LEAGUE OF WOMEN VOTERS®

Overview of Animal Management

The numbers are staggering: 29 million cattle, 68 million hogs, 250 million turkeys, 8.4 billion broilers (chickens), and 93 billion eggs. These are the 2012 production figures for U.S. animal agriculture.[1]

In the past two decades, four important trends have emerged in the livestock sector: (1) growth and concentration; (2) shifting geographic location; (3) increasing scale; and (4) the movement of meat processing from urban centers to rural communities.[2]

Animal herd management and housing varies depending on climate, topography, the type of animal and the producers' interest and inclination.[3] While some producers pasture their animals, which permits them to engage in natural behaviors such as rooting (hogs), scratching (chicken), and consuming forage and insects, other producers employ confined settings where the environment can be controlled so that the animals are not temperature-stressed, exposed to predators or disease vectors, and where product uniformity can be achieved through a prescribed diet.[4] For these producers, technology has enabled them to raise more livestock with less labor on less land.

Whether primarily pastured or confined, an animal may spend its entire life in one location (e.g. "grass fed and finished" cattle operation; "farrow to finish" swine operation). Alternatively, farmers and ranchers may focus on one or more phases of an animal's life (cattle: cow-calf operation; background or stocker; feedlot finishing;[5] swine: farrow-to-wean, farrow-to-feeder, and feeder-to-finish.[6])

Consolidation

Following World War II, increased grain yields, improvements in refrigeration, and expanded transportation options made possible the growth of intensive animal feed operations. In 1935, 5.1 percent of the nation's 42.8 million beef cattle were being fattened in feedlots, where cattle spend the last 90-120 days before slaughter rapidly putting on weight by consuming a grain-intensive diet. By 1963, that number had jumped to 66 percent. By the end of the century, almost all cattle were being fattened on feedlots.[7]

While feedlots with less than 1,000 head of cattle are still in the majority, they "finish" only a small percentage of cattle. Lots with 1,000 head or more finish 80 to 90 percent of US cattle, and the few feedlots with 32,000 head or more account for around 40 percent of cattle.[8]

Even greater consolidation has taken place in the dairy sector. In 1940, 76.4 percent of all US farms included cows for milking. As of 1997, that number was down to just 6.1 percent. While the number of cows kept primarily for milking dropped from around 24 million in 1940 to about

9 million in 2000, milk production rose steadily as a result of more efficient milking technology, advances in animal nutrition and health, as well as biotechnological interventions in breeding and pharmacology (discussed below).[9]

Similar consolidation has taken place in the management of hogs and of poultry. According to the GAO, there were about 3,600 large-scale poultry and meat operations in the US in 1982. By 2002 that number had jumped to almost 12,000.[10]

AFO and CAFO Definitions

While the term CAFO has become part of common language, synonymous with "factory farming" as a way to refer to very large concentrated animal operations, the EPA has specific definitions that help explain the variety of farms and complexity of regulation.

According to EPA, an operation is an AFO (animal feeding operation) if:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.[11]

Animal Sector	Size Thresholds (number of animals)		
	Large CAFOs	Medium CAFOs[1]	Small CAFOs[2]
cattle or cow/calf pairs	1,000 or more	300 - 999	less than 300
mature dairy cattle	700 or more	200 - 699	less than 200
veal calves	1,000 or more	300 - 999	less than 300
swine (weighing over 55 pounds)	2,500 or more	750 - 2,499	less than 750
swine (weighing less than 55 pounds)	10,000 or more	3,000 - 9,999	less than 3,000
horses	500 or more	150 - 499	less than 150
sheep or lambs	10,000 or more	3,000 - 9,999	less than 3,000
turkeys	55,000 or more	16,500 - 54,999	less than 16,500
laying hens or broilers (liquid manure handling systems)	30,000 or more	9,000 - 29,999	less than 9,000
chickens other than laying hens (other than a liquid manure handling systems)	125,000 or more	37,500 - 124,999	less than 37,500
laying hens (other than a liquid manure handling systems)	82,000 or more	25,000 - 81,999	less than 25,000
ducks (other than a liquid manure handling systems)	30,000 or more	10,000 - 29,999	less than 10,000
ducks (liquid manure handling systems)	5,000 or more	1,500 - 4,999	less than 1,500

[1]Must also meet one of two "method of discharge" criteria to be defined as a CAFO or may be designated.
[2] Never a CAFO by regulatory definition, but may be designated as a CAFO on a case-by-case basis.

