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The Impact of Industrial Farm Animal Production on Food Security in the Developing World

An HSI Report:
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Abstract

Food security is often incorrectly used as a justification for the inhumane confinement of animals on industrial farm animal production facilities, while in reality, the industrialization of animal agriculture jeopardizes food security by degrading the environment, threatening human health, and diminishing income-earning opportunities in rural areas. Support from governments and international agencies for more humane and sustainable agricultural systems can ensure adequate food consumption and nutrition throughout the developing world.

Intensification of Farm Animal Production

Evaluating the impacts of industrialized animal agriculture on food security requires an understanding of the global trends towards industrialization. By 2050, meat and milk production is expected to approximately double from 1999–2001 levels.[1] Most of that growth in production is taking place in developing countries, [2] which are projected to account for about 78% of the increased meat production between 2011 and 2020.[3] Much of that growth will also be in the form of industrial farm animal production (IFAP). By the end of the 20th century, IFAP was increasing worldwide six times as fast as grazing systems and twice as fast as traditional mixed farming systems.[4] Worldwide, industrial systems now account for approximately two-thirds of egg and poultry meat production and over half of pig meat production.[5] Based on calculations by the Food and Agriculture Organization (FAO) of the United Nations, developing countries produced approximately half of the world's industrial pork and poultry.[6]

These industrial facilities concentrate tens of thousands (or often even hundreds of thousands[7,8,9]) of farmed animals along with their waste, frequently in welfare-depriving cages, crates, and pens[10] (see Appendix 1 for a more detailed definition of IFAP). A growing number of egg-laying hens, pregnant sows, and other farm animals are reared in small, barren, crowded cages and crates that severely impair the animals' welfare, as they are unable to exercise, fully extend their limbs, or engage in many important natural behaviors. Industrial farm animal production results in tremendous animal suffering. For more information on IFAP's impacts on farm animals, please see HSI's Report on the Welfare of Intensively Confined Animals.

At the same time, there is increasing consolidation of farm animal production in developing countries.[11,12] These changes are readily apparent in Latin America and Asia. For example, approximately 40% of Brazil's market for broiler chickens is supplied by just four integrators.[13] In 2006, an industry estimate suggested that six large poultry companies account for nearly 40% of India's egg industry.[14] In Brazil's dairy industry, the number of milk producers fell by approximately 23% between 2000 and 2002, while maintaining the same volume of milk production.[15] Globally, between 1980 and 2000, pork production nearly doubled, with a decrease in the total number of farms and an increase in larger facilities raising 1000 or more pigs.[16] Such consolidation has been

shown to decrease income opportunities in rural areas by pushing small farmers out of the market,[17] reducing on-farm employment opportunities,[18,19] and damaging the natural resources[20] upon which rural communities rely. For example, in the Philippines, growth in demand for pig products has not translated into growth in market share for small holders.[21] Although the number of commercial pig farms and pigs per farm increased between 1991 and 2002 in the Philippines, the number of pig producers (full-time and part-time) decreased.[22]

Not only is farm animal production becoming consolidated in developing countries, the facilities themselves are becoming more geographically clustered.[23] In Brazil, these high levels of geographical concentration can be seen in the pork and poultry industries. For example, in 1992, 78% of Brazil's hen population occupied just 5% of the country's area. By 2001, the proportion of hens housed on this same land area had grown to 85%.[24] The percentage of Brazil's pig population confined on just 5% of the nation's land area rose from 45% to 56% during the same time period.[25] The geographical concentration of farm animal production can cause environmental and public health threats,[26] which in turn may reduce worker productivity[27] and harm agricultural resources[28] which are crucial to food security.

The trend towards industrialization also diminishes farm animal genetic diversity by excessively favoring a few breeds of farm animals with traits of commercial interest[29] and putting traditional breeds at risk for extinction.[30] The proliferation of these monocultures threatens food security. Poor households rely on farm animals for a variety of purposes, from forms of insurance and savings, to sources of energy and fertilizer, but these commerical breeds cannot always fulfill this multi-purpose role required by semi-commercial and subsistence farmers.[31] Further, (as discussed below), relying exclusively on these monocultures in IFAP threatens communities worldwide by creating the conditions ripe for the emergence of new zoonotic disease strains.

Stemming the spread of IFAP in the developing world is critical to maintaining more environmentally sustainable, healthy, animal-welfare-friendly, and equitable food production systems. Though food security is often used as a justification for the industrialization of animal agriculture, IFAP systems in fact jeopardize food security by degrading the environment, threatening human health, and pushing small farmers out of the market.

Defining Food Security: Going Beyond Measures of Production

In their recent efforts to develop a Global Strategic Framework on Food and Nutrition Security, the United Nations Committee on World Food Security uses the follow definition,: "[f]ood security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."[32] The committee further holds that proper health care, child care, and sanitation are required to translate food security into nutrition security.[33]

Similar comprehensive food security definitions and frameworks have been embraced by a number of development institutions. The Sustainable Livelihoods Approach (SLA) framework, employed by the United Kingdom's Department for International Development (DFID),[34] provides further guidance for evaluating food security by identifying five different types of capital (human, natural, financial, social, and physical) that influence a household's strategies for acquiring food and other livelihood outcomes, and places them within the context of household vulnerabilities and community and national-level policies and institutions.[35] The complexity of this framework highlights the fact that food security requires more than just adequate food production. Achieving food security requires equitable social and economic systems, healthy communities, and ecological sustainability.

