The Impact of Epizootics on Livelihoods

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Epizootics (nonhuman animal disease epidemics) can have detrimental impacts on livelihoods through a complex interaction of demographic trends, food production, and animal disease. Differences in the rate of demographic shifts, including rates of population growth, economic growth, urbanization, environmental sustainability, and role of women in society, are strong driving forces that will determine to what extent food demand will be matched by food production capacity. Epizootics can negatively affect commerce and trade in all countries, and in low-income countries limited infrastructure and resources as well as competing priorities provide additional disincentive to controlling or eradicating animal diseases. Economic growth is critical to overcoming disparities among countries and is best supported by integrated animal health, public health, labor, and foreign policies. The adverse impacts of epizootics can be largely overcome through programs that support job growth along the value-added chain of food production and will require significant investments in science- (risk-) based education.

Already during the “Green Revolution,” livestock production was the fastest expanding sector of agriculture worldwide. Although much smaller in scope than arable agriculture, the increase in the livestock production index from the early 1980s to the late 1990s was consistently higher, in both middle- and low-income countries, than that of crops (Heath, 2007). Today, trade in livestock and livestock products (LLPs) makes up approximately one sixth, by value, of all agriculture trade worldwide (Upton, 2002). Meat exports (mainly beef, pork, and poultry meat) represent about half the total value of the global livestock trade. As a group, developed countries account for more than three quarters, in quantity, of the world trade in LLPs. Developing countries are net importers, and dairy produce is the largest single-import item (Upton).
The steady growth in production, productivity, and trade in LLPs is demand-driven in response to growing human populations, economies, and consumer preferences for meat and dairy products (Delgado, Rosegrant, Steinfeld, Ehui, & Courbois, 1999). These growth trends are associated predominantly with developing countries. Despite concerns in the developed world over the excessive intake of protein, fat, and carbohydrates, much of the developing world will benefit from increased food intake, especially food of nonhuman animal origin (Table 1). There is plenty of opportunity for increased production and consumption of food of animal origin in developing countries because animal protein provides only about 30% of protein calories in developing world diets, and that is only about one third as much as consumed in developed world diets. Given that animal protein for human consumption comes from livestock, how do epizootics (animal disease epidemics) affect livelihoods? To answer that question, one needs to review the interactions of demographic trends, food production, and animal disease.

### DEMOGRAPHIC TRENDS

#### Economic Growth

Per capita, gross domestic product (GDP) is lowest in countries with high rates of population growth, and high rates of population growth are positively associated with the proportion of GDP derived from agriculture. This is because many low- and middle-income countries derive much of their GDP from agriculture. For example, low-income countries derive, on average, 26% of their GDP from agriculture; however, developed countries, such as the European Market Union, derive only 2% of their GDP from agriculture. In countries where agriculture makes a large contribution to the GDP, a large proportion of the workforce is employed in the agriculture sector. Low-income countries generally employ more than 50% of their population in agriculture; middle-income countries employ, on average, less than 40% of their population in agriculture; and approxi-

<table>
<thead>
<tr>
<th>Country Income Level</th>
<th>Calorie Intake per Day</th>
<th>Protein Intake g/Day (% Change Since 1970)</th>
<th>Fat Intake g/Day (% Change Since 1970)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>2,166</td>
<td>65 (30.7%)</td>
<td>55 (96.2%)</td>
</tr>
<tr>
<td>Middle</td>
<td>2,743</td>
<td>78 (17.6%)</td>
<td>76 (39.5%)</td>
</tr>
<tr>
<td>High</td>
<td>3,371</td>
<td>105 (14.3%)</td>
<td>134 (22.4%)</td>
</tr>
</tbody>
</table>
mately 4% of the population in high-income countries works in the agriculture sector. Furthermore, less value added occurs in agriculture in low-income countries compared with high-income countries and even less value added is generated as the agricultural contribution to a county’s GDP increases. This low productivity is, in part, due to low-income countries having the lowest levels of mechanization (number of tractors, machines, and mechanized transportation) to manage crops (Table 2) and having to rely more heavily on physical labor to plant and harvest crops. These factors result in low rates of economic growth within poor populations and effectively create a vicious cycle of poor economic growth and lack of opportunity. These disparities between high- and low-income countries are the basis for a growing gap in the vitality of economies in these income categories. Epizootics perpetuate this cycle because animal diseases are a disincentive to improved efficiency of production.