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CAFOs (concentrated animal feeding operations) are more narrowly defined as AFOs "with potential to impact water supply, either as a result of size (number of head of animals housed at any given time) and/or impact on proximate surface water." Specifically, a large CAFO confines at least the number of animals described in the table below. A medium CAFO falls within the size range in the table below and either: "has a manmade ditch or pipe that carries manure or wastewater to surface water; or the animals come into contact with surface water that passes through the area where they're confined." Any small or medium AFO found to be "a significant contributor of pollutants" may also be designated as CAFO.[13]

The EPA estimates that there are about 450,000 AFOs in the US, with about 15% of those designated as CAFOs.[14] In discussions about concentrated farming, precision is sometime difficult, but helpful. While some observers see any confinement of animals as harmful, other critics are concerned about very large-scale operations, operations in which animals are mistreated, or the loss of independent small to mid-size farms. Is there an optimum size of concentration, where benefits are realized without the attendant hazards? Are there factors that

push farms ever larger, even to the detriment of animals or local farm communities? These are just a few of the questions to consider in a discussion of concentration and consolidation.

Efficiencies and Externalized Costs

Production efficiencies realized in concentrated animal systems have increased the national supply of inexpensive, readily available meat.[15] Efficiencies of scale, capital-intensive new technologies for breeding, feeding, and processing; pressure from global competition; and consumer demand for uniform, convenient, inexpensive meat products all point to the continuing need for concentrated, consolidated animal management.[16] Biogas experimentation suggests that aggregated animal waste could be an important new source of biofuel, potentially adding more economic incentive to further consolidation.[17]

Questions have been raised about the impact of CAFOs on local communities. A report funded by the National Association of Local Boards of Health found significant impacts on surface water (rivers, ponds, lakes), including "pathogens… growth hormones, antibiotics, chemicals used as additives to the manure or to clean equipment, animal blood, silage leachate from corn feed, or copper sulfate used in footbaths for cows."[18] The same study documented concerns about noxious odors, dramatic increases in air-borne insects (primarily flies and mosquitos), as well as the health impacts of CAFO air pollutants.[19]

A Pew Trust review of CAFO community impacts cited studies describing higher incidence of certain health and behavioral concerns, including: asthma; neurobehavioral issues (from chronic exposure to air-borne compounds toxic to the nervous system) resulting in depression, anger, fatigue, confusion; and an increase in neuropsychiatric abnormalities, including impaired balance, hearing, memory, mood, intellectual function, and visual field performance.[20]

With regard to economic impacts of CAFOs on rural communities, a 2004 review of literature found:

Economic concentration of agricultural operations tends to remove a higher percentage of money from rural communities than when the industry is dominated by smaller farm operations, which tend to circulate money within the community. Goldschmidt (1978) documented this as early as 1946 in California, one of the first states where industrialized agriculture developed.[21]

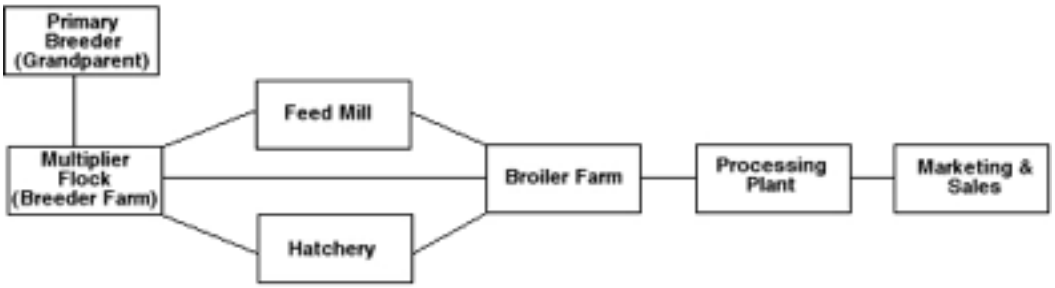
Property values drop around large-scale feeding operations, as do local purchases and local tax receipts. Studies "consistently show that the social and economic well-being of local rural communities benefit from increasing the number of farmers, not simply increasing the volume of commodity produced."[22]

Contract Farming and Vertical Integration

Vertical integration and contract farming began in the 1940s in the poultry industry. Different stages of production (feed preparation, hatching, growing to full size, processing) had generally been owned and managed by the same farm, but as farms began to specialize, "integrators"

began to coordinate the stages of production, retaining ownership of chickens from breeding stage to final sale, while contracting out portions of the production process.

