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Beef Production: Ethical Issues

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Synonyms

Animal welfare in the beef industry; Food safety; Human and animal health; Husbandry and industry; Sustainability of the beef industry

Introduction

The ethics of food animal production did not represent a significant area of societal concern until 25 years ago, with the rise of public attention to both environmental consequences of raising food animals and effects of production systems on animal welfare. Beginning with Jeremy Rifkin's *Beyond Beef: The Rise and Fall of the Cattle Culture* (Rifkin 1993) and continuing with other books such as Michael Pollan's *The Omnivore's Dilemma* (Pollan 2006) and the UN report of 2006 *Livestock's Long Shadow* (UN 2006) and films such as *Food, Inc*. (2008) and periodic reports linking meat to the epidemiology of various diseases, ranging from cancer to cardiovascular diseases and bird flu, public scrutiny of meat industries has increased exponentially and led to campaigns in favor of limiting meat consumption, such as *Meatless Mondays*. In particular, beef has been hit hard, as fear of red meat has proliferated. Consider, for example, the pork industry's position absurdly calling pork "the other white meat."

Probably the most accurate document on the ethical issues occasioned by meat production is the report of a 3-year study by the Pew Commission on Industrial Farm Animal Production, published in 2008 as *Putting Meat On the Table: Industrial Farm Animal Production In America* (Pew 2008; available online at PCIFAP.org). The commission consisted of 14 experts on various aspects of animal production, who spent more than 2 years studying all of the major meat production systems dominating the US landscape. The commission focused on a variety of ethical issues arising out of such systems, including environmental despoliation, animal welfare, human health, rural communities, worker health and welfare, animal health, animal welfare, and food safety. All commission recommendations published required unanimous agreement from all commissioners. The report was the first systematic account of the problems raised by confinement agriculture since its inception and was well received and well reviewed. One industry expert revealingly called it "a blueprint for the future of animal agriculture in America."

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Historical Considerations

Current thought places the domestication of cattle at somewhere between 7,000 and 9,000 years ago. So important was this event to human history that veterinarian–historian Calvin Schwabe calls the cow "the mother of the human race" (Schwabe 1978). Cattle were utilized historically for food, leather, transportation, haulage, plowing, and their dung used for fuel.

In the United States, the production of beef has changed comparatively little in comparison to the production of other animals, with only sheep production undergoing similar minor modification. Cattle production today can be divided into extensive ranching, or cow-calf production, and more intensive cattle feeding, based on utilizing grain to produce fat cattle. Ranching is without a doubt the most unchanged among animal production systems in many hundreds of years. Typically, cattle are grazed in large open areas of pasture or native indigenous grasses. A minority of producers will grow the animals to market weight on such forage. Beef from such animals is designated as "grass-fed" meat and is more commonly produced in South America, where there are vast areas of grassy forage. After World War II, when the improvements in crop production known as "the Green Revolution" produced huge increases in available grain, the practice of feeding grain to cattle in order to increase profitability began, since the grain is worth considerably more when it creates meat in animals than when it is marketed strictly as grain. Eventually, the US public developed a preference for "grain-fed" beef until gradually the meat from such cattle dominated the market, and "grass-fed beef," which is generally not as tender as beef from cattle fed grain, became a specialty item rather than a staple of consumer diets.

Environmental Issues

From an environmental perspective, grass-fed beef fattened on indigenous forage is a good deal more sustainable than grain-fed beef. After all, there are significant energy costs involved in transporting grain to the animals, keeping the animals highly concentrated in feed yards, disposing of the manure, which creates odor and groundwater contamination. In addition, a great deal of energy is expended shipping cattle to feedlots and from feedlots to processing plants and markets. It is clear that fattening and marketing beef locally has a far smaller environmental impact than moving animals and meat across the country.