The Role of Women

The role women play in society is critical to economic growth in low-income countries because women represent on average 50% of a nation’s capable workforce and account for an even greater proportion of the labor force in the agriculture sector. In low-income countries, women make up more than 70% of the labor force in agriculture, whereas women make up only 22% and 7% of the agriculture workforce in middle- and high-income countries, respectively (World Bank, 2001a). High rates of population growth are, in turn, often associated with low levels of education and unequal rights of women. In low-income countries, the literacy rate of females is only 76% of the literacy rate of males, whereas in middle-income countries it is 94% (Upton, 2002). These associations have huge implications for animal and public health services and, with that, the likely success of disease-control programs. This is because providing education and employment opportunities to women is critical to break the vicious cycle of

<table>
<thead>
<tr>
<th>Country Income Level</th>
<th>Tractors per 1,000 Agricultural Workers</th>
<th>Tractors per 100 Hectares of Arable Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Middle</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>High</td>
<td>519</td>
<td>927</td>
</tr>
</tbody>
</table>
poverty and lack of opportunity in low-income countries. Education and empowerment of women is therefore also critical for successful disease-control and eradication programs.

**Urbanization**

The projections for urbanization are that low- and middle-income countries will have massive cities in the foreseeable future. Although the proportion of the population living in urbanized areas is the lowest in developing countries, the much larger populations of these countries indicate that the future cities in developing countries will be the largest in the world. The factors driving urbanization are limited access to jobs, economic growth opportunities, health services, education and poor infrastructure in rural areas, and the perception that cities will bring good fortune.

In cities there is, and will continue to be, a huge demand for services that ensure the safety of food and adequacy of food distribution. Providing safe and abundant food is essential for a vigorous workforce, without which cities cannot prosper. There will be a demand for the creation of new jobs in food safety and handling in the areas of food processing, packaging, distribution, storage, and retail, with the objective of providing “just-in-time delivery” of food to the cities. Massive training initiatives will be required to reeducate professionals and educate persons entering new jobs in food safety and handling. Development of performance standards for new positions, training curricula, and training of teachers and management experts should be the responsibility of the animal and public health professions; by requiring appropriate standards, these services will secure the commitment to the public and private sectors and, with that, facilitate the creation of new jobs. Epizootics can result in disruptions in the supply chain and therefore potentially undermine the success of urban employment programs.

**Value-Added Employment Opportunities**

A lack of infrastructure is a major hindrance to economic vitality in rural areas, especially for areas with agriculture systems that depend heavily on a functioning transportation infrastructure to deliver goods to markets. Costs of transportation depend on the condition of the transportation routes and, in many cases, the cost of energy (fuel) delivery to rural areas needed to power vehicles. The costs of transportation and fuel have to be recovered in the sale price of goods that—under the conditions prevalent in many developing countries—are high and unattractive to city customers. As a result of the high cost of domestically produced food, cities seek alternate sources of food from overseas that can be
delivered cheaply and in bulk to the burgeoning urban populations. The high price of domestically produced food in low-income countries places rural areas at a considerable disadvantage with the imported food market. The low demand for domestic food produced in rural areas, where purchasing power is already low, is a significant disincentive for economic growth in rural areas. Graphic media reports on epizootics and their control further undermine consumer confidence in food from affected areas.