Today, 90 percent of chickens raised in the US (for meat supply) are managed by farmers working under contracts that specify growing conditions, feed, and veterinary care. Of the other ten percent, most are raised on company-owned farms; less than one percent are raised by independent, non-contracted growers.[23]



ag.ansc.purdue.edu/nielsen/www245/lecnotes/unit2.html [24]

According to the National Chicken Council, vertical integration ensures sanitary conditions, uniform product, and a steady supply of inexpensive protein, while providing guaranteed income for chicken farmers.[25] From the perspective of chicken farmers themselves, what began as a mutually beneficial business practice has shifted in recent decades into a highly structured system that puts control in the hands of a small number of integrator/processors, and leaves farmers carrying disproportionate risk and debt, and an ever-diminishing share of profit.[26] Just two companies control almost half the supply and demand of broiler chickens; the top three companies account for over two-thirds of poultry market share.[27]

While poultry production has shown the most dramatic shift to consolidation and contract farming, the same is taking place, at varying levels, in hog and beef production. In a series of workshops held by the Department of Justice in 2008, participants identified the following concerns:

> **Anticompetitive Mergers:** these yield "a severely concentrated marketplace in which power and profit are limited to a few at the expense of countless, hard-working family farmers."
>
> **High Market Concentration**: "at various stages of the food chain, there are only a handful (if that many) of buyers or sellers, resulting in a lack of options for producers and lower prices for their commodities or higher prices for supplies."
>
> **Contracting:** "Many participants claimed that a disparity of bargaining power between processors, on one side, and producers who grow or sell animals under contract, on the other side, leaves those producers powerless to resist unfair treatment, particularly in the poultry sector."

> **Market Transparency and Captive Supply:** "Producers across industries raised concerns about the increasing difficulty they are having obtaining timely and accurate information about current market prices."[28]

A corresponding concern for small and mid-size farmers is the loss of open, competitive markets ("spot markets") for independent growers. Farm coalitions have asked for passage of a Livestock Marketing Fairness Act, and would like to see legislation prohibiting packer-owned livestock.[29] Farmers are also interested in seeing increased support for local food hubs[30] and continuing expansion of farm cooperatives.[31]

Indirect and Direct Subsidy of Concentrated Animal Feeding Operations

In 2007, researchers at Tufts Institute reviewed the impact of Farm Bill commodity subsidies (see Subsidies and Crop Insurance) on the economic structure of animal management. Their conclusion was that federal subsidies on corn and soy guaranteed below-cost feed, making purchase of feed less expensive than growing feed on-site or maintaining adequate pasture. In effect, subsidies of industrial feed saved large scale farms "an estimated $3.9 billion per year . . . a reduction amounting to 5%-15% of operating costs."[32]

> *The implicit subsidy to industrial feed has contributed to the consolidation of factory hog operations. With a 15% discount on operating costs compared to hog farmers who grew their own feed crops, factory farms enjoyed a competitive advantage that did not come simply from their economies of size. Using cost data from the U.S. Department of Agriculture and other published sources, we estimate that mid-sized diversified farms – those with 500-2,000 hogs fed largely by on-farm crops – would have comparable production costs to those of industrial producers if the latter had to pay full cost for their feed.*[33]

CAFOs receive a more direct subsidy through Environmental Quality Incentives Program (EQIP) funding. Through EQIP, farmers can apply for financial and technical assistance "to help plan and implement conservation practices that address natural resource concerns." Introduced in the 1996 Farm Bill, EQIP originally targeted small and mid-size farms. In 2002, the program was reauthorized with greatly expanded funding and removal of the restrictions on large-scale waste management systems. The National Sustainable Farm Associations has petitioned for greater transparency regarding disbursement of EQIP funds, economic and environmental analysis of the impact of EQIP contracts, lower caps with no "special exceptions," and restriction of EQIP funds to mitigation of existing environmental challenges, rather than financing waste management operations of new or expanding CAFOs.[34]

EPA regulation of CAFOs

In 2008, the GAO issued a report noting EPA's inability to gather adequate information about CAFO size, location, and waste management strategies, as well as its failure to assess the impact of CAFO pollutants on the environment or human health.[35,36] Operations that meet CAFO size thresholds are only registered for National Pollutant Discharge Elimination System (NPDES) permits[37] if they voluntarily acknowledge waste discharges. Therefore, the majority of facilities are not regulated under EPA rules, although they may be subject to widely varying state laws. In 2009, an EPA working group found that, since only a small percentage of CAFOs seek permits to discharge, EPA oversight of feeding operations was limited. The taskforce recommended that EPA lower the regulatory threshold for AFOs, set a threshold for multiple AFOs in impaired watersheds, begin "a comprehensive data collection plan" to provide information on all CAFOs and their waste management plans, and "[i]nspect more AFOs to determine which might be significant contributors of nutrient pollution to waters."[38]

