Smallholder Livestock Production and the Global Disease Risk

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Emergence of highly contagious diseases from animal populations have heightened public awareness of global linkages between livestock production and public health. We examine livestock management practices for smallholders in developing countries and their linkage to the global commons of viral disease resistance. We conclude that a pro-poor multilateral initiative is needed to reduce animal and pandemic disease risks.

Recent emergence of highly contagious diseases from animal populations, including Severe Acute Respiratory Syndrome (SARS) and Highly Pathogenic Avian Influenza (HPAI), have raised public awareness of global linkages between livestock production systems and public health. The "globalization" of HPAI, for example, reminds us that local animal husbandry can impact global health risk. Because of dramatic changes in personal mobility and the emergence of worldwide agro-food networks, human populations now share a global commons of disease resistance that is now more apparent and immediate for everyone. Today's reserve of human immunity is constantly under threat from emerging viral organisms, many of which are incubating continuously within other animal populations.

Linkages between smallholder livestock management and global disease risk are apparent in Bovine Spongiform Encephalopathy (BSE), HPAI, SARS, and other contagious diseases of animal origin. Repeated HPAI outbreaks have drawn attention to this issue, and concerns for biosafety justify a better understanding of smallholder risk and disease incidence. For example, smallholder populations have suffered disproportionately from human infection, but this is to be expected because they are so numerous and often live within close proximity to animal populations.

Higher absolute human morbidity and mortality among this population does not, however, support an inference that smallholder practices are aggravating pandemic risk. Indeed, many aspects of smallholder production systems, including animal dispersion, genetic variety, etc., actually contribute to risk reduction. A balanced perspective on this issue can promote a better understanding of the role of smallholders in local, national, and global disease risk.

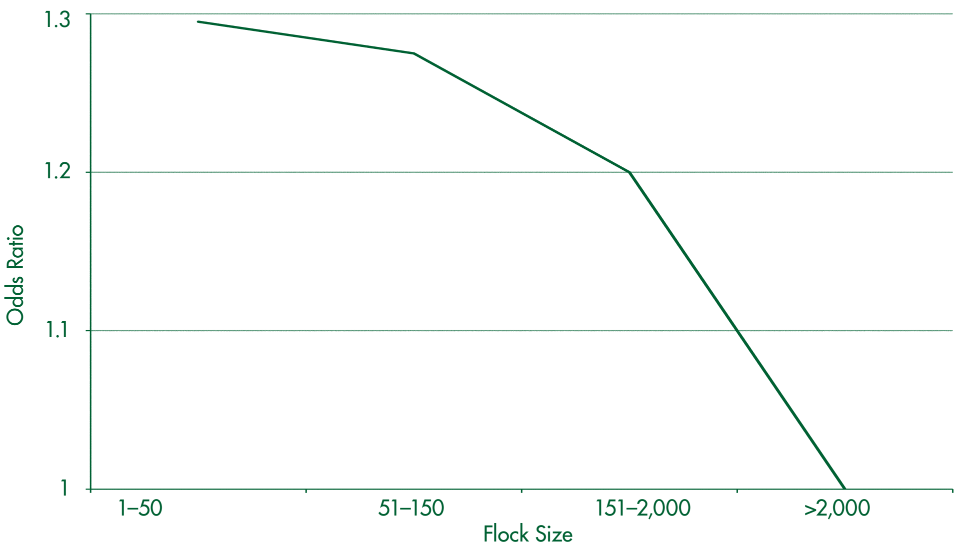
Smallholder Livestock Keeping and Biosafety

Because of their financial circumstances, smallholders are constrained from making significant investments in modern sanitary and phytosanitary (SPS) technologies for animal production and marketing. It should be recognized, however, that smallholder production presents important natural defenses to disease.

Despite their wide geographic and demographic dispersion, smallholder farmers have many fundamental attributes in common. These include significant reliance on local resources, such as plant and animal genetic material from established legacy varieties. Local varieties have three characteristics relevant to disease evolution: local adaptation, genetic divergence, and physical isolation. Specifically, legacy species have established themselves as robust against local environmental, nutritional, and biological stresses. Such hardiness can reduce vulnerability to opportunistic diseases that infect animals in less opportune conditions (such as those in large-scale production systems). Secondly, legacy varieties are genetically divergent, having evolved in enclave gene pools for long periods. This confers antiviral protection on them because they lack genetic homology with dominant commercial varieties that provide the most intensive substrate for viral incubation. Third, geographic isolation lowers risk for smallholder animals by reducing opportunities for viral transmission via interaction with outside animal communities.