The Global Environmental Change and Food Systems project, launched in 2001 to examine the links between food security and global environmental change, builds upon this by incorporating environmental factors such as water availability and quality, climate, biodiversity, and land cover and soils into the list of variables impacting food security.[36]

These comprehensive food security definitions and frameworks illustrate the importance of multi-variable approaches to ensuring food security. Consequently, programs and policies which seek only to increase the quantity of food and reduce food prices in the immediate term by industrializing agriculture, often at the expense of these other drivers of food security, may not in themselves reduce hunger or malnutrition. Sufficient caloric availability at the national or global level, while a critical component of food security, neither ensures equitable distribution of those calories, nor does it ensure that those calories are nutritionally appropriate.[37] In fact it is common for nations with adequate grain reserves, whether produced domestically or imported, to have significant portions of their population suffering from food insecurity or undernutrition.[38]

In Africa, since 1990, the quantity of staple foods produced within and imported into the continent is theoretically sufficient to provide each person with 2,500 Kcal/day, yet hunger remains widespread on the continent, suggesting that food distribution, rather than availability, is key.[39] For example, the Southwest region of Uganda has had the highest prevalence of stunting (a key indicator of malnutrition in children) in the past decade, despite being considered the "food basket" of the country.[40] In much of Latin America, the incidence of malnutrition is higher in indigenous children relative to the national average.[41,42] The growth in Latin America's farm animal sector in the 1990s[43] had not been accompanied by significantly improved nutritional or economic outcomes for these households by the early part of the 21st century.[44] A 2005 study on poverty amongst indigenous peoples in Latin America concluded that "[p]overty rates changed little for indigenous people over the 1990s, and where poverty declined, progress was slower for indigenous peoples."[45] Further, the prevalence of malnutrition amongst indigenous children remains extremely high relative to the general population.[46]

South Asia is home to the largest number of malnourished people in the world, despite India and other nations in the region maintaining surplus food stocks.[47] The increase in egg and poultry meat production in India, specifically, has failed to equitably increase the intake of animal source foods (ASF) by the poorest communities. Rapid industrialization of India's poultry sector has put it among the top egg and chicken meat producers in the world.[48,49] Over the past 50 years, egg and chicken meat production has been radically transformed from a largely backyard activity to a massive agro-industry.[50] By the 1990s, production and consumption of poultry meat in India was growing by as much as 15% annually.[51] However, by the start of the 21st century, people in lowest income quintile in rural areas were still consuming fewer than 10 eggs per capita per year.[52] This is notable because the prevalence of underweight children amongst the Indian population is higher in rural areas than in urban areas, and the prevalence of underweight children is approximately 60% in the lowest wealth quintile.[53] Moreover, during the 1990s, while commercial poultry production continued to expand in India[54], the urban-rural and inter-income-quintile inequalities in nutritional status widened throughout India.[55] Thus, the massive growth of the Indian poultry sector has failed to sufficiently improve nutritional outcomes for the rural poor, instead threatening the natural resources and production systems upon which rural communities are built.

There are many reasons for the disparity in egg and meat consumption in India and other developing countries, and for the failure of IFAP to significantly increase ASF intake amongst the poorest segments of the population, particularly in rural areas. While urban residents purchase almost all their food from the market, rural dwellers, who account for 70% of the world's poor in agriculture-based countries,[56] acquire 60% of their food from their own production.[57] As discussed in the following sections, IFAP often impoverishes small farmers and rural communities, diminishing their ability to produce and otherwise acquire nutritious foods.

It follows that an overall increase in the production of calories from ASF is not necessarily an effective strategy for improving food security, or even the intake of ASF among malnourished populations, and may instead be contributing to the growing epidemic of diseases relating to overweight/obesity in many developing countries,[58,59] particularly in urban areas.[60]

Despite the complex nature of food security, some industry groups continue to frame food security solely in terms of production quantity.[61,62] For example, an industry-authored article titled "U.S. Soybean Farmers

Feeding the World" calls for research and technology to help U.S. farmers increase soy production in order to fulfill their duty of feeding the growing global population;[63] this despite the fact that a large proportion of soymeal produced in the U.S. and worldwide is diverted to feed farm animals,[64,65,66] and animal products are disproportionately consumed by wealthier populations worldwide.[67] Framing food security solely in terms of production, justifies further intensification and industrialization in the farm animal sector. This, in turn, leads to numerous environmental, animal welfare, and social problems, which impede equitable access to food and undermine efforts to improve food security. Simply put, the spread of industrialized animal production in the developing world has the exact opposite of its purported effect—it harms food security rather than improving it.