Estimates of the amount of water required for producing 1 lb of beef range from a low of 441 gal to a high of 2,500. These estimates clearly vary with the political bias of the source. The higher figure comes from a vegetarian website (Vegsource 2001), the lower from an industry website (Explore Beef 2012). There is, however, no question that the production of beef does utilize a good deal of water. Similarly, there are predictably huge variations in estimates of greenhouse gas production created by the cattle industry. (It is important to stress that claims regarding anthropogenic causes of global climate change are greatly disputed in the scientific community.) The largest environmental impact from beef occurs in South America, where "slash-and-burn" techniques for clearing the rainforest to produce grazing land for cattle result in impoverishing the rainforest environment and potential desertification. It is therefore clear that the production of beef does have some impact on the environment. The issue is how significant is that impact, and can it be mitigated. It is also argued that the production of beef by grazing preserves a significant amount of land, with 85 % of that land in the United States unsuitable for any use other than grazing. Since Western ranch lands are among the most beautiful landscapes in the United States, it has been suggested that ranching helps preserve land that would otherwise fall prey to development. Coalitions between environmentalists and ranchers developed in the 1990s have pressed "cows not condos" as a rather surprising common interest. Ranchers sometimes feed deer and elk over difficult winters.

Human and Animal Health Issues

Shortly after the discovery of antibiotics in the 1940s, it was noted that regular feeding of such drugs was conducive to growth promotion in farm animals. Although the precise mechanism by which this occurs remains unknown, various explanations have been suggested, including the claim that these drugs reduce subclinical infections which cause animals to utilize energy to fight disease-causing organisms rather than utilizing that energy to promote growth. In 1985, a Swedish referendum banned the use of antibiotics for growth promotion. After a frantic search for alternatives, it was suggested that significantly increasing cleanliness and hygiene in animal facilities could reduce pathogen load and thus eliminate the traditional use of antibiotics. Such an effort was introduced, and subsequently the cost of animal products fell, showing that in modern animal factories in which animals are severely crowded and antibiotics are deployed as a way of covering up the effects of pathogenic, unhygienic conditions, a remedy is increased sanitation. In other words, antibiotics were utilized as "technological sanders" so that "square pegs" could be forced into "round holes." In general, in such cases, it makes more sense to improve the animals' living conditions, rather than attempting to cover up the effects of less than optimal husbandry (Rollin 2001).

Very early in the history of antibiotic use for growth promotion, it was suggested on the basis of simple Darwinian evolutionary principles that such use would inevitably drive bacterial resistance to antibiotics. The mechanism creating such resistance is conceptually simple. As greater amounts of antibiotics are fed to farm animals, resistant pathogens are killed off, creating new opportunities for nonresistant pathogens to colonize the ecological niche in question, thereby in effect breeding for drug-resistant pathogens. That this in fact occurred has been demonstrated empirically.

Whereas much of Europe has followed the Swedish lead and banned nontherapeutic use of antibiotics, the United States has been considerably less proactive. Although regulatory agencies such as the Centers for Disease Control have strongly agitated for such policy, agricultural lobbyists have blocked massive policy change. Though the largest amount of antibiotics is utilized in the beef industry, these drugs are not typically cutting-edge antibiotics that represent the final line of defense against certain bacteria. The chicken industry, on the other hand, keeps animals under such pathogenic conditions that antibiotic residues from cutting-edge drugs utilized against dangerous human pathogens, such as fluoroquinolones, have been found in groundwater near poultry facilities, as well as in chicken meat purchased in groceries.

It is clear that use of antibiotics in beef cattle increases production efficiency. It has been claimed, for example, by the Animal Health Institute, a meat industry lobby group, that to reach current beef production levels without antibiotics would require 23 million additional cattle. Despite growing political pressure to ban antibiotic use for growth promotion in cattle and other farm animals, the US Congress has failed to act, and thus the United States is well behind Europe on such limitation of antibiotic use. This author served on a World Health Organization panel setting guidelines for prudent use of antimicrobials in 2000. At this conference, there was significant public pressure to ban *any* antibiotic use in farm animals to protect humans. This proposal was defeated on ethical grounds, as it was argued that we have a moral obligation to treat patently sick animals being raised under our aegis.

The issue of antibiotic resistance appears almost exclusively in cattle fattened in feedlots, not in animals that are ranch-raised under extensive conditions, and generally not fed antibiotics. There are other health issues, human and animal, that emerge in the course of the production of beef. Animals are significantly more crowded in large feedlots, which may contain up to one million animals in a relatively small space, than they are under range conditions. Furthermore, the animals in feedlots and processing plants come from many different locations and thus would harbor more diverse pathogens than would animals on pasture. The bulk of dangerous microbes are found in fecal material and are more easily spread in confinement, though pathogens from range cattle feces may cause problems by leaching into groundwater. Antibiotics such as chloramphenicol, which have been shown to leave residue in meat, may cause human health hazards beyond accelerating antibiotic resistance. Chloramphenicol, for example, when consumed in meat, can lead to aplastic anemia and was thus banned for use in cattle (Rollin 2001).