In 2011, following these recommendations, EPA published a new reporting regulation, based on Clean Water Act Section 308 (as recommended by the 2009 task force report), requiring CAFOs to submit basic information about location, number and type of animal, permitting status, and "number of acres available for land application of manure."[39] This regulation was withdrawn in July 2012 after strong opposition from livestock trade associations and NASDA (the National Association of State Departments of Agriculture). The stated concern was that CAFOs are family businesses, and that releasing information was an invasion of privacy, and also put operations at risk of from animal rights extremists.[40,41,42] Environmental groups, including the Center for Food Safety, Food & Water Watch, Humane Society of the United States, Environmental Integrity Project, and Iowa Citizens for Community Improvement countered in August 2013 with a lawsuit asserting that the EPA "lacks basic information about the nation's thousands of CAFOs, such as their location, size, ownership, waste management procedures, history of illegal discharges, or whether they have or require a CWA permit."[43,44,45]

While concerns over water pollution have dominated efforts to regulate to CAFOs, air emissions from manure management operations are also an issue. The Environmental Integrity Project and other groups have sought EPA regulation of CAFO-generated gases and particulate matter under the Clean Air Act.[46] But a recent review of Clean Air Act application in the agriculture sector described lack of standard measures, inadequate data collection, diminished funding, and political opposition to any regulatory oversight.[47]

Of interest is the role of individual states and local communities in the regulation and permitting process for both air and water. States may implement mandatory permit requirements, under the oversight of EPA. Some states require permits for AFOs of a certain size; others require permit for all AFOs, regardless of size. Regulations may also be adopted by EPA regions (collections of states in a geographic area), by counties, or local governments, depending on the state.[48] The stated position of the LWVUS is that "the federal government should have the major role in setting standard for environmental protection and pollution control," and that "the federal government should enforce standards if other levels of government do not meet this

responsibility."[49] Recent lawsuits in response to EPA attempts to clarify and enforce standards demonstrate the complexity of application with regard to different regulatory authorities and impacts of varying farm practices.[50,51,52]

Right to Farm Laws

All fifty states have Right to Farm laws, initially designed to protect farmers from nuisance suits from non-farming neighbors concerned about normal barn-yard smells and noises. These laws are particularly valuable today in areas where farming is promoted through zoning that identifies agriculture as the primary use and limits residential development to one house to a large number of acres. In high-income areas the limitation on housing density is insufficient to prevent "estate" development in the agricultural area. The right to farm law prevents nuisance complaints about operating farm machinery early in the morning or on weekends, about moving farm equipment on the roads, and about other normal farming operations.

Not all Right to Farm laws are the same. Model Right to Farm legislation promoted by the American Legal Exchange Council (ALEC) since 1996, serves to restrict the regulating authority of local government, in many cases hindering the ability of local communities to restrict size or number of large scale feeding operations, or to claim damages from lost property value as small or mid-size AFOs expand.[53] In some states these laws also shield CAFOs from waste-discharge or air-quality regulation.[54] While the laws are promoted as protection for farmers from over-zealous animal rights advocates, some small farmers see recent Right to Farm bills as a way for large-scale operations to ignore the rights of rural communities.[55]

Corollary model legislation, also promoted by ALEC, often appears under the title "Animal Enterprise Terrorism Act," dubbed "ag-gag bills" by critics. The wording is different in each state, but these bills make it a terroristic offence to record images or sounds from an agricultural or research facility without the owner's consent, in effect criminalizing whistle-blower activity and raising First Amendment issues.[56]

Animal Health and Welfare

Farm animal health and welfare are the concern of livestock producers, the food industry, and consumers. Popular media reports often focus on the work of consumer groups involved in *animal welfare*, those attempting to change the conditions in which animals are raised (e.g. U.S. Humane Society), as well as groups advocating for *animal rights* and calling for elimination of the use of animals for food and clothing.[57]

In conventional animal production, poultry and hogs are generally kept in confined areas for their entire life cycles. Beef cattle and sheep are generally raised on rangeland and pastures and then finished on feedlots, where the animal densities are high. Dairy production is intermediate in nature, with the dairy cattle being fed and milked in confined units, but allowed out to pasture for a given period.[58,59]

Federal laws governing farm animal welfare are limited to animal handling during interstate transportation (The 28-Hour Law), slaughtering practices (The Humane Methods of Livestock Slaughter Act, which excludes poultry slaughter), and use in biomedical research, testing, teaching and exhibition (Animal Welfare Act). On-farm animal welfare is governed by state law.[60]