Small Farmers Lose, Employment Opportunities Deteriorate

Although industrialized animal agriculture may increase production for large farmers, it simultaneously crowds small farmers out of the market[68] and reduces employment opportunities,[69,70] demonstrating that economic growth at a national level does not necessarily improve food security.[71]

Small farmers who try to directly compete with large animal agribusiness are at risk of being pushed out of the market because they lack the political and economic power of the larger companies, or the ability to exploit economies of scale.[72] For example, rural women in many developing countries tend to engage in smallholder egg and poultry meat production,[73] but increased levels of intensification in egg and chicken meat production have been shown to decrease the number of women involved in poultry keeping.[74]

The industrialization of animal agriculture in Mexico, partly driven by competition with U.S. imports and the North American Free Trade Agreement's facilitation of joint ventures between U.S. and Mexican companies, has forced small farmers out of the market.[75] The industrialization of animal agriculture has also damaged Amazonian society. Soy production (to feed farm animals) and cattle ranching are substituting native forests, displacing smallholder farmers' diversified farming systems, and harming the indigenous communities that rely on the forest.[76]

The few small or mid-size farmers who continue to farm will likely do so by adopting industrial farm animal production practices, and by becoming contract farmers to large corporations—dependent on distant markets and a remote corporate governance body for their income.[77] This shift comes with its own set of risks. Sociologists who have studied the contract systems in the U.S. suggest that the unequal bargaining power with agribusiness firms results in the individual producer bearing a greater share of risks and costs than the firm.[78,79] The corporations supply company-owned animals, feed, and transportation, but the growers, who likely own the land, must construct company buildings according to the corporations' own specifications, in which they might invest hundreds of thousands of dollars.[80,81] Growers are also typically responsible for managing the animals' waste, so the controlling companies may have no financial obligation to control or rectify pollution from these facilities.[82,83]

Farmers in the Indian states of Punjab, Assam, and Kashmir have spoken out against the contract system of poultry production. In a May 2007 article, the president of the Amritsar Poultry Industry Association was quoted as saying, "These mega companies [are] neither generating new employment nor putting any investment in Punjab."[84] Another article in Greater Kashmir that same week reported that the Kashmir Valley Poultry Farmers Association had characterized the contract system as "anti-farmer."[85] Contract farming in India lacks government oversight or regulation, and some producers report that the contracts are heavily biased in favor of the purchasing company.[86] With no formal mechanism for solving disputes, company decisions are final. Producers have no recourse if the company does not fulfill its contractual obligations but face significant consequences if they violate the contract themselves. Producers lack control over the quality of the inputs from the company, but must bear the reduced income associated with low output.[87]

Growers are also at the mercy of large agribusinesses' decisions to unilaterally end the contracts. In India, complaints are emerging about inequities in the contract system.[88] This is also the case in the U.S. After borrowing loans in excess of $12,000 to make improvements to their chicken sheds and receiving numerous letters of commendation from Perdue (a chicken integrator) for two years, one family's contract was suddenly terminated, with company officials reportedly blaming a slow economy.[89] Writes environmental journalist Karen Charman, "[t]hey say the corporations that control the chicken industry hook new growers on the promise of making a good, steady income at home. Instead, growers find themselves trapped in debt-laden relationships that turn them into serfs at the mercy of the companies that make a fortune on their backs."[90]

The potential decreases in small-farmer autonomy or market share resulting from IFAP are accompanied by reduced wage earning opportunities for laborers. When animal agriculture becomes industrialized, it can decrease on-farm employment opportunities within rural communities.[91,92] A University of Missouri study suggested that the best way to promote employment in the pig meat production sector is to support small farmers using pasture-based production systems. The study showed that ten small-scale farmers collectively producing 12,000 feeder pigs per year can create eight full-time positions, while a single industrial farm animal facility producing the same number of pigs only employs 2.5 people.[93] In Mexico, the industrialization of the farm animal sector has meant fewer agricultural workers are needed and salaries are typically lower than average.[94] A 2004 report on the economic impacts of industrialized pig production estimated that if industrialized pig production facilities replaced independent farms producing the same amount of animals, approximately two pig farmers would be left without a job for each new job created.[95]

IFAPs negative impacts on local farmers and job markets are further coupled with a depletion of local capital. [96] The authors of a 2007 book entitled Environmental Management of Concentrated Animal Feeding Operations (CAFOs) sum up the strain that IFAP imposes on U.S. communities:

> Corporate livestock factory owners and management tout themselves as "saviors" to the rural communities they target. Everyone is promised salvation: job creation for local inhabitants, increased tax revenues for local coffers, expanded markets for family farmers, and increased purchasing power for hometown businesses, with high-tech production for consumers…However, the facts of the industry paint a different picture. Corporate livestock factories actually disable community development with self-serving contracts and tax breaks, market-monopolizing strategy, and few local purchases…While communities naturally want to attract jobs, wealth, and capital for investment, transferring…[farm animal] production from local families to corporations facilitates and accelerates the extraction of wealth and capital from rural areas.[97]

Industrial animal operations not only threaten the livelihoods of small farmers, and decrease on-farm employment opportunities, but they actually harm the entire community by leaching out local economic resources. In addition, IFAP exploits the natural resource base of a community, harming the environment and threatening public health. A more sustainable system of animal agriculture involves fewer numbers of animals raised under ecologically balanced extensive systems, and is led by small farmers who generate both local employment and food availability within rural communities.