In recent years, transfer of dangerous pathogens onto carcasses has been illustrated by the case of *E. coli* O157: H7, an enteric bacterium found in cattle and capable of causing severe, even fatal intestinal disease in humans, particularly in children. An outbreak of such cases led the beef industry to increase cleanliness and avoid carcass contamination in packing houses by decontaminating them during processing, a prophylactic procedure that seems to have reduced the threat to public health. In general, the beef industry seems to be the most proactive of all meat production industries as regards risks to human health, though it would probably be wise to "cowboy up" and eliminate antibiotic use for anything other than treating patently sick animals.

Additional risks associated with the consumption of beef are "mad cow disease," or bovine spongiform encephalopathy (BSE), a fatal neurological disease caused by *prions*, and long-standing accusations leveled against beef regarding cardiovascular disease arising in some people from unsaturated fat and cholesterol. Risk of BSE in the United States is virtually nil. Responsibility for cardiovascular problems seems to fall upon the individual consumer and his or her choice of the amount and sort of beef consumed, rather than on the industry.

Animal Welfare: The Transformation of Animal Agriculture from Husbandry to Industry

The traditional account of the growth of human civilization out of a hunter-gatherer society invariably invokes the rise of agriculture, i.e., the domestication of animals and the cultivation of crops (Rollin 1995, 2004). This of course allowed for as predictable a food supply as humans could create in the vagaries of the natural world – floods, droughts, hurricanes, typhoons, extremes of heat and cold, fires, etc. Indeed, the use of animals enabled the development of successful crop agriculture, with the animals providing labor and locomotion, as well as food and fiber. The "ancient contract" with animals, was a highly symbiotic relationship that endured essentially unchanged for thousands of years. Humans selected among animals congenial to human management and further shaped them in terms of temperament and production traits by breeding and artificial selection. The animals provided food and fiber – meat, milk, wool, leather – power to haul and plow, and transportation and served as weaponry – horses and elephants. As people grew more effective at breeding and managing the animals, productivity was increased.

As humans benefited, so simultaneously did the animals. They were provided with the necessities of life in a predictable way. And thus was born the concept of husbandry, the remarkable practice and articulation of the symbiotic contract. The essence of husbandry was care. Humans put animals into the most ideal environment possible for the animals to survive and thrive, the environment for which they had evolved and been selected. In addition, humans provided them with sustenance, water, shelter, protection from predation, such medical attention as was available, help in birthing, food during famine, water during drought, safe surroundings, and comfortable appointments.

Eventually, what was born of necessity and common sense became articulated in terms of a moral obligation inextricably bound up with self-interest. In the Noah story, we learn that even as God preserves humans, humans preserve animals. The ethic of husbandry is in fact taught throughout the Bible; the animals must rest on the Sabbath even as we do; one is not to seethe a calf in its mother's milk (so we do not grow insensitive to animals' needs and natures); we can violate the Sabbath to save an animal. Proverbs tells us that "the wise man cares for his animals."

The true power of the husbandry ethic is best expressed in the 23rd Psalm. There, in searching for an apt metaphor for God's ideal relationship to humans, the Psalmist invokes the good shepherd:

> The Lord is My shepherd; I shall not want.
> He maketh me to lie down in green pastures,
> He leadeth me beside the still waters,
> He restoreth my soul.

We want no more from God than what the good shepherd provides to his animals.

Though this ancient contract with domestic animals was inherently sustainable, it was not in fact sustained with the coming of industrialization. Husbandry was born of necessity, and as soon as necessity vanished, the contract was broken. The industrial revolution portended the end of husbandry, for humans no longer needed to respect their animals to assure productivity.

Animal husbandry may be characterized as putting square pegs in square holes, round pegs in round holes, and creating as little friction as possible in doing so. Failure at husbandry meant that one's animals did not produce; failure to respect animal needs and natures hurt oneself as well as the animals. This was suddenly overridden by technological tools, as it were "technological sanders," that allowed people to force square pegs into round holes and round pegs into square holes, and where, at least in the short run, productivity flourished at the expense of respect for animal needs and natures. These tools replacing the need for husbandry included antibiotics, vaccines, bacterins, air handling systems, and manure handling systems and resulted in systems that do not respect the animals' physical and psychological needs and natures (Rollin 1995, 2004).

