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Smallholder Livestock Production and the Global Disease Risk

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Key Findings

- The rural poor in HPAI epicentre countries are part of the solution to reducing disease risk, not the problem.
- If this approach is seen as punitive, it will undermine effective reporting and control responses, needlessly enlarging outbreaks and extending genetic incubation time.
- Smallholders need positive incentives to contribute to the global commons of disease prevention.

Recent emergence of highly contagious diseases from animal populations, including SARS and HPAI, have heightened public awareness of global linkages between livestock production systems and public health. In the case of HPAI, for example, it has become apparent that conditions of animal husbandry and the livestock supply chain can influence health risks for large and widely dispersed human populations. 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, among themselves and in co-habitation with other animal species. Today's reserve of human immunity is constantly under threat from emerging viral organisms, incubating continuously in our own and other animal populations. HPAI offers a recent and dramatic example of how a new viral challenge can emerge from another species, first overcoming immunity reserves in poultry and then incubating there with mutagenic risks for humans and other species.

To elucidate the linkage between smallholder livestock management and the global commons of viral disease resistance, we can draw upon experiences from HPAI, SARS, BSE, and other contagious diseases of animal origin. Repeated HPAI outbreaks have drawn attention to this issue, and concerns for biosafety mandate a better understanding of smallholder risk and disease incidence. Surely smallholder populations have suffered disproportionately from human infection, but this is to be expected because they are so numerous and often cohabit with the animal reservoir. Higher absolute human morbidity and mortality does not, however, support an inference that smallholder practices are aggravating pandemic risk. Indeed, there are many aspects of these production systems that contribute to risk reduction. A balanced perspective on this issue can promote better understanding of the contributions of smallholders to managing 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 technologies for animal production and marketing. It should be recognized, however, that smallholder production has important natural defenses against 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 of relevance to disease evolution: local adaptation, and 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 compromised by ambient stresses (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 dominate commercial varieties that provide the most intensive substrate for viral incubation. Third, geographic isolation lowers risk for smallholder animals by reducing opportunities for interaction with outside animal communities.

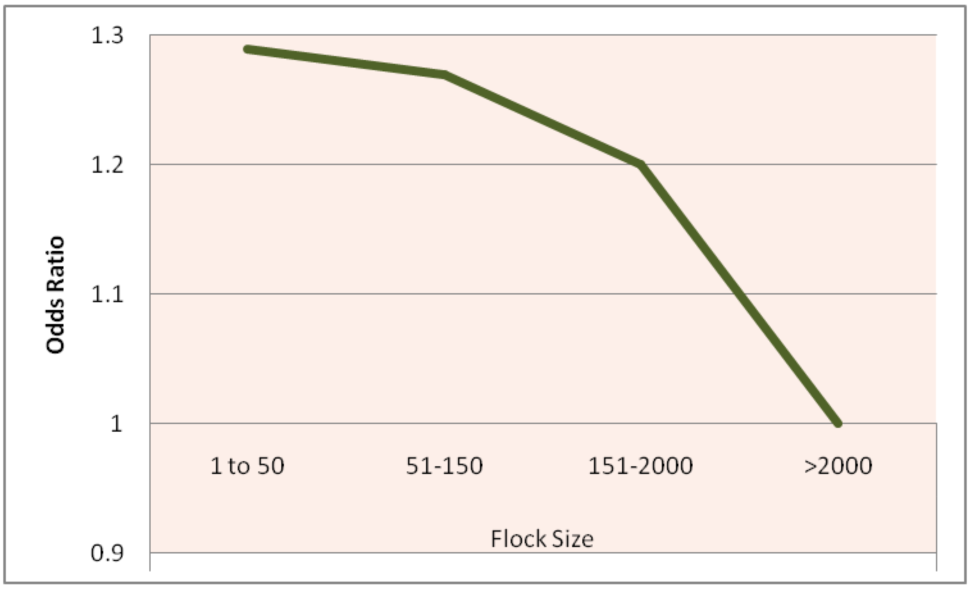
Another important characteristic common to most small holders is extensive production, where animals are raised in free range and/or open air settings. This approach is a sound economic strategy, making better use of marginal natural resources, and is also less demanding of private property and investment resources, but it also confers two important health advantages on animal populations. 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 vulnerable to environmental stress. HAPI, 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.

Disease Transmission across the Food Supply

As has already been observed, smallholder populations have been associated with higher human disease incidence. Does this 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 a producer toward consumers, but the realities of smallholder systems limit their individual contribution to total supply chain risk. These producers are usually removed from consumers by many intermediaries over whom they exert limited influence. The intermediaries consolidate and process animals, multiplying opportunities for disease transmission in more intensive environments. Because smallholders are numerous, they create more opportunities for individual infection, but these are aggregated by downstream activities. For these reasons, investments in downstream biosafety, coupled with tracing to isolate infection sources, should be a high priority. Because smallholders apparently represent lower per capita infection risk, an intensive approach to surveillance would be more cost effective than extensive (farm by farm) one.

Evidence regarding 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 is 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 risk at the former operation will multiply in the same manner. 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 can thus improve their balance sheets by acquiring stock from larger producers, but this relationship implicates biosafety regimes across production systems and is a primary threat to biocontainment. When small producers participate in such 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 chick from outside suppliers, while farms in the denominator are self-sufficient.

Figure 1: Odds Ratios for HPAI Suppression in Vietnam
(ratio of observed likelihood of poultry stock culling, by source of chicks, outside source/own source)



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. Links across farm animal varieties, including chickens, quail, ducks, and pigs, may be important to the aetiology of HPAI. Better information is needed in this area, but attention and resources should not be diverted from more immediate risks extending across the poultry industry.

Ultimately, the direction of disease risk transfer is an empirical question, but the basis of such evidence regarding HPAI remains weak. The frequency of reported outbreaks in smallholder setting 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 percent of reported outbreaks. Before resources are committed to restructure the poultry sector, much more needs to be known about original smallholder contributions to risk and risk reduction.

Conclusions

Livestock management and marketing practices everywhere influence human health risk through their impact on animal health in an increasingly globalized food supply chain. At the present time, smallholders are facing the prospect of significant adjustment costs because they have been implicated in adverse biosafety events. 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 and numbers, smallholder livestock producers have an essential constructive role to play 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 positive incentives to contribute to the global commons of disease prevention. On the other hand, high income countries benefit most from this in economic terms. Recognizing these facts provides a strong collaborative basis for pro-poor multilateral initiative to reduce animal and pandemic disease risks.