Scarce Resources Exploited, Environment and Human Health Degraded

Meat, egg, and milk production are not narrowly focused on the rearing and slaughtering of farm animals. The animal agriculture sector also encompasses feed grain production, which requires substantial inputs of water,[98] land,[99]and energy.[100] The growth in farm animal production is projected to increase strain on water resources, particularly due to the high water demands involved in growing animal feed.[101] Globally, land is also becoming

a scarce resource,[102] and animal agriculture already constitutes the largest anthropogenic use of land worldwide.[103] As in the case of water, a significant percentage of this land is diverted to produce feed for farm animals.[104] In developing countries, the use of feed concentrates grew over 150% from 1980-2005,[105] most likely due, in part, to a rise in IFAP. This suggests that the industrialization of feed crop production is linked to IFAP, which is reliant on a steady source of cheap feedstuffs.[106] Currently, food prices are artificially low—reliant on the unsustainable externalization of environmental and health costs.[107] However, growing water, land, and energy scarcities are projected to limit future growth in food production.[108,109] This will likely increase food costs in the longer term.[110] Increased food production and low meat, egg, and milk prices (the only arguments for the industrialization of animal agriculture) are themselves jeopardized by the expansion of IFAP in the long term due to its negative impacts on scarce agricultural resources.

Land use and degradation

Animal agriculture occupies 30% of the earth's total land area.[111] Approximately 33% of total arable land is used to produce feed crops,[112] in addition to vast areas of forested land that is clear-cut to graze or grow feed for farmed animals.[113] Globally, more than 60% of corn and barley, and over 97% of soymeal, are fed to farm animals.[114]

Land degradation exacerbates the problems of scarcity, and farm animal production is a leading driver of land degradation.[115] Much of the human-induced soil degradation in Africa has resulted from overgrazing.[116] Overgrazing has contributed to the degradation of approximately 20% of the world's pastures and rangelands, including almost three-fourths of rangelands in dry areas, through compaction and erosion.[117] As it expands to new areas, feedcrop production also plays a significant role in land degradation.[118]

Animal agriculture is a leading player in deforestation, a well-known form of land degradation. A marker of just how significant the sector is for deforestation, 70% of previously forested land in the Amazon is used as grazing pastures, and the remainder is used largely for feedcrop production.[119] Mato Grosso, the state that has led Brazil in both deforestation and soybean production since 2001,[120] lost approximately 36,000 km^2 of forest to intensive mechanized agriculture between 2001 and 2004.[121,122] The animal feed from this deforested land is destined for nations across the world. For example, China has increased its import of soy from Brazil, in response to increasing demand for meat products within China.[123] Brazil exported approximately 9.2 million tons to China between January and May 2011, accounting for approximately 68 percent of Brazil's sales in soy during that time period.[124]

Deforestation and other forms of land degradation have a profound impact on our ability to sustain vital agricultural resources and produce food. The pollution of aquifers, deforestation-related climate change, and the depletion of water resources resulting from the soil's reduced ability to hold water (due to alteration of soil texture or loss of vegetative cover), are all potential impacts of land degradation.[125] In terms of hunger and food security, it is notable that in West Africa, mortality for children under five years of age is greatest in areas of high soil degradation.[126]

Water scarcity and pollution

In addition to its role in land use and degradation, animal agriculture uses significant amounts of the water supply available to humans globally.[127] Raising animals for food requires substantially greater quantities of water than raising plants for human consumption. According to the International Water Management Institute and the Stockholm International Water Institute, an average of 6000 liters of water is required to produce 1 kg (2.2 lb) of chicken, whereas less than half of that is needed to produce 1 kg (2.2 lb) of cereals.[128]

Raising animals for food contributes to water scarcity in numerous ways. Farm animals require water for hydration. But an increasing amount is needed—particularly at industrial operations—to clean enclosures (e.g. cages, stalls, pens) and sheds, to dispose of waste, and for cooling animals.[129] Processing animal products also requires large volumes of water and can result in significant amounts of wastewater.[130] Water levels in the Perote-Zalayeta aquifer in Mexico have reportedly declined precipitously since industrial pig production first took hold in the region in the mid-1990s.[131] Rapidly increasing demands for meat and other animal products in Africa's urban centers has also been implicated in water and land scarcity,[132] further jeopardizing food security in the region.

Not only are water supplies shrinking, the farm animal sector is increasingly polluting the available water. According to the FAO, "The livestock sector…is probably the largest sectoral source of water pollution, contributing to eutrophication, 'dead' zones in coastal areas, degradation of coral reefs, human health problems, emergence of antibiotic resistance and many others."[133]

IFAP, in particular, is a key culprit in the degradation of water supplies. Traditional farming systems combine animal agriculture with crop agriculture, thereby balancing the number of animals with the crops' ability to absorb the animals' manure. At IFAP facilities, where tens of thousands of animals are confined indoors, the amount of manure typically exceeds the ability of the surrounding land to absorb it. When this happens, it can contaminate water supplies and emit harmful gases into the atmosphere.[134]

Farm animals confined on IFAP facilities in the United States produce three times more waste (manure) than humans, and regulations relating to the treatment of farm animal manure are lax relative to the regulations mandating the treatment of human waste.[135] According to the United States Department of Agriculture's (USDA's) Economic Research Service, IFAP operations spread 1.23 million tons of nitrogen on fields (in the form of manure) in the United States in 2007; however, cropland and pasture owned by these operations only had the capacity to assimilate 38% of this nitrogen.[136] Nitrogen deposition, largely from agriculture, is expected to increase significantly in the coming years, with the resulting nitrogen oxide and ammonia leading to eutrophication and soil acidification.[137]