The singular beauty of husbandry is that it was at once an ethical and prudential doctrine. It was prudential in that failure to observe husbandry inexorably led to ruination of the person keeping animals. Not feeding, not watering, not protecting from predators, not respecting the animals' physical, biological, psychological, and physiological needs and natures – what Aristotle called their *telos*: the "cowness of the cow," the "sheepness of the sheep" – meant your animals did not survive and thrive, and thus neither did you. Failure to know and respect the animal's needs and natures had the same effect. The ultimate sanction of failing at husbandry – erosion of self-interest – obviated the need for any detailed ethical exposition of moral rules for husbandry: Anyone unmoved by self-interest is unlikely to be moved by moral or legal injunctions! And thus one finds little written about animal ethics and little codification of that ethic in law before the twentieth century, with the bulk of what is articulated aimed at identifying overt, deliberate, sadistic cruelty, hurting an animal for no purpose or for perverse pleasure, or not providing food or water.

Animal Welfare in Modern Industrial Agriculture: The Beef Industry as Preserving Animal Husbandry

Even the superficial examination of modern agricultural systems reveals the almost total loss of animal husbandry and its replacement by industrial approaches, and "technological fixes." Whereas, historically, the dairy industry represented the paradigm of good husbandry, with quantitatively and qualitatively high milk production, it was solidly dependent on good animal husbandry. Cows lived on pasture, to which they were well adapted. Herds of milk cows were small, and dairy farmers knew each cow as an individual, and often by name. Though lameness was not unknown, it did not pose the huge problem it does today, due to the fact that the animals often live in herds of 10,000 or more and largely are maintained on concrete, footing totally unsuited to cow hooves. Whereas yesterday's dairy cow could remain productive for 20 years, today's cow lasts barely 2.5 lactations. While milk production has skyrocketed, cow welfare is greatly compromised. Mastitis is rife, as are foot and leg problems.

A similar dark picture can be painted regarding animal welfare in virtually all confinement animal production systems. Modern veal production systems grew out of the dairy industry and were probably the first industry to shock the public when the media showed calves raised in isolation in dark small wooden crates and kept marginally anemic to assure pale, soft flesh. These miserable animals could not even walk to the trucks by which they were transported to slaughter. Laying hens are kept in small cages, as many as 9 per cage, and never see the light of day and debeaked to avoid cannibalism. Broiler chickens are raised in dark barns, where the air quality is appalling in terms of ammonia levels. (When the Pew Commission toured an "exemplary" barn chosen by the industry, a number of commissioners developed asthma symptoms after a few minutes.) Confinement swine operations are equally horrendous. Mother pigs are kept confined in 2′ by 7′ by 3′ "gestation crates," in which these animals cannot stand up or turn around or, in the case of large sows, must lie in an arched posture. The animals again never see the light of day, lie on concrete slats in their own excrement, and develop severe behavioral anomalies.

These systems typically inflict four kinds of suffering on the animals raised within them:

1. Production diseases arise from the new ways the animals are produced. For example, liver abscesses in cattle are a function of certain animals' responses to the high-concentrate, low-roughage diet that characterizes feedlot production. Although a certain percentage of the animals get sick and die, the overall economic efficiency of feedlots is maximized by the provision of such a diet. The ideas of a method of production creating diseases that were "acceptable" would be anathema to a husbandry agriculturalist.
2. The huge scale of industrialized agricultural operations and the small profit margin per animal militate against the sort of individual attention that typified much of traditional agriculture.
3. Another new source of suffering in industrialized agriculture results from physical and psychological deprivation for animals in confinement: lack of space, lack of companionship for social animals, inability to move freely, boredom, austerity of environments, and so on. Since the animals evolved for adaptation to extensive environments but are now placed in truncated environments, such deprivation is inevitable.
4. In confinement systems, workers may not be "animal smart"; the "intelligence," such as it is, is in the mechanized system. Instead of husbandmen, workers in swine factories are minimum wage, often animal-ignorant labor. So there is often no empathy with, or concern for, the animals.