To break the cycle of high cost of production and low demand for expensive, domestically produced foods, either rural infrastructure has to improve or energy delivery costs have to decrease. A potential solution lies in generating biofuels (ethanol and biodiesel) in rural areas to provide a cheap source of energy on-site. Ethanol is a high-octane alternative to petroleum-based fuels and can be produced economically using locally produced crops such as sugarcane, cassava, switchgrass, and many agricultural by-products. Local production and substitution of petroleum-based fuels with biofuels will promote mechanization of agriculture and lead to the development of infrastructure from within rural areas. Furthermore, by-products of biofuel production such as brewers grain present additional opportunities and can be used as animal feed to support the development of local livestock production. In addition, animal waste can be recycled into methane. Hence, biofuels and livestock production are intricately linked. Specifically, increased livestock production will create a demand for animal and public health services in rural areas to support the expanding livestock production and help improve the productivity of the livestock enterprises. Furthermore, although cities will probably continue to import food, local production and consumption of domestically produced food will support the growth in jobs of food processing in rural areas. Increasing the availability of food in rural areas is an important factor contributing to the vigor of the workforce (Hamoudi & Sachs, 1999).

ENVIRONMENTAL STEWARDSHIP

Agriculture has large-scale impacts on water, soil, and air. In low- and middle-income countries, the percentage of land area used for arable and permanent cropland is increasing (Table 3). In developing countries, agriculture accounts for most of the freshwater withdrawals. These trends are the opposite of those seen in high-income countries, where the amount of land used for agriculture is decreasing and industry utilizes the greatest amount of water (Table 3). These factors and encroachment of pristine bat and other wildlife habitats—resulting from the expansion of the agriculture sector—further expose naïve populations of humans and animals to diseases and can result in disease outbreaks such as severe acute respiratory syndrome (SARS), Nipah virus, and Hendra virus.
To reduce the adverse environmental impacts of agriculture on water, soil, and air, wide-area risk-dispersion solutions have been proposed (Perry et al., 1999). In addition to risk-dispersion models, however, economic models need to be developed to convert negative economic externalities of farm-waste production into jobs such as in waste management, recycling, and water conservation (Steinfeld et al., 2006) (externalities are the cost of one party experienced by another, such as the disposal of farm waste on public lands instead of on the farm). Although internalizing the costs of meat production (the farmer bears all costs of production) may initially increase the cost of meat, over the long term, employing more people will increase purchasing power and lead to greater environmental sustainability. Also, environmental stewardship can be effective mitigation of epizootics and increases job opportunities for animal and public health experts to identify, respond to, and control new and emerging diseases.

Livestock Trade

Approximately 75% of the world’s cattle live in low- and middle-income countries; however, exports from these countries account for less than 15% of the global value in LLP trade. Part of the reason for this paradox is that many countries in the developing world have cattle infected with foot and mouth disease (FMD) and many other diseases that restrict trade (Figure 1).

This paradox of supply and value in LLP trade is a reflection of unequal opportunities between countries for the trade of livestock and livestock products related to a country’s animal-disease status. Unequal opportunities result from differences in relative costs that are incurred for a country to become disease free and, once free of disease, to prove and maintain disease-free status. Although absolute costs may be similar for all countries, these costs can be proportionately large for low- and middle-income countries and small for high-income countries. In other words,

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**TABLE 3**

Comparison of the Percentage of Land Area Used for Arable and Permanent Cropland and Water Withdrawal Between Countries With Different Income Levels (World Bank, 2001d, 2001e)

<table>
<thead>
<tr>
<th>Country Income Level</th>
<th>% Land for Arable Cropland</th>
<th>% Land for Permanent Cropland</th>
<th>% Annual Water Withdrawal by Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>11.8</td>
<td>13.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Middle</td>
<td>7.9</td>
<td>8.9</td>
<td>1.0</td>
</tr>
<tr>
<td>High</td>
<td>12.0</td>
<td>11.8</td>
<td>0.5</td>
</tr>
</tbody>
</table>
animal and public health services are not available at an equal relative cost to countries with different levels of income and, therefore, potentially this discrepancy presents a preferential advantage to the users of animal and public services in countries with a high-income status. In other words, epizootics have a longer lasting and greater adverse effect on low- and middle-income countries than on high-income countries.