Phosphorous is another nutrient in manure that wreaks environmental havoc when over-applied to the land. It plays a major role in the eutrophication of lakes, [138] which in turn compromises other water uses such as drinking water and fisheries.[139]

Intensive pig production in Southeast Asia has been implicated in the flow of surplus nutrients and minerals into the South China Sea.[140] A study conducted in a pig producing region of the Philippines reported that the majority of commercial and small-scale pig producers dump waste directly into streams and other waterways.[141] The same study reported a variety of negative environmental and public health impacts resulting from the proliferation of large pig farms in the area.[142] A 2001 estimate by the World Bank suggested that approximately 100,000 square kilometers in the developing world were already "threatened by severe nutrient loading at that time, causing eutrophication of waterways and subsequent damage to aquatic ecosystems."[143]

In 2006, the prestigious Pew Commission report on Industrial Farm Animal Production warned that, in the developing world, the known costs of industrial farm animal production systems "may be exacerbated by institutional weaknesses and governance problems."[144] Additional studies are required in developing countries to elucidate the negative impacts of IFAP on air, land, and water resources in rural communities. An agricultural system that does not protect land and other natural resources cannot support long-term food security.

Community Health Compromised

A variety of air-, water-, and soil-borne outputs from IFAP operations raise serious public health concerns and undercut food security by potentially jeopardizing workers' health. Exposure to bacterial toxins is often

implicated in respiratory ailments among workers in egg and chicken production facilities, particularly caged hen facilities.[145] Ammonia, hydrogen sulfide, odor, respirable dust, and dust containing allergens, fungi, and bacterial toxins from IFAP facilities can also be transmitted by air off-site to local residents at levels sufficient to harm human health or well-being.[146] Based on their review of four large epidemiological studies, the Pew Commission concluded that children and adults living in close proximity to IFAP operations were more likely to experience asthma symptoms.[147] Other studies in the United States have also documented an association between the exposure to IFAP air-borne pollutants and respiratory and psychological effects.[148] See HSI's Fact Sheet: Human Health impacts of odors from industrial farm animal production facilities for more information.

Respiratory ailments constitute just one of a range of health problems created by these industrial facilities. Pathogens from manure used to fertilize crops may be transmitted to food crops, and runoff can also pollute water supplies. "Animal manure has been found to be the source of more than 100 zoonotic pathogens that may directly contaminate the food supply".[149]

Furthermore, non-therapeutic antibiotics used in industrial cattle, pig, and chicken operations have led to the emergence of *Salmonella* and *E. coli* strains resistant to antibiotics.[150] To accelerate weight gain and prevent disease in the stressful and unhygienic conditions characteristic of these industrial settings, many IFAP operations feed farm animals the same types of antimicrobials used to treat human disease. Antibiotic resistant bacteria at IFAP operations can transfer by air from intensively farmed animals to laborers and others who live near the operation.[151] In a study of airborne concentrations of resistant bacterial forms at IFAP operations, Gibbs et al. found that bacteria were recovered inside and outside the facilities at concentrations that could cause a potential human health hazard.[152] By fostering antimicrobial resistance in pathogens, IFAP creates new challenges for physicians trying to treat human disease.[153]

The crowded, stressful, and unsanitary conditions in IFAP facilities are also ripe for the emergence of new infectious diseases, including highly pathogenic strains of avian influenza, which can potentially impact humans.[154,155] A reduction in the genetic diversity within species raised in industrial animal agriculture systems has also been implicated in the emergence and spread of diseases.[156] Intense selection for productivity traits may create immunological problems.[157] Non-industrial systems may house greater genetic diversity amongst their flocks and herds,[158] and allow the animals a less crowded and less stressful environment, thereby reducing antibiotic use and reducing the risk of emergence of novel disease strains. For more information on the public health impacts of industrial farm animal production, please see, The Human/Animal Interface: Emergence and Resurgence of Zoonotic Infectious Diseases.

Freedom from disease, valuable in its own right, is also an important component of food security. Food usage/utilization, or the ability to translate food consumption into positive nutritional outcomes, requires clean water, sanitation, and good health,[159] all factors jeopardized by IFAP.

Climate Change Exacerbated

IFAP is also contributing to climate change, which threatens to further exacerbate food insecurity and malnutrition. According to the FAO, the animal agriculture sector is responsible for approximately 18% of human-induced greenhouse gas (GHG) emissions. In nearly every step of meat, egg, and milk production, climate-changing gases are released into the atmosphere, potentially disrupting weather, temperature, and the environment.[160] For more information on animal agriculture's significant contribution to climate change, please see HSI's Report, The Impact of Animal Agriculture on Global Warming and Climate Change.

Farm animals are significant contributors to the production of the three most important GHGs influenced by human activity,[161,162] and, as farm animals' numbers grow, their emissions are also likely to grow, even assuming "efficient" growth. Based on expected demand, farm animal production alone is projected to emit over two-thirds of the amount of GHGs considered safe by 2050.[163] A study by the United States Department of

Agriculture also explains that larger farm animal populations will mean greater emissions.[164] Therefore governments and international development agencies must reconsider their support for the growth of farm animal populations, particularly through the expansion of IFAP, from a climate change perspective.