Several producer groups have developed programs that promote better animal welfare.[61]In addition, non-producer groups such as Animal Welfare Approved and the American Humane Association have third-party certification programs based on the "Five Freedoms of Animal Welfare."[62,63,64]

Animal Feed

Feed is the most expensive part of livestock production, usually ranging from 60-70% of total production cost.[65] As in humans, animal health and welfare is dependent upon ingesting a proper balance of nutrients. Animal diets vary depending on their digestive process (i.e. ruminants--cattle, sheep; non-ruminants--pigs, chicken; or hindgut fermenters--horses), their life stage (e.g. young animals; pregnant or lactating; feedlot finishing), gender, season, purpose (e.g. production; show), management method (pastured or confined) and other factors.[66,67] The science of animal nutrition is complex and is the subject of much research.[68]

Some operations grow their own feed (corn, soy, hay, and create silage and haylage). They may also use Total Mixed Rations (TMR) formulated by animal nutritionists,[69] or DDGs (dried distiller grains), a high gluten by-product from ethanol processing. DDGs are fed as an alternative to cracked corn and soybean meal. In the recent past, ethanol plants' demand for corn combined with adverse weather conditions have driven up corn prices, making use of DDGs a more affordable protein source. Dietary decisions may be made by producers in conjunction with their veterinarians, or may be made by the integrators supplying the feed. Exact composition of feed is considered proprietary information.[70]

National animal feed production is currently a 32 billion dollar industry,[71] with the US taking the lead in world production with 21.6% of market share. Not surprisingly, the nation's top vertical integrators are also among the top feed producers, with tight ties between animal rendering operations, feed mills, and the vertical integrators.[72] Many contract farmers have strict contracts requiring feed supply from the integrator.[73]

Feed for use in confined management systems is influenced by price and supply, which are in turn influenced by federal commodity subsidies. About 80% of US corn, 22% of US wheat,[74] and 77% of global soy[75] are used in animal feed each year. Ground fish meal provides protein: a third of the fish caught every year (31.5 million tons) are used in animal feed.[76]

Pharmaceuticals in Animal Feed

The FDA's Center for Veterinary Medicine (CVM) regulates the manufacture and distribution of food additives and drugs (excluding vaccines) that will be given to animals, both livestock and

companion animals. The Federal Food, Drug, and Cosmetic Act (FFDCA) defines a drug as something that prevents or treats a disease, or changes the structure or function of the body in humans or animals. An example of the latter is "heat synchronization" in which a compound is given to a group of cows to make them ovulate at the same time.[77]

A complete list of approved prescription and over-the-counter drugs for animals is contained in FDA's *Green Book*, which is updated monthly.[78] According to the FDA, the approval process involves evaluation of research conducted by the drug's sponsor, including a review for (1) safety to the animal and food products made from the treated animal, (2) effectiveness, (3) impact on the environment, and (4) safety of the people administering the drug or who may come into contact with the drug.[79] To prevent drug residues in animal-derived foods from entering the food supply, FDA approval specifies a "withdrawal time", i.e. a waiting period following administration of a drug to when the animal may be slaughtered or when milk may enter the food supply.[80]

Through its *Guidance for Industry*, FDA recommends how drugs should be used.[81] The drugs may be administered by injection, in animal feed, or in water. Some types can be acquired over-the-counter while other drugs can only be administered by a veterinarian consistent with an FDA Veterinary Feed Directive.

Antimicrobials are drugs administered to counteract infections by bacteria (antibiotics), viruses (antivirals), worms (antihelminics), parasites (antiparasitics), protozoa (antiprotozoans), and fungi (antifungals). They may be administered to an individual sick animal or a group of animals to control disease when some in the group show overt signs of disease. Of concern is the administration of antimicrobials to conventionally raised livestock in non-therapeutic doses for disease prevention. Many of the antibiotics used in animals are the same as those administered in humans. Others, like ionophores, have been developed for exclusive use in animals. Widespread use of antimicrobials in animal feed is linked to antibiotic resistant bacteria.[82] According to the Animal Health Institute, which represents animal health drug sponsors, animal antibiotics make our food supply safer and people healthier. Antibiotics are a critical tool to prevent, control and treat disease in animals. In doing so, they also reduce the chance of bacterial transmission from animals to humans.[83]

A GAO report issued in September 2011 noted the necessary connection between antibiotic use and consolidated animal feeding:

