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Safe and sustainable livestock production

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1. The Big Picture

About one third of the global protein consumption by humans comes from animals raised for food. Globally, the demand for animal-derived protein is expected to double by 2050, driven by increasing wealth leading to higher meat consumption. This growing demand will be largely met by sustainable intensification of livestock production as arable land is limited. Intensified livestock production is accompanied by a shift in the human population from rural to urban settings, with a corresponding increase in farm size and density of animal housing. In these systems, both microbial and chemical contaminants can pose food safety risks. Less human contact with livestock with urbanization increases susceptibility to foodborne infections, and the risk of inadvertent consumption of contaminants. The shift from extensive to intensive livestock systems will require significant changes in management and market practices and a "One Health" consideration of humans, animals and the environment to ensure food safety from the farm through to the consumer.

2. Key Considerations

2.1 Policy that promotes sustainable intensification of livestock production systems

Food safety within intensified livestock production systems must be integrated and aligned with government policies on nutrition, food security, poverty alleviation, environmental health and infrastructure development. Without alignment, intensification of livestock production can have negative consequences, including promoting disease transmission among animals and from animals to humans. Accumulation of nitrogen, phosphorus, metals and microbes at the site of livestock production can pollute surface and ground water and threaten soil health. If unchecked, livestock intensification can have serious impacts on biodiversity through overgrazing, deforestation and the conversion of grasslands to cropland, enabling transport of feed to denser livestock populations. It is imperative that food safety policy be developed from a "systems perspective" as safe practices introduced upstream in the production process can have unintended negative downstream consequences. For example, pesticides can improve the health of livestock by reducing pests, but their improper use can lead to the contamination of meat, milk and the environment. Lack of enforcement of public and environmental health policies can exacerbate the negative impacts of livestock intensification.

2.2 Ensuring adequate biosecurity measures

Many of the threats to food safety by intensification arise from housing livestock at higher densities. Greater animal-to-animal contact can promote disease transmission. In intensive ruminant systems, animals from a wide geographical area are congregated at a single location in feedlots or barns. Pathogens from across this geographical area can enter the production system and be transmitted among individuals, potentially becoming endemic. Intensively-produced swine and poultry are confined within barns, which rely on biosecurity and hygienic practices to prevent pathogens from entering the production chain. Biocides and hygienic practices are used to reduce the abundance and prevalence of pathogens, but care must be taken to ensure that biocides do not contaminate meat, milk or the environment. Biocides can also select for bacteria that are resistant to antibiotics. Biosecurity can fail and food safety threats such as avian flu can infect poultry in intensive production systems. In these incidences, regulatory agencies need the authority to contain and control disease, while preventing affected products from entering the food system.

2.3 Immunity and stress management in animals

Livestock populations with no prior exposure to pathogens or that are stressed from transport and dietary changes are more susceptible to disease. Consequently, intensive production systems often rely on antibiotics to prevent and treat infections. The use of antibiotics promotes resistance, which can make infections more difficult to treat in both animal and humans. Vaccines reduce antibiotic use and thereby resistance. However, vaccines do not work if the animal is already sick or has a compromised immune system. Meeting nutritional needs and reducing stress can enhance immunity and reduce disease. It is important that stress is minimized during transport and that the nutritional and water needs of the animal are met upon arrival, as disease is highest early in the feeding period. Regulations that enforce proper transport, handling and husbandry of livestock can reduce disease and food safety risks.

2.4 Waste management strategies

Increased livestock density can result in the accumulation of nutrients and pathogens at the production site. If improperly managed, manure can contaminate water and soil. In fact, the use of irrigation water contaminated by livestock waste has become a common cause of foodborne disease. Proper management of livestock waste is also imperative to ensure that microbial and chemical contaminants do not enter surrounding food production systems. Composting manure can reduce antibiotic and chemical residues and kill most pathogens. Nutrient capture is maximized if land application of manure matches crop requirements.

2.5 Developing appropriate feeding strategies and additives

Precision feeding ensures that the nutrient requirements of livestock are aligned with the feed provided, reducing the release of chemicals and pathogens into the environment. Balanced nutrition improves immune function and production efficiency. Byproducts and wastes from food streams for humans can be valuable feed, but care must be taken to ensure they do not contain toxins. Some feeds contain bioactive compounds like essential oils or tannins that can improve feed efficiency and reduce pathogens in the animal and manure.

2.6 Harmonized and flexible regulatory and food safety systems

Intensification impacts not only the farm site, but also downstream activities in the production chain. Large numbers of livestock from a vast geographical area are processed at a single location, increasing the risk of pathogens entering meat. Implementation of hazard analysis and critical control point (HACCP) systems that assess and mitigate food safety risks during slaughter and meat processing are essential. Compared to extensive systems, microbial

contamination in intensive systems is far reaching, as product from a single processor can be distributed nationally or internationally.

Regulatory oversight throughout the livestock and the meat production continuum is an integral component of food safety. These systems must be harmonized so that food safety practices are similar across countries, but sufficiently flexible to be regionally relevant to specific livestock production practices. Food safety regulations that support public health should be based on science and not on market forces or international trade.

2.7 Informing and educating consumers

Educating consumers on food safety practices is critical as 30-40% of food-borne illnesses originate in the household. Investment in food safety measures upstream are virtually worthless if proper food safety is not practiced at home. Awareness of the health benefits (e.g., rich source of micronutrients and protein) and risks of meat and milk products (e.g., allergens) is equally important. Consumers should be aware of the impact of different productions systems on the environmental footprint of livestock products. It is important that food safety information is science-based and not just sales promotion. Social media is also effective for delivering and assessing the impact of food safety education as well as awareness of environmental impact of different types of production systems.

2.8 Livelihoods and equity

Policies for livestock development need to be consistent with policies for economic development (see 2.1). Labor-intensive – smallholder livestock production systems often generate low returns and lack land and capital. Capital-intensive systems use mechanization to reduce labor and generate higher returns. Foreign investment and rural to urban migration is driving the transition from labor-intensive to capital-intensive systems. Blanket application of food safety regulations can generate inequities in production costs for smallholders. Foreign investment can also result in uneven wealth distribution. Strategies are needed to enhance the access of smallholders to food safety technologies so that these systems can compete.

2.9 Promoting research in priority areas

Food safety research in livestock production needs to be from a “One Health” perspective, considering the entire farm to food supply chain. Alternatives to antibiotics such as vaccines, prebiotics, probiotics, bacteriophage and new management practices need to be developed. Systematic research is needed on manure handling practices that reduce environmental impact. Rapid and sensitive methods to detect pathogens and chemicals in meat and milk are required to prevent adulterated meat from entering the food system. Methods that improve source attribution and prevent meat fraud and assess the safety of alternative protein sources such as insects and lab-grown meat are needed. Under regulatory oversight, technologies such as gene editing may play an important role in ensuring food safety within the intensified livestock production systems that will satisfy the future demand for meat and milk.

3. Conclusions

Humanity needs to accept that sustainable intensification of livestock production is a prerequisite to satisfy the future demand for meat and milk. Regionally-specific systems will need to consider the sustainable development goals of policy-makers and government. Food safety practices will need to be dynamic and aligned with changing livestock production practices as result of climate change and market forces. Regulatory oversight and food safety standards need to be harmonized in a regionally-appropriate manner. Food safety measures should be implemented from a holistic perspective, considering animal welfare, human nutrition, environmental health, social benefits and wealth distribution. Trade-offs will be inevitable and it

is important that consumers are educated on those food safety measures and health benefits that are most appropriate to their societal and cultural practices.

Key words: foodborne disease, toxins, intensification, sustainable, livestock.