moving to areas of low labor costs and amenable regulatory environments, and distribution centers centered at major transportation hubs to capture economies of scale. Many developed countries are now "net importers" of food, importing more than they export, fed by a year-round appetite for exotic fruits and regional delicacies and increased demand for protein as consumers' discretionary incomes grow.

NEW VULNERABILITIES AND THREATS

This robust supply chain also creates new vulnerabilities, limitations and threats. Of those 50,000 supermarket items, many are not locally produced, having crossed many borders to arrive at the supermarket, and may have originated from relatively unchecked sources with questionable sanitation controls. Meat served in American homes, for instance, has traveled, on average, 1,000 miles from its farm of origin to the dinner table. One might question the awareness and appreciation of the influence of other nations upon our food safety, quality and availability, both positively and negatively.

Global distribution can also be credited for the number of products that lose their "identity of origin" as ingredients may be sourced from dozens of countries. A fast-food hamburger, for instance, has as many as 300



ingredients, each coming from a single supply chain that has tapped upwards of 300 farms to arrive at the restaurant where it was prepared.

Small accidents, processing errors, economic malfeasance or intentional contamination can affect consumers in far-off places as well as local producers seated at the origin of the event. The melamine contamination of pet foods is an example of how a potentially dangerous product can move across regional and national boundaries to reach thousands of animals or humans before the problem is recognized.

A similar occurrence in June 2007 prompted the U.S. Food and Drug Administration to urge consumers of toothpaste manufactured in China to throw away the product after discovering a poisonous chemical among its ingredients. The chemical, diethylene glycol, is used in automobile antifreeze and is toxic to animals and humans. Also used improperly in a variety of sedatives and medicines worldwide, contaminated cough syrup caused more than 40 deaths in Panama in 2006.

REDEFINING THE GROUND RULES

Expanding international standards for safe trade represents part of the solution, but not all. Australia and New Zealand have a bilateral agreement allowing for joint regulation of food safety issues. As two exporters of food products geographically distant from other nations, both countries strive to keep out plant pests and animal diseases while maintaining a reputation for disease-free food.

When such arrangements do not exist, animals, plants, food products, drugs and vaccines move through illegal channels. Rampant organized smuggling may represent the primary movement channel for some high-value and high-risk items like bushmeat from Africa or certain experimental drugs.

The counterfeiting of consumables, including prescription medications, is also a threat. The U.S. Federal Bureau of Investigation calls counterfeiting the "crime of the 21st century." In 2004, it was a \$512 billion market, up 100 times over the last twenty years, accounting for 7 – 10 percent of global trade. Eight percent of all world trade is counterfeit, along with three percent of the 34 million annual U.S. drug prescriptions. Forty-three percent of all counterfeit medications seized per year contain no active ingredient.

Food is no exception. Counterfeiting techniques include substituting the contents of a product with another, mis-labeling or re-labeling a product, changing the expiration dates, and substituting unauthorized ingredients such as Sudan Red. Smuggled meat products are considered the source of the 2001 foot and mouth disease epidemic in England when food scraps from an ethnic restaurant were fed to pigs.

MOVING PEOPLE, PRODUCTS AND PESTS

Our globalized world has lessened the time needed for transit between two points and expanded modes of conveyance now available. As international travel by humans continues to grow, showing increases of nearly five percent per year, it is one of the largest export goods. In the U.S., it ranks ahead of agriculture and automobiles at \$107 billion.

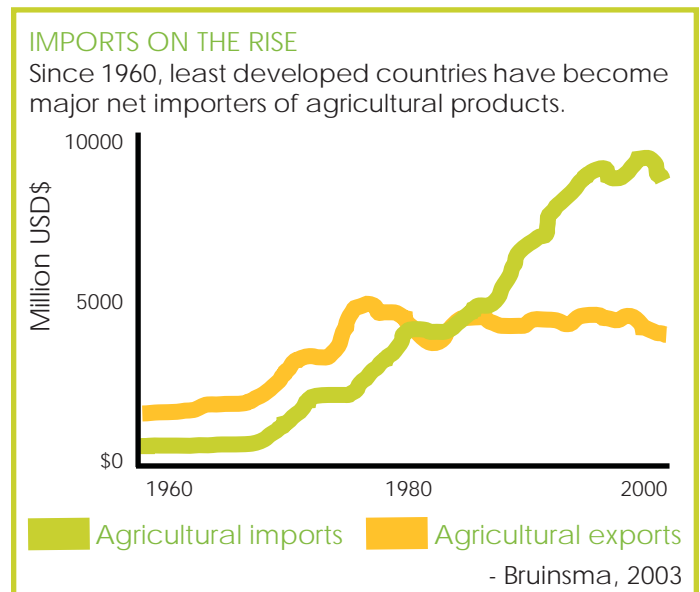
Rapid transit via varied means contribute to the risk facing animal and human health as local problems rapidly emerge as global problems. The transfer of severe acute respiratory syndrome (SARS) from China to other countries in 2002 highlights the ability for contaminated humans, such as the American lawyer infected with tuberculosis in 2007, to travel the globe unchecked.

Non-human travelers - pests, vermin and invasive species - can catch a ride in a shipping container, airline cargo bay, freighter's ballast water or even in the wooden pallet on which the product is shipped. These unwelcome immigrants may be pathogens themselves, disease vectors, or a new species that disrupts the ecosystem homeostatis.

The Asian tiger mosquito, *Aedes albopictus*, is an example that has posed one of the more significant health threats in recent times. Responsible for outbreaks of dengue, equine encephalitis and dog heartworm, it crossed the Pacific to North America, thriving in the stagnant rainwater captured in shipments of retread tires from Asia.

SUMMARY

What once was local is now global, increasing the speed and complexity with which animal health and public health can converge. Goods and services move at record levels, and tourism and the globally mobile workforce add to this constant flux of agents, vehicles and hosts. Protecting animal and public health is no longer a national need but rather a global imperative for which civil society and our educational institutions have yet to fully comprehend.





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