**Value-Added Export**

As with many economic principles, trade has winners and losers. Those in favor of trade will argue that trade is universally positive, in part because exports provide added value to the economy. However, this argument is not equally applicable to all aspects of all economies. In a flourishing economy such as the United States, it is estimated that every US $1 million value added to agricultural commodities (crops) through exporting meat supports approximately 5,000 domestic jobs. In the United States, this large number of jobs is thought to be, in part, a result of livestock practices in which cattle are fattened on corn and soy diets (in economic terms, beef is value added to arable commodities) and sales of packaged meat. Similar observations are reported for poultry exports from Brazil and swine exports from Taiwan. In all cases, much of the value-added

![Figure 1: Number of cattle and value of livestock and livestock products exports grouped by country foot and mouth disease (FMD) status. Sources: OIE Handistatus II, United Nations Trade Statistics, FAOStat agricultural data.](image-url)
chain supports employment in the agriculture sector beyond the farm gate—such as jobs related to fattening livestock and jobs in other sectors of the economy: transportation, processing, packaging, distribution, and retail of livestock products. For this reason, it is estimated that value added to agriculture supports as many as 16% of all jobs in the United States, which makes agriculture this nation’s single largest economic sector. Under these conditions, even though the individual producer benefits little directly from trade, the economy benefits as a whole. Thus, although the total agriculture work force constitutes less than 5% of the United States’ population; the large number of jobs supported by agriculture leads to broad-based support for exporting agriculture goods.

In contrast, in countries where many people are directly employed in agriculture, livestock are pasture raised, and diseases such as FMD are frequently endemic. Although such diseases can also lead to trade restrictions, because—in low-income countries—little value is added to the economy from processing meat, LLP trade also has few incentives to start with. Consequently, the low value added manifests predominantly as trade in live animals rather than processed meat. For example, FMD-infected countries derive only 73.3% of their LLP trade from meat compared with 84.9% in FMD-free countries.

Marginal Costs

Another argument in favor of trade is that the marginal costs associated with exports are important determinants of domestic prices and profit. Marginal costs of trade are the costs associated with establishing and maintaining export markets. Verifying the animal-disease status within the exporting and importing countries accounts for a portion of the marginal costs. In effect, these costs are the product of the Sanitary Phyto-Sanitary (SPS) Agreement. The effect of the marginal costs is that, once the marginal costs have been overcome, global markets offer a more secure outlet for sales. Sales to stable customers and the opportunity to save costs by selling in bulk encourage many large-scale producers in low-income countries to preferentially sell their products on overseas markets. The domestic buyers are thus forced to compete with traders who are willing to pay a higher buying price, resulting in domestic buyers having to raise the local selling price.

Different relative marginal costs of exports on domestic prices have different implications in high- and low-income countries. In high-income countries, the higher domestic prices for meat resulting from trade are small when compared with the average cost of food; because of the value-added effects, the economy as a whole benefits. In contrast, in many developing countries, increases in domestic meat prices have the potential to lower purchasing power; many people with an already limited income may be denied easy access to abundant local supplies of food.
(meat and dairy products). Furthermore, in developing countries that rely heavily on agriculture for their GDP, the increase in domestic food prices that results from the marginal costs of trade can disproportionately and negatively affect large numbers of poor people in rural areas (Perry et al., 1999). Trade can thus worsen the state of poverty for some populations and, because many of the poor employed in agriculture are women, can further suppress opportunities for women.

All countries have to weigh the costs of disease control and eradication against investments in other programs. Therefore, when—in low-income countries—meeting SPS requirements through disease-eradication programs leads to higher domestic prices for food, the implementation of these programs to gain access to global markets becomes a disincentive to eradicate a disease. In contrast, control programs such as vaccination campaigns directly support jobs and maintain purchasing power. Regrettably, this is true even if the programs are ineffective at controlling disease. In the long term, however, because the horizon for growth is limited, ineffective disease-control programs are detrimental to economic growth. To overcome the disincentives for trade and turn livestock exports into a viable export commodity, countries have to invest in jobs in domestic agriculture-allied industries that allow people to gain from employment through the value added of exports (Perry & Rich, 2007; Perry & Sones, 2007).

