DAIRY SYSTEM MODULE READING

ELABORATE LESSON 5

From:
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1. Impacts on Worker Health

There are a number of potential biological, chemical, and physical occupational health hazards associated with dairy production. Dairy farm workers, farm residents, veterinarians, and abattoir workers are at increased risk for zoonotic diseases. For example, leptospirosis is an important occupational zoonosis and farm workers are at high risk for exposure to *Leptospira*. Other commonly reported bovine zoonotic pathogens include *Salmonella*, Shiga toxin-producing *Escherichia coli*, *Campylobacter* spp, *Cryptosporidium, Mycobacterium bovis, Listeria, Coxiella burnetii, Trichophyton verrucosum, Yersinia*, and *Giardia.*

A number of studies, including several large cohort studies, have shown a decreased prevalence of asthma, atopy, and atopic disorders in children raised on farms. The so-called "farm effect" has been extensively documented, but it is not clear how exposure to a farm environment during childhood might modify the risk for asthma, atopy, and atopic disorders. Neither the specific protective factors of farm exposures, nor the underlying immunological mechanisms have been conclusively determined.

Agricultural chemicals (e.g., pesticides), gases (e.g., hydrogen sulfide, nitrogen oxides, and ammonia) and volatile organic compounds (VOCs) can pose a health risk to farm workers. Pesticides are commonly used in agricultural production systems and many have been associated with a number of different adverse human health impacts. Exposure to pesticides can occur cutaneously, through ingestion, or through inhalation. There is strong evidence that pesticide exposure contributes to both acute and chronic health effects, including dermatological, gastrointestinal, neurological, carcinogenic, respiratory, reproductive, and endocrine effects.

Certain gases and emitted on dairy farms can cause respiratory symptoms in humans. On dairy farms, gases can be released from animals, animal wastes, fodder, and bedding materials (e.g., sawdust).

Agriculture is one of the most hazardous work sectors globally and dairy farming has been associated with significantly increased risk of injury in a number of different countries. The International Labour Organization estimates that approximately 170,000 of the 355,000 workplace fatalities that occur worldwide each year involve agricultural workers. Dairy farm worker injuries and fatalities are often associated with heavy machinery and vehicle operation, livestock handling, and manure management systems. Slips, trips, and falls are also a common mechanism of injury on dairy farms.

2. Air Pollution

The global dairy sector emits a number of different air pollutants, including particulate matter, nitrogen oxides, VOCs, ammonia, methane, and carbon dioxide. Generally, important sources of air pollutants on dairy farms include emissions from animals, cropping systems, fossil energy use, feed management, waste, and air pollutants can contribute both to environmental damage and human health outcomes, either directly or indirectly. Air pollution is now the environmental health hazard with the largest health burden through its contribution to cardiovascular and respiratory disease morbidity and mortality. Outdoor air pollution has also been linked to the development of various forms of cancer, including cancers of the lung, urinary tract, and bladder.

Agricultural emissions play a critical role in the formation of particulate matter smaller than 2.5 µm ($PM_{2.5}$) in certain regions of the world, including the United States, Europe, Russia, and East Asia. Livestock production has specifically been estimated to account for approximately 8% of total PM_{10} emissions and 4% of total primary $PM_{2.5}$ emissions, but the contribution of livestock production to secondary $PM_{2.5}$ emissions remains unclear. While the emission of primary particulate matter from dairy farms is typically much lower than from poultry or pig operations, the emission of secondary $PM_{2.5}$ in the presence of ammonia is a major concern. Smaller particles (e.g., $PM_{2.5}$) have a longer atmospheric lifetime than larger particles, which tend to settle more quickly. Therefore, smaller particles can contribute to air pollution on a regional scale, while larger particles tend to contribute to air pollution on a local scale.

<u>3. Water Use & Pollution</u>

Numerous aspects of the hydrological cycle are regulated by the natural functions of ecosystems. Freshwater is essential for human health and agricultural development, including dairy farming, and can influence or interfere with the hydrological cycle in a variety of ways. Irrigated agriculture and livestock production require increasing volumes of water. For example, dairy production requires substantial quantities of freshwater, both for drinking and for servicing. Lactating cows require considerably more drinking water each day than goats, sheep, camel, chickens, or swine. Additionally, only industrial swine production requires more water per animal per day for servicing than industrial dairy production.

Dairy cattle, and other livestock, have a major impact on water use and availability, water quality, hydrology, and the health of aquatic ecosystems. For example, in the United States, livestock accounts for approximately 55% of soil erosion, 32% of nitrate loading to freshwaters, and 33% of phosphate loading to freshwaters. Globally, the livestock sector accounts for almost 10% of anthropogenic water use, primarily for the irrigation of feed crops. Livestock production may also be the single largest sectoral source of water pollution. Major sources of water pollution from dairy farms include animal wastes, pharmaceutical residues (e.g., antibiotics and hormones), fertilizers and pesticides used for growing feed crops, and sediment from eroded pastures. Antibiotic-resistant bacteria and their genes can also act as environmental contaminants.

Cattle also excrete a number of different zoonotic pathogens that can contaminate the environment and cause illness in humans. Contamination of water with pathogens occurs through animal contact with waterways, through fecal runoff into surface waters, or through the leaching of fecal matter through the soil matrix into groundwater. Fecal runoff can increase during periods of heavy rainfall and under high livestock densities. For example, catchment scale modeling has specifically shown high concentrations of ruminant *Campylobacter* strains during flood events as a result of agricultural runoff. Studies have also shown that heavy rainfall events can significantly increase surface runoff of *Cryptosporidium* oocysts over agricultural land. Humans can then be exposed to waterborne zoonotic pathogens through recreational contact with waterways or through the consumption of contaminated drinking water.