> *The use of antibiotics in animals poses a potential human health risk, but it is also an integral part of intensive animal production in which large numbers of poultry, swine, and cattle are raised in confinement facilities… However…larger farms with higher concentrations of animals may be more vulnerable to the rapid spread of animal diseases, which producers may combat by using antibiotics. Some producers elect to raise food animals without using antibiotics, in what are known as "alternative modes of production."*[84]

The GAO also noted that the FDA does not have appropriate tools to assemble "crucial details necessary to examine trends and understand the relationship between use and resistance," has no legal enforcement power regarding the use of pharmaceuticals, and does not have the resources to withdraw antibiotics already approved for market.[85]

Consumer groups, including Consumers Union, have repeatedly recommended that the FDA:

- Phase out the use of antibiotics in livestock except for the treatment of sick animals.
- Require drug companies and feed mills to disclose sales of antibiotics for use in food animals, broken down by drug, animal species and purpose (growth promotion, disease prevention, disease treatment).[86]

Growth promoters include ionophores (non-human antibiotics) as well as hormones, both steroid and non-steroid. The drugs produce leaner meat and increase feed efficiency (that is, the ratio of feed to muscle growth).[87] They also result in faster growth, which permits more production, either by bringing livestock to market more quickly or producing greater milk yields. Their use also results in reduced methane production per animal.[88]

Beta-agonists are another class of growth promoters that include ractopamine hydrochloride, approved for use in turkeys, cattle and swine.[89] Ractopamine residue in meats has recently come under scrutiny.[90] Ractopamine has been banned in the EU, China, Taiwan, and other global markets, after evidence that the drug harms animals, and concern about limited testing regarding human safety.[91] Its detection in turkey samples recently led to a significant trade dispute with Russia, which has a zero tolerance policy.[92] In the most recent development, Smithfield Foods, the largest American pork producer whose acquisition by a Chinese company is pending, announced it would be 50% ractopamine-free by June 1, 2013.[93]

Organoarsenicals (organic arsenic compounds) in use as growth promoters since 1944, had been a focus of concern with regard to direct toxicity in animals and humans, and accumulating residues in water and soil. In September, 2013, the FDA withdrew approval for three of the four arsenical drugs that have been in use, and is studying the possible withdrawal of the fourth.[94,95]

Pain medications, including non-steroidal anti-inflammatory drugs may be co-administered with antimicrobials to treat an infection and its associated pain and inflammation. Or, they may be administered to animals with chronic inflammation.

Other Ingredients of Interest

In addition to pharmaceutical additives, livestock feed may contain other ingredients of interest: **Rendered animal products** include meat and bone meal, poultry byproduct meal, blood meal, and feather meal.[96] Rendering and reuse of animal protein in feed are essential elements of a concentrated animal management system, creating economies in both feed and carcass disposal.[97] Use of rendered animal materials in feed has been associated with increased levels of bacteria, antibiotic resistant bacteria, and prions, (protein agents associated with Bovine spongiform encephalopathy, BSE, or Mad Cow Disease).[98,99] A 1997 FDA regulation prohibits

the use of most mammalian protein in the manufacture of animal feeds given to ruminant animals, (cows, sheep, and goats), with an additional 2008 prohibition of the use of clearly defined high-risk cattle tissue in all animal feed.[100] Debate continues regarding the efficacy of current regulations and inspections.[101]

Animal Waste (including poultry litter and dried swine and ruminant waste) is used in animal feed for protein, crude fiber, and other nutrients. Traditionally, animal waste was used almost exclusively as fertilizer. The use of waste in animal feed developed concurrently with concentration of feeding operations, and provides cost savings for growers with excess animal waste, as well as cost savings relative to other forms of feed.[102] Sapkota, et al., claim that animal wastes have been found to contain "pathogenic microorganisms, pesticide residues, or drug residues," all of which can be passed on through animals to the meat prepared for human consumption.[103] Feed nutritionists counter that with appropriate handling and phase-out before slaughter, animal waste provides inexpensive nutrition with no risk to animals or humans.[104]

Other additives include plastic pellets, ("Polyethylene roughage replacement") used as an inexpensive fiber substitute, contaminated or adulterated food (heat treated to destroy pathogenic organisms), and a wide mix of byproducts derived from processing of other foods.[105]

Residue Testing for these and other additives is under the oversight of the USDA's Food and Safety Inspection Service (FSIS) National Residue Program. Testing for residual amounts of drugs like ractopamine is limited, as seen in FSIS' May 2013 Residue Sample Results report.[106]

Organic Feed standards prohibit most of the feed additives described above.[107]

Aquaculture

Aquaculture is the farming of aquatic organisms such as fish, shellfish (oysters, mussels, shrimp) and plants. In addition to raising animals for direct food consumption, aquaculture includes hatcheries as well as fish raised for bait, for stocking surface waters, and for ornamental purposes.