Another important characteristic common to most smallholders is extensive production—animals are raised in free range and/or open air settings. This approach makes sense economically, making fuller use of marginal natural resources and ill-defined property rights, but it also confers two important animal health advantages. Firstly, animals are exposed to more diverse environmental stress and thereby become better able to mobilize immune resources against new viral agents. Second, viruses are themselves vulnerable to environmental stress. HPAI, for example, is extremely labile and becomes unstable without ambient moisture or upon exposure to sunlight. By keeping animals in more demanding conditions, smallholders reduce both the risk of original infection and also limit viral colonization and propagation.

Figure 1. Odds Ratios for HPAI Suppression in Viet Nam



Ratio of observed likelihood of poultry stock culling, by source of chicks, outside source/own source

Disease Transmission across the Food Supply

Smallholder populations may have more numerous human infection events, but this does not mean disease risk is flowing from smallholders to other producer and consumer populations. Certainly, vertical movement of infected livestock along the food supply chain will shift risk from producers toward consumers, but smallholder systems make very limited individual contributions to total supply chain risk. These producers are usually removed from consumers by market intermediaries who consolidate and process animals, multiplying opportunities for disease transmission in more stressful circumstances.

Because smallholders are vastly more numerous, they create more opportunities for individual infection which are unfortunately aggregated by downstream assembly and resale activities. Thus, investments in downstream biosafety, coupled with traceability that can isolate sources of infection, should be higher priority than blanket suppression of smallholder production. Because smallholders apparently represent lower per capita infection risk, an intensive, downstream approach to surveillance would be more cost effective than an extensive (farm by farm) approach.

Evidence on horizontal animal health risk, i.e., transfer of infection among producers, is more ambiguous. Clearly, this depends on individual producer biosafety, but also on the magnitude and direction of resource flows across producer populations.

In the livestock sector, these patterns are especially complex because of specialization at different stages of animal production and processing. Large-scale production at all stages can be highly concentrated, with small numbers of large, intensive facilities and even fewer responsible enterprises. In the poultry sector, individual large-scale egg and chick producers can sell to thousands of smallholders, and any upstream risk will multiply accordingly.

Large producers generally have more advanced biosafety capacity, but the intensity of their operations also poses higher risks for viral infection and propagation. Smaller producers seek to improve their balance sheets by acquiring stock from larger producers, but this relationship bridges biosafety regimes and is a primary threat to biocontainment. When small producers participate in such high-dispersion horizontal supply chains, they expose themselves to specific risk from their suppliers and to systemic risk from the distribution system.

To see the significance of this in practical terms, consider the results in Figure 1. This graph depicts results for Viet Nam poultry, showing the relative odds of experiencing a livestock cull for HPAI. For the ratio in question, the numerator is the observed likelihood of a cull for farms buying day-old chicks from outside suppliers, while farms in the denominator are self-sufficient.

More concerted efforts are needed to identify transmission pathways between diverse animal populations. In the case of HPAI, for example, migratory birds have been identified as a vector of global transmission, yet their effectiveness is not well documented and many experts believe this source has become a euphemism for illegal transboundary livestock trade. As yet, unexplained links between livestock varieties, including chickens, quail, ducks and pigs, may also be important to the cause of HPAI. Better evidence and more research is needed in this area.

Ultimately, patterns of disease risk transfer are an empirical question, but such imformation on HPAI remains fragmentary and inconclusive. The frequency of reported smallholder outbreaks, for example, is probably due more to their overwhelming numerical majority than to differences in biosafety. If disease risk were uniformly distributed across all production technologies, smallholders would account for well over 90% of reported outbreaks. Before resources are committed to restructuring the poultry sector, particularly in ways that increase the vulnerability of poor rural majorities, much more evidence and research is needed.

Conclusions

In an increasingly globalized food supply chain, livestock management and marketing practices everywhere influence human health risk. At the present time, smallholders are facing the prospect of significant adjustment costs because they have been implicated in adverse biosafety events like SARS and HPAI. If this approach is seen as punitive, it will undermine effective reporting and control responses, needlessly enlarging outbreaks and extending genetic incubation time.

Because of their ubiquity, smallholder livestock producers can play an essential constructive role in global disease prevention. Limiting opportunities for the emergence of pandemic pathogens is something that benefits everyone, everywhere, even if it is happening at the most microeconomic level. Smallholders need only modest but positive incentives to contribute to the global commons of disease prevention, while high-income countries will benefit most in economic terms. Recognizing these facts provides a strong collaborative basis for a pro-poor multilateral initiative to reduce animal and pandemic disease risks.

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Suggested Citation:

Behnke, D., S. Heft-Neal, J. Ifft, R. Soares Magalhaes, J. Otte, D. Pfeiffer, D. Roland-Holst, and D. Zilberman. 2011. "Smallholder Livestock Production and the Global Disease Risk." *ARE Update* 14(3): 9-11. University of California Giannini Foundation of Agricultural Economics.

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