Waterborne transmission of bovine zoonotic pathogens has been documented for a number of pathogens and presents an important public health risk in both lower- and higher-income nations. For example, an outbreak of *Escherichia coli* O157 in Swaziland cattle was thought to be the source of more than 40,000 human cases of waterborne infection. Additionally, a study that assessed the impacts of intensive dairy farming and border strip irrigation on the leaching of *Campylobacter* spp. to shallow groundwater in a catchment in New Zealand found *Campylobacter* in 12% of samples from five wells over a 3-year period.

<u>4. Chemical Pollution</u>

Cattle manure and urine, as well as farm wastewater, can contain high levels of nutrients, drug residues, pathogens, or heavy metals that can enter waterways or accumulate in soils. These pollutants can enter waterways either directly from runoff from farm buildings, spills or the failure of manure storage facilities, the deposition of fecal matter directly to streams, transport through soil layers via drainage waters on farms, or contamination can occur indirectly from surface runoff and overland flow from pastures or agricultural fields. Livestock can also contribute to soil compaction, which can in turn reduce water infiltration, increase overland runoff, and lower groundwater tables, potentially contributing to both water scarcity and water quality challenges.

Nitrogen and phosphorus are critical pollutants from dairy farms to surface waters, groundwater, and marine waters. When nitrogenous fertilizers are applied to crops, only a portion is taken up by plants and the rest is often transported downstream or downwind. Manure and urine are also important sources of nitrogen emissions on dairy farms. Excessive nitrate can pollute the environment and is a direct threat to human health. High levels of nitrate in drinking water can lead to the development of methemoglobinemia in infants. Nitrate toxicity has also been linked to abortions in pregnant women and certain forms of cancer in adults. Specifically, elevated nitrate levels in water lead to the formation of potentially carcinogenic N-nitrosamines. In some studies, the long-term consumption of nitrate in drinking water has been positively associated with a higher risk for non-Hodgkin's lymphoma, stomach, colorectal, bladder, breast, and ovarian cancers, and thyroid disease, although findings over time have not been consistent. Phosphorus is not directly toxic to human beings, but it is often the limiting nutrient in aquatic ecosystems and changes in concentration can severely alter ecosystem functions.

5. Dietary Benefits and Harms

Agricultural development can benefit human health by increasing food availability and security, and improving overall nutrition, particularly in lower-income nations. Dairy cattle can provide milk and dairy products that are an important source of protein, vitamins and minerals. Dairy cattle are also an important source of meat.

Milk and dairy products play an important role in human nutrition and are a key source of protein, vitamins, and minerals. Generally, the epidemiological evidence indicates that the moderate consumption of dairy products does not increase the risk for most chronic conditions and may actually confer protection against cardiovascular disease, stroke, diabetes, dementia, certain cancers, and mortality.

Dairy products are estimated to contribute approximately 20% of total fat consumed in Western diets and more than 50% of energy from milk is derived from fat. Around 70% of milk fat is composed of saturated fatty acids. Milk also contains high-quality protein, although the fat and protein content of milk varies by cow breed and nutrition. Additionally, milk contains vitamins, minerals, and other components that may benefit health including bioactive peptides, milk fat globule membrane, prebiotics, and probiotics. While whole milk naturally contains a number of vitamins and minerals, milk can also be fortified with additional vitamins and minerals during processing. For example, in some countries milk is fortified with vitamins A and D.

A number of studies, including several large cohort studies, have shown a decreased prevalence of asthma, atopy, and atopic disorders in children raised on farms. The so-called “farm effect” has been extensively documented, but it is not clear how exposure to a farm environment during childhood might modify the risk for asthma, atopy, and atopic disorders. Neither the specific protective factors of farm exposures, nor the underlying immunological mechanisms have been conclusively determined. However, evidence suggests that organic dust exposure, and endotoxin specifically, may be responsible for the observed protective effects. However, it has also been suggested that exposure to the microbiological diversity of the farm environment may provide protection through effects on the innate immune system.

6. Economic, Social, and Cultural Impacts

Livestock keeping and production provide economic opportunities around the world, including employment and income generation, although there may be fewer opportunities in higher-income regions due to intensification and consolidation within the sector. Additionally, as in lower-income regions, livestock production in higher-income regions may be associated with benefits related to leisure, recreation, tourism, education, and inspiration opportunities.

Livestock manure can be used to improve or maintain soil fertility and contribute to greater crop production for food and additional income generation. Animal manure supplies around 15% of nutrients applied as crop fertilizer globally. Additionally, in some areas manure is used as solid fuel or for the generation of biogas. Dung can also be used as a building material and is often a marketable commodity. Livestock can also provide power for transportation or be used in place of farm equipment for crop production. Approximately two billion people in lower-income nations rely on livestock for draft power and transportation.

Livestock, including dairy cattle, are important to both the urban and rural poor and can contribute to poverty reduction in a number of different ways. Generally, livestock can serve as assets that help to meet livelihood needs or as safety nets, especially for vulnerable populations (e.g., the poorest, women, and those who are immunocompromised), and provide a pathway out of poverty. Livestock can also contribute to the livelihoods of those who do not keep livestock.

While a number of the impacts associated with livestock production, including dairy farming, are markedly different in higher-income regions, there are a number of effects that may be common across regions. Livestock keeping and production provide economic opportunities around the world, including employment and income generation, although there may be fewer opportunities in higher-income regions due to intensification and consolidation within the sector. Additionally, as in lower-income regions, livestock production in higher-income regions may be associated with benefits related to leisure, recreation, tourism, education, and inspiration opportunities.