According to the U.N.'s Food and Agriculture Organization, in 2013 the world will consume more farmed fish than wild fish.[108] Seventy percent of wild fish stock is overfished.[109] Overfishing in combination with pollution, and natural occurrences such as algal blooms and weather phenomena like El Nino, are all drivers of the need for more controlled production using aquaculture.[110]

Aquaculture encompasses both marine and freshwater species and can range from land-based to open-ocean production. Land-based production can be conducted indoors in tanks or in outdoor ponds, raceways, cages, or tanks. Aquaponics is a closed-loop system combining aquaculture and hydroponics in which waste and wastewater from fish raised in tanks are used to provide nutrients to plants. As aquaponic systems can be compact and can be configured for small spaces, they are found increasingly in urban agriculture settings.[111]

U.S. seafood consumption has increased 50% since 1950 and has remained fairly consistent the past few years (finfish consumption is down, but shellfish consumption is up). According to National Oceanic and Atmospheric Administration (NOAA), about half of the seafood consumed in the United States is farmed, yet American aquaculture accounts for less than 5% of that consumption. Eighty-six percent of our seafood is imported.[112] In light of these consumption and availability patterns, multiple steps have been taken towards expansion of U.S. marine aquaculture.[113]

Aquaculture production is governed by a number of regulatory agencies. The USDA is the lead agency for freshwater aquaculture and also approves use of vaccines. Through USDA's National Institute of Food and Agriculture, five Regional Aquaculture Centers support research and development, demonstrations and extension education at colleges and universities.

The Fish & Wildlife Service (FWS--Department of the Interior) and the National Marine Fisheries Service (part of National Oceanic and Atmospheric Administration (NOAA)--Department of Commerce) regulate ocean-based aquaculture. The National Marine Fisheries Service is advised by eight regional fishery management councils, whose gubernatorially-nominated members are involved in fisheries or related economic activities. The National Seafood Inspection Lab tests for chemical and microbiological contaminants in domestic and imported seafood.[114]

In addition there are at least six federal EPA-administered laws governing aquaculture.[115] The EPA and FDA roles with respect to use of pesticides and drugs are described in the Regulatory Agency Overview.

Imports

Mislabeling of fish is a well-documented phenomenon.[116] The consequences of mislabeling are financial, with consumers overpaying for fish fraudulently labeled as higher priced species. Mislabeling may also have health consequences if consumers unknowingly purchase fish that contain toxins or contaminants.[117] FDA electronically screens all food imports but only 2% of it is inspected, based on risk, and some (4%) will undergo laboratory analysis.[118] The National Seafood Inspection Lab tests for chemical and microbiological contaminants in domestic and imported seafood, and the Department of Homeland Security Customs and Border Protection also has labs for testing seafood. However, according to a 2009 GAO report, the agencies haven't effectively collaborated to fight food fraud.[119]

Feed

Though farmed fish are being bred to require less feed[120] approximately 50% of aquaculture production cost is attributable to feed. The feed conversion ratio is a problem in aquaculture as it takes 5 lbs. of forage fish (e.g. anchovies, sardines, mackerel) to raised 1 lb. of farmed Atlantic salmon. While fishmeal and fish oil is still produced from forage fish, low value fish considered "by-catch" from higher value species, and post-processing fish remains, the price and availability of fish food sources has resulted in many farmed fish being fed soybean meal and soybean oil.[121]

Fish gain weight quickly on this feed but, as with land-based livestock, there is criticism that this is not a natural food for fish. Currently, there is no organic certification of fish under USDA's National Organic Program. In 2008 the National Organic Standards Board approved final recommendations for aquaculture, but they have not yet been incorporated into the regulations.

Environmental Impacts

- The concentration of ocean fish in cages has led to the proliferation of parasitic sea lice both within farmed and wild salmon populations. Recent studies have shown high mortality in wild salmon.[122,123] Concentration has also led to bacterial and viral diseases.[124] Fish receive vaccines, pesticides, and antibiotics in their feed in order to prevent or treat these conditions. This has led to antibiotic resistance.[125]
- Overfeeding and concentration of fish waste have caused habitat deterioration under and near fish farming sites.[126]
- Some Native American tribes have experienced a loss of diversity and an overall decline in the presence of wild fish stocks, the presence of which are an important part of their worldview and economy. Aquaculture is a contributing factor to that decline. Additionally, Gulf Coast fishing communities are concerned that expansion of aquaculture will threaten the existing commercial and recreational fishing industry, costing jobs and loss of community.[127]
- The escape of farmed fish into the wild can have serious consequences for local ecosystems (e.g. Asian Carp and the challenge of keeping them from the Great Lakes).[128]

Many of these potential impacts can be mitigated through the practice of Integrated Multitrophic Aquaculture[129] and sustainable aquaculture certification programs.