The climate changing effect of IFAP will have profound implications for food security, and agriculture in the developing world is particularly vulnerable.[165] Drought induced by climate change will bring obvious human suffering. In less than 10 years, up to 250 million people may experience water shortages, and in some African nations food production could fall by half.[166] The IPCC also warns that warming temperatures could result in food shortages for 130 million people across Asia by 2050. For example, a 3.6°C (6.5°F) increase in mean air temperature could decrease rain-fed rice yields by 5-12% in China. In Bangladesh rice production could fall approximately 10% and wheat by one-third by 2050.[167] By 2080-2100, climate change (without adaptation) could cost India 10-40% of its crop production.[168]

At the same time, farm animals will be affected by climate change-induced rangeland drought and other weather events, which could lead to animal deaths.[169] "As grazing areas dry up in sub-Saharan Africa, pastoralists will be forced to travel farther to find food and many animals will likely starve. In particular, cattle, goats, camels, sheep, and other animals who depend on access to grazing areas for food will suffer from hunger and dehydration."[170] Thus, industrial animal agriculture, as a major contributor to climate change, will likely undermine food security, especially for those already at risk.

Animal Source Foods: A Questionable Use of Scarce Resources

Given the significant threats IFAP in particular, and growing farm animal populations in general, pose to the environment and long-term food security, it is worth evaluating the value of promoting increased consumption of animal source foods in the developing world, outside of small pockets with severe malnutrition and limited arable land.

Growing water and land scarcities, an underlying factor of the food price spikes during the years 2005–2007,[171] are exacerbated by animal agriculture. The looming scarcity of fossil fuels, of which animal agriculture is a significant consumer, has also been implicated in the global food price volatility because of the pressure it places on both the supply and demand of global grains and oilseeds.[172] Therefore, animal agriculture, as a major consumer of land, water, and energy resources (predominantly for animal feed production), needs to be evaluated for its efficiency in converting grains to protein and calories.

The conversion of energy and protein in animal feed into edible meat calories and protein is highly inefficient.[173] Most of the energy farm animals consume from grains and other sources of food is used for metabolic processes or for forming bones, cartilage, and other non-edible parts (offal), as well as feces.[174] This suggests that, in many cases, scarce agricultural land and water are better allocated to the production of high-nutrient plant-based foods.

While estimates of feed conversion vary across production systems and regions, studies conducted in the U.S. offer some insight into the inefficiency of milk, egg, and meat production. Smil calculated feed conversion efficiencies of various types of farm animal production based on USDA data from 1999.[175] According to his calculations, it takes 4.2 kg of feed to produce 1 kg of chicken meat, 10.7 kg of feed per kg of pig meat, and 31.7 kg of feed per kilogram of beef.[176] Eggs are similarly inefficient by this measure, requiring 4.2 kg of feed to produce an edible kg of eggs.[177] In a world where fish are increasingly farmed under intensive aquaculture systems,[178] it is important to note that it takes 2.3 kg of feed to produce 1 kg of edible carp meat.[179] As a result, only 30% of the protein in the feed becomes available to humans eating the fish or eggs produced with that feed.[180] Consumers of chicken, pig meat, and beef capture 25%, 13%, and 5%, respectively, of the protein contained in the feed required to raise these animals.[181] Milk is only slightly less inefficient, with a 40% protein

conversion efficiency.[182] Other studies from the U.S. report similar inefficiencies in the conversion of animal feed into meat, eggs, and milk.[183,184]

Furthermore, many of the countries where IFAP is expanding do not require an overall increase in the consumption of animal source foods (ASF) amongst all segments of their populations, as a significant proportion of their populations are already meeting or exceeding their energy requirements. Ironically, many developing countries with high levels of hunger and malnutrition now simultaneously bear the burden of an obesity-related public health crisis,[185,186] with the number of overweight women exceeding the number of underweight women in most developing countries.[187] Twenty-four percent of urban Indian adults are now overweight,[188] and approximately the same percentage of urban children in New Delhi are overweight or obese.[189] Throughout Latin America, the prevalence of overweight/obesity (Body Mass Index greater than or equal to 25) amongst adult women aged 15 and older is greater than 50%;[190] and the prevalence of overweight amongst adult men in this region is greater than 40% in all countries except Haiti.[191]

The negative health consequences of agricultural policies that reduce the short-term cost of meat can also been seen in Central America. In the 1990's, trade liberalization in Central America reduced the cost of meat production by lowering barriers for the import of cheap animal feed from the United States. In addition to possibly pushing local corn farmers out of the market, this resulted in significant increases in meat production and consumption, and contributed to a dietary shift from a largely plant based diet to one high in animal products. This shift has been implicated in the region's rising epidemic of obesity and related diseases.[192]

In his article on changing diets in China, Dr. Barry Popkin, one of the world's foremost authorities on rising obesity rates in developing countries,[193] warns, "Current agriculture development policy in many developing countries focuses on livestock promotion and does not consider the potential adverse health consequences of this strategy….[T]he potential adverse health effects linked with an increased ASF intake should no longer be ignored."[194]

This is not to discount the potential value of ASF in the diets of the poor. Certainly eggs, meat, and milk can offer a valuable source of nutrition for malnourished households, particularly for children. Further, farm animals can also provide a variety of other supports to approximately 70% of the world's rural poor, including pastoralists, mixed farmers, and landless peoples.[195] In countries that bear the double burden of under-nutrition and obesity, under-nutrition is greater in rural areas.[196,197,198] To these rural households, the value of farm animals likely extends beyond measures of quantity of meat, egg, and milk production. Around the world, the rural poor use farm animals as a means of acquiring cash income, saving and accumulating assets, as a food source, and as insurance against health or other financial crises.[199,200,201] Integrated into a larger agricultural system, animals provide inputs and services for crop production.[202,203,204] This multi-purpose view of farm animals is well adapted to low-input, free-range systems managed by the rural poor. IFAP, which is a capital intensive system dominated by resource-rich producers, cannot meet these other social needs met by small-scale farm animal production because such large-scale systems inherently exclude poor, small-scale producers and pollute the natural resource base critical to the well-being of human communities.