Terrorism

Although there is much concern and talk about the impacts of intentional versus accidental causes of epizootics, much of this discussion fails to acknowledge that acts of terrorism are a minor driving force for change compared with the massive global changes in consumer food demands resulting from shifts in population demographics and economic opportunity. Ultimately, it is these global trends, not terrorism, that will drive the adaptation of animal and public health service delivery.

There is also a tendency to overlook considerable differences in the likelihood that a particular country will be a target of terrorism, the capability of a country to respond to disease outbreaks, and the political will of a country to eradicate—or live with—a disease. To remain relevant in the debate on disease introductions and subsequent control and eradication, animal and public health services will need to consider these and other factors.

Transaction Costs

Typically, the costs associated with disease eradication are presented as cost tallies, that is, summaries (counts) of expenditures related to disease outbreak-
response measures. However, these estimates do not measure the true cost of an outbreak response. During the response to a disease outbreak, money is transferred from agriculture to other sectors of the economy: for example, from paying farm labor (agriculture sector) to paying technicians to euthanize animals, dispose of carcasses, and clean and disinfect premises (service sector). Yet, because the money remains in the economy as a whole, the immediate costs to a country from the response to a disease outbreak are not clear from a tally. Rather, the actual costs result from transferring money from one sector of the economy to another. These costs are the transaction costs. For example, the FMD hoax of 2005 in New Zealand provides one example of transaction costs associated with a potential disease outbreak. The response to a letter threatening the introduction of FMD cost over US $2 million. All of these costs were associated with money transferred from the agriculture sector to the service sector, and none of the costs were associated with disease-control operations.

Opportunity Costs

Once money has been transferred from one sector of the economy to another, the final analysis has to be a comparison between the returns of investing in agriculture by supporting the response to a disease outbreak versus investing in other sectors of the economy. Because agriculture is typically not as great an economic multiplier as, for example, the manufacturing or service sectors, the long-term costs (or gains) from relocating investments from agriculture to a different sector of the economy has other implications. The implications are that political will often becomes the determining factor that prioritizes in which economic sector investment is considered more beneficial to the economy as a whole. This explains, why, in the case of epizootics, because the economic impact of agriculture is often less than other sectors of the economy, political will to support agriculture can be lacking.

Tipping Points

As per capita income rises, countries rely less on agriculture as a source of national revenue; employment and other sectors of the economy bring greater value added to the economy than agriculture (World Bank, 2001b). Consequently, this change can alter political will and have dramatic and unexpected influences on the level of support politicians are willing to provide for animal- and public-health programs. For example, the response to the 2001 outbreak of FMD in the United Kingdom has been questioned technically and scientifically: The slow response time to the outbreak resulting in excessive animal deaths was
widely criticized. However, many of these criticisms overlook the political situation in which national policy decisions and political will were major determinants. In the United Kingdom, in 1999, the agriculture sector provided only 1% of value added to the GDP, whereas the services sector added 74% value to the GDP (World Bank, 2001b). Furthermore, in 2000, although agriculture added £6,617 million value to the overall economy, £2,187 million (33.1%) of this amount was redistributed to livestock farmers in the form of subsidies (Department of the Environment, Food and Rural Affairs, 2002). Therefore, when the FMD outbreak occurred in 2001, the United Kingdom was at a tipping point. The extensive culling program to control FMD resulted, in the year following the outbreak, in reduced subsidy payments to livestock farmers by £264 million—an amount then available to other economic sectors with greater potential than agriculture to add value to the overall economy.

In large disease outbreaks, government officials have to decide which choice will do the least harm or have the greatest economic benefit. The opportunity costs of placing resources into disease control versus other programs become a tipping point for decision making. When the transaction costs of disease control become greater than the opportunity costs for disease control, the decision by a country to live with the disease becomes an economically viable option. Living with an animal disease is a feasible option for countries in which the livestock sector provides only a small contribution to the nation’s GDP, either because the sector is small in size or because it contributes little value added.