Bee Keeping

Bees are the smallest of managed livestock, and arguably the most important. The USDA estimates that 80% of the fruits and vegetables eaten in the US are bee pollinated, as is much of the feed grown for livestock. The value of pollination by bees is estimated at $20 to $30 billion a year.[130] A 2012 survey notes, there are 115,000 to 125,000 beekeepers in the United States, most considered hobbyists with less than 25 hives. Commercial beekeepers (about 1% of the total) are those with 300 or more hives; most commercial beekeepers move their colonies throughout the year to provide pollination service to farmers.[131]

Since 2005, US beekeepers have been noting an dramatic increase in loss of bees. Expected losses of 5 to 10% have given way to losses of 25 to 30%, with some beekeepers reporting losses of 40 to 55% in 2012.[132] The EPA has called attention to the essential role of bees in US agriculture, and identified multiple stressors, including loss of genetic diversity, lack of nutrition rich forage, spread of the parasitic Varroa mite, and exposure to agricultural pesticides.[133]

One particular class of chemicals, neonicotinoids, has been of particular concern with regard to bees. Neonicotinoids are neurotoxins, insecticides that affect the central nervous system of insects. They are toxic to any insect at high enough levels, but at low levels they impair the navigational function of bees. In August, 2013, the EPA issued new labeling rules for the use of neonicotinoids, requiring a colorful new "bee advisory box" with information instructing user to avoid direct exposure and apply only after flower petals have fallen.[134,135]

Critics contend that the new rules are inadequate, since most neonicotinoids are applied as protective seed coatings, not as sprays, and travel systemically through the plant.[136] Industry and farm groups express concern about a "rush to judgment," pointing to the economic benefit of seed coating and other uses of neonicotinoids.[137] The EPA continues deliberation and review which began in 2008; completion of the review is scheduled for 2019.[138]

While research on neonicotinoids continues, beekeepers and researchers point to the growing burden of complex, chronic exposure: "the growing soup of pesticides, fungicides and herbicides that are used to control pests. While each substance has been certified, there has been less study of their combined effects."[139] Sub-lethal amounts of pesticide have been shown to lower bee resistance to disease,[140] and studies have documented multiple pesticide residues in weeds grown in unplanted fields, in various crops and forages, and in hives themselves, in complicated mixtures with "remarkably high levels" in combination.[141,142] Beekeepers themselves can contribute to this "toxic stew" through "beekeeper-applied chemicals:" miticides fluvalinate and coumaphos, paradichlorobenzene (used to fumigate combs to control wax moth), copper napthenate (used to preservative wooden hives), and other chemicals used to control ants and other hive pests.

Toxicology assessments provided to the EPA regarding pollinator impact are often short-term, and always focus on one chemical at a time. Analysis of research suggests that effective assessment must consider long-term exposures, overall pesticide loads, and the synergistic effect of multiple toxins.[143,144]

Climate Change

Agricultural practices both sequester and generate greenhouse gases. Sequestration occurs through conservation program set-asides, conversion from annual crops to perennial grassland or forest farming, as well as practices such as no-till agriculture.[145] On the other hand, according to a report by the UN Food and Agriculture Organization (FAO) issued in 2005, global meat production is responsible for a significant contribution to greenhouse gas emissions, some from energy use in growing and harvesting crops, but much more animal waste. According the study, the livestock sector "contributes 18 percent (7.1 billion tonnes CO_2 equivalent) of global greenhouse gas emissions. Although it accounts for only nine percent of global CO_2, it generates 65 percent of human-related nitrous oxide (N_2O) and 35 percent of methane (CH_4)."[146,147]

Findings of that report have been contested, as have assertions that consolidated feeding operations use more energy and release more methane than pastured animal management systems.[148,149,150] Recommendations for reducing agricultural methane emissions include:

- Balanced feed[151]
- Improved forage and management of perennial grasslands[152]
- Use of ionophores – antibiotic feed additives that increase feed efficiency, act as a growth promotants, and temporarily reduce methane emissions[153]
- Selective breeding[154,155]
- Improved use of animal waste[156]
- Reduced consumption of meat, particularly of beef[157]

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