Global Policy & Development Finance that Undermines Food Security

Despite the failure of industrial animal agriculture to promote and sustain food security, development agencies and finance institutions, along with governments in both developed and developing countries, have played an integral role in supporting private industry's efforts to spread IFAP in the developing world.

Examples of IFAP facilities recently or currently supported by development institutions include the International Finance Corporation's (IFC) support for an industrial pig production facility in China,[205] the U.S. Agency for International Development (USAID) facilitating of the entry of the world's largest pork producer into

Romania,[206] the European Bank for Reconstruction and Development's (EBRD) financing of industrial pig production in Poland,[207] and the Inter-American Investment Corporation's (IIC) support for the expansion of IFAP in Nicaragua.[208] The beneficiary of the IFC-financed project in China is Muyuan Foodstuff Co. Ltd, one of the largest hog producers in China with an annual production capacity of around 500,000 hogs and breeders.[209] The IFC will be supporting further expansion of this IFAP facility in China,[210] a country with a growing obesity epidemic[211] and a heavy reliance on soy-based feed from deforestation-plagued Brazil to support its pig population.[212] The promotion of industrial pig production by USAID[213] and EBRD[214] in Eastern Europe supported the U.S.-based corporation Smithfield Foods, the largest pork producer in the world,[215] and has come under fire from local communities suffering from pollutants emanating from the industrial pig production facilities.[216] The IIC loan went to the company Avícola La Estrella, the second largest producer of chicken and eggs in Nicaragua.[217]

As discussed above, the environmental, human health, and livelihood threats posed by IFAP facilities undermine the very human development goals espoused by these development institutions.

A Better Model: Supporting Higher Welfare Agriculture at the Household and Commercial levels

By contrast, supporting high-welfare systems can strengthen rural communities, and will not only improve rural food security but may also stem the spread of food insecurity to urban zones, as it will slow migration away from rural areas.

Given the growing burden of overweight and obese populations in developing countries, policies aimed at increased farm animal production should be targeted towards small holders, pastoralists, and other food insecure households in rural areas, instead of supporting massive industrial farm animal production facilities. From an ecological and long-term food security perspective, assistance to this sector should be targeted towards agroecological zones where extensive, pasture-based farm animal production is the most sustainable form of agriculture.

Donor-financed Models that Promote Welfare and Food Security

There are numerous examples of international finance and development institutions, including some of those mentioned above, that promote food security in a more humane and sustainable manner.

For example, The World Bank has initiated projects to support pastoral communities in Ethiopia.[218] This project engages targeted households in community decision making, provides them with increased access to social services and credit, and improves the government's ability to prepare and protect pastoral communities in times of natural disaster.[219] Pastoral systems are typically extensive systems that provide animals with much freedom of movement.

USAID's Kazungula milk project in Zambia has expanded income opportunities for small-scale milk producers by providing the physical infrastructure and forward linkages that smallholders need to access larger markets. Developed by USAID's Zambia Agribusiness Technical Assistance Center, this initiative developed the linkages between the milk producers and the dairy processor, Finta Dairy Ltd., in addition to leveraging funding from Japan's international development agency to finance a 2,400 liter cooling tank that keeps milk fresh while awaiting pick up by Finta.[220] Such projects have tremendous potential to improve livelihoods for farmers, while maintaining extensive, environmentally sustainable production practices.

Helen Keller International (HKI) also targets smallholders in its agricultural interventions. This organization operates successful home gardening programs, which incorporate poultry keeping, aimed at female household members in rural Bangladesh.[221] In addition to providing inputs and training for improved fruit and vegetable production, and higher yielding breeds of poultry, HKI provides the project beneficiaries with nutrition education. By focusing on improving yields from small-scale homestead gardening, which is typically in the women's sphere of work, HKI empowered women, which in turn led to a greater proportion of the nutritious foods produced being consumed by children in the household (rather than sold). Women empowered by this program also invested more in their children's education. HKI reports that this program has resulted in the "establishment of 900,000 women-tended Homestead Food Production gardens, which have benefitted over 4.5 million people, at a cost of just $9.00 per garden."[222]

Such small-scale interventions lend themselves to more animal welfare-friendly methods of production that do not confine farm animals in welfare-compromising cages or crates, as they have smaller flock sizes and often raise the animals on the same land on which crops are cultivated. However, it cannot be assumed that all programs targeting small holders automatically protect animal welfare. For example, the widely replicated Bangladesh Poultry Model, aimed at women from poor households, has now begun to encourage women to rear chickens in cages, though traditionally the focus was on extensive production systems that allow the birds more freedom of movement.[223] The program's promotion of higher yielding breeds of poultry[224] can also raise welfare concerns, as improvements in yields often comes at the expense of animal welfare. For example, in the U.S., unintended genetic side effects of selection for rapid growth and increased body weight in broilers have resulted in leg disorders, including bone deformities, lameness, tibial dyschondroplasia (TD), and ruptured tendons, as well as metabolic diseases, such as ascites and sudden death syndrome.[225,226,227,] Therefore, animal welfare must be specifically considered when designing projects involving farm animals.