Existing Animal Health Status and Infrastructure

It is important to remind ourselves that all high-income countries that have recently suffered epizootics and that had the political will to implement disease-control measures have been able to eradicate the disease. This is likely to remain the case because high-income countries can usually absorb the transaction costs of disease eradication into their existing animal-health infrastructure and the economy as a whole.

The situation is different for low- and middle-income countries in which diseases may already be endemic or epi-endemic and the diseases often reside in livestock owned by poor people who are politically marginalized and live in dispersed, inaccessible, or remote areas. An issue confounding the interest in controlling diseases of trade concern is that many of these diseases, such as FMD, have limited impact on the production and productivity of small-scale farmers; a producer is adversely affected only if a cow aborts or a draft animal is infected when needed for plowing. Hence, control of diseases of trade concern is often not a high priority for small-scale farmers. Small-scale farmers are usually more concerned with access to clean water, maternal health care, and education of their children—all of which
directly affect the health and prospects of the farmers and their families. Animal diseases—brucellosis, coenuriasis, and onchocerciasis—may be much more important to small-scale farmers than diseases of trade concern. The chronic and zoonotic nature of these diseases can have large-scale impacts on the economic potential of local communities and families (Roth et al., 2003). Animal- and public-health services have to consider these priorities when attempting to develop buy-in to sustainable disease-control programs for small-scale farmers. This is in contrast to the current approach when animal diseases occur in marginalized populations that adversely affect mainstream animal production or public health, such as avian influenza in grazing ducks in Asia. Under these circumstances, interventions are usually abundant and swift from both domestic and international sources but have variable support from within the affected communities.

In extreme cases and over repeated outbreak-response cycles, the differential capability of recovering from a disease outbreak results in the livestock industry being restructured such that large-scale enterprises are favored and many small-scale producers end up with less resources for disease control than they had before the outbreak. In other words, disease outbreaks can lead to industry consolidation and segregation of disease status, as has been observed since the 2001 FMD outbreak in the United Kingdom (Ward, 2006). If disease remains in the animal populations, these factors paradoxically increase the risk of disease outbreaks because the source of disease is retained in livestock owned by poor small-scale farmers, whereas international traders maintain and expand disease-free and susceptible herds. It should not come as a surprise that under these conditions small-scale farmers develop a sense of resentment toward decision makers who prioritize disease-control programs for diseases of trade concern instead of focusing on disease-control programs that are important to the small-scale (artisan) farmers.

**CONCLUSION: IMPACTS BEYOND THE LIVESTOCK SECTOR**

Large-scale epizootics have implications that go beyond the livestock industry. For example, a widespread outbreak of FMD in North America could potentially affect the national grain industry, which, in turn, could have widespread global consequences. The United States supplies approximately 70% of the world’s feed grains and is a major supplier of feed grains to the livestock industry in Canada and the United States (livestock in Canada and the United States are finished on corn and soy diets). Thus, if North American livestock were infected with FMD, huge volumes of feed grains would become available on the global market as a result of stamping-out procedures and reduced-feed consumption among diseased and recovering animals. The excess amount of feed grains on
the global market could destabilize global soy and corn prices for many years, much to the detriment of developing countries trying to compete in global agriculture-commodity markets.

Epizootics in countries that purchase large volumes of feed grains also have large impacts on the supply and prices of global feed grains. For example, since the FMD outbreak in Taiwan in 1997, there has been a long-term reduction in the importation of soybean meal (Figure 2).

Alternative markets in which the soybean meal could be sold had to be identified, resulting in transaction costs associated with finding and supporting the new markets. These types of impacts can be minimized through preventing disease outbreaks and establishing alternative markets ahead of time by creating strategic alliances with trade partners and allied private-sector industries. By engaging the private sector, which responds more rapidly to market demands than does the public sector, it is also more likely that early indicators of the successes and failures of animal- and public-health service programs will be detected at a time when corrective actions can keep the programs on course.

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REFERENCES