Further, as discussed above, given the large environmental footprint of animal agriculture, policies and programs to increase global farm animal populations may threaten food security in the long term by exacerbating climate change and over-exploiting land and water resources. However, properly targeted interventions in the animal agriculture sector can improve food security within malnourished populations while maintaining high standards of animal welfare and ecological balance.

Policy Frameworks Necessary to Promote Welfare and Food Security

Supporting smallholder, sustainable agriculture requires the cooperation of a variety of sectors, including agricultural banks and development finance institutions, which must start providing loans for producers wishing to engage in cage-free egg production and higher welfare forms of meat and milk production. Government financed agricultural research and extension services must support organic, cage-free egg, extensive, and other innovative, higher welfare production systems.

While financing from governments and the development sector should focus on smallholders, large-scale commercial animal agriculture will undoubtedly continue to be part of the food system. Therefore, environmental, public health, and animal welfare regulations are necessary to minimize the negative impacts of IFAP on animals and the environment.

There are numerous examples of successful farm animal welfare legislation throughout the world. Gestation crates for pregnant sows and barren battery cages for egg-laying hens are being phased out in the European Union.[228,229] The country of New Zealand and the Australian state of Tasmania are also phasing out gestation crates.[230] And the EU has already phased out individual housing and continual tethering of veal calves.[231,232,233]

Recent policy changes in the U.S. have indicated a clear move away from the intensive confinement of farm animals. The states of Florida,[234] Arizona,[235] Oregon, [236] Maine, [237] Colorado,[238] and Rhode Island[239] have passed laws against gestation crate confinement of pregnant sows. Arizona, [240] Maine, [241] and Colorado[242] also passed laws against confining calves in veal crates. California, Michigan, Ohio, and Rhode Island have moved to restrict the use of cages and crates to confine farm animals, including restricting battery cage confinement of egg laying hens.[243, 244,245,246]

Where policies have been initiated to protect animal welfare, producers have adapted and animal source foods continue to be produced on a commercial scale. The existence of these alternate agricultural systems around the world suggests that the development of sustainable and more animal-welfare-friendly practices is not hindered by technological barriers, but by economic and agricultural policies.[247] The FAO's 2009 report, The State of Food and Agriculture: Livestock in the Balance, encourages rectifying these problems through proper incentives and dis-incentives in the agricultural sector:

> A key policy focus should be on correcting market distortions and policy failures that encourage environmental degradation. For example, subsidies that directly or indirectly promote overgrazing, land degradation, deforestation, overuse of water or GHG emissions should be reduced or eliminated. Market-based policies, such as taxes and fees for natural resource use, should cause producers to internalize the costs of environmental damages caused by livestock production.[248]

Animal welfare should also be a focus of market-based incentives and other public policies. Large-scale producers have shown the capacity to adapt to new regulations, and forcing them to account for negative externalities will level the playing field for small farmers, lead to higher levels of animal welfare and sustainability, and improve food security.

Conclusion

In order to ensure long-term food security, particularly for vulnerable groups in the developing world, development finance and policies must favor small farmers who give proper care to their animals, act in accordance with the basic ethic of compassion towards animals under their control, and practice and promote more humane and environmentally sustainable agriculture.

By contrast, past and current support for IFAP has threatened the food security of poor households by pushing small farmers out of the market, removing jobs from rural areas, polluting the environment, exploiting scarce agricultural resources, and jeopardizing human health. Hope for the future lies in positive examples of donor support for small-farmer led and animal welfare-friendly agriculture, as well as in strong animal welfare regulations in many countries which have demonstrated that properly guided policies and supports can simultaneously benefit both humans and animals worldwide.

APPENDIX 1:

The United States Environmental Protection Agency (EPA) offers a more specific classification of these facilities, defining them as small, medium, or large Confined Animal Feeding Operations (CAFOs). According to the EPA, "Animal Feeding Operations (AFOs) are agricultural operations where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland."[249]

Facilities that confine animals for at least 45 days in a 12-month period, in a confinement area lacking grass or other vegetation during the normal growing season, are designated as AFOs.[250] In addition to meeting the definition of an AFO, CAFOs meet the criteria for a large, medium, or small CAFO. A facility is designated as a large CAFO based on the number of animals confined. A large pig CAFO, for example, confines 2,500 or more pigs weighing over 25 kg (55 pounds), or 10,000 or more pigs weighing less than 25 kg (55 pounds). A large chicken CAFO utilizing a liquid manure handling system confines 30,000 animals or more (the minimum number of chickens required for this designation increases if an alternative manure management system is employed).[251]

Medium and small CAFOs confine fewer animals, but may have been cited by the EPA as a significant contributor of pollutants; medium sized CAFOs may allow the animals or their waste to come in contact with surface water.[252] More detailed definitions of CAFOS, and size classifications for additional species, can be found on the EPA website. [253]

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