Though the beef industry also employs confinement in feedlots, these systems are nowhere near as severe as the other industries. Generally, feedlot cattle are kept in large pens, where they can express much of their natural behavior. Welfare problems arise from historically poor drainage so that the animals may be standing in mud or frozen mud, since feedlots are typically sited in the Great Plains and Midwest. These areas are typically characterized by harsh winters, icy and severe winds, extremely hot summers, and lack of shelter and shade. The cattle, being ruminants, are built for grazing. But after the spectacular increases in grain production after World War II, forage was replaced by grain. A certain percentage of the animals developed rumenal and liver abscesses, but the extra value added to the majority of cattle that did not more than offset the economic losses.

The quality of labor working in feedlots varies considerably regionally. In Colorado, both workers and managers tend to come from a cattle background and therefore are knowledgeable and often empathetic with the animals. Workers in feedlots in other states have quit in disgust at the callousness and lack of empathy of the employees they deal with. In one case, workers allowed sick animals to freeze in a puddle!

Generally, feedlots have improved over the past couple of decades. Most noteworthy, perhaps, is that the stocking density has been considerably diminished, and drainage has been considerably improved. When members of the Pew Commission toured a very large Colorado feedlot after touring dairies, swine facilities, egg "farms," and broiler operations, they were pleasantly surprised at the lack of obvious welfare problems and the condition of the animals. But there is certainly no assurance that all feedlots conform to even a minimum welfare standard (Pew 2008).

Transport from feedlots to packing houses can create welfare issues during extremes of temperature. High stress can result in "shipping fever," which can be reduced by "preconditioning" cattle. Bruising represents an additional welfare issue.

Western Ranching: Cow-Calf Operations

As mentioned earlier, extensive ranches represent the last and best examples of the husbandry ethic in today's agricultural world. The vast majority of ranches are small (with some notable exceptions) and family owned and operated. The primary value driving ranchers is way of life – how they interact with animals, nature, and the environment. Despite the fact that many Americans see ranchers as plutocratic land barons as was depicted in the movie *Giant*, driving Rolls-Royce pickups, this is far from the case. About 10 years ago an animal scientist reported that the average income of a rancher living in the Front Range (Eastern slope of the Rocky Mountains) was $35,000. And a huge part of ranchers' ethic is care for the livestock. The vast majority of ranchers would affirm, "if I had to raise animals the way the chicken or pig people do, I would get the hell out of the business." Unlike these other industrialized, confinement industries, the animals live their lives extensively, as their natures dictate. There are few "technological sanders" deployed in ranching because there is no forcing of square pegs into round holes. Structurally, there is very little in ranching that forces compromising animal welfare. What is there are certain very invasive "management practices" such as castration without anesthesia and hot iron branding that are largely sanctified by custom and tradition.

This latter claim is supported by a thought experiment one can perform with rancher audiences: "if God came down and told you that you may continue to raise cattle, but you may not hurt them, would you go out of business?" Invariably, they say no. This of course evidences that these practices are dispensable or alterable to avoid pain.

Shortly after the birth of a calf, the same ranchers will brand, dehorn, castrate, and vaccinate these animals with no pain control in a festive, party-like occasion (Rollin1995). How can this be reconciled with the ethic of animal husbandry, both historically and today? One can focus on branding for an in-depth look at such practices historically, conceptually, and ethically. Branding of cattle by the use of a hot iron to create an indelible mark on the skin by infliction of a third-degree burn can be traced back to the Egypt of 3000 BC. Obviously, such burns are extremely painful and work by destroying melanocytes or pigmentation cells. The purpose of the resulting mark in today's world is twofold: first, it provides proof of ownership, with each ranch employing a unique, centrally registered mark. Second, it allows for easy recognition of one's cows under mixed range conditions, where many different animals with numerous different owners may graze together. In addition, ranchers claim that brands help to prevent rustling, i.e., theft of cattle. With periodic change in cattle ownership, an animal may be branded more than once.

Historically, there were no alternatives for permanently identifying cattle, nor were there methods for controlling the pain of the burn. Over the past 30 years, as industrial agriculture has become increasingly less acceptable to society, and a return to husbandry agriculture is sought, some ranchers realize that they would do well to underscore their commitment to animal welfare by eliminating painful management practices and marketing beef as the humane meat product. Ironically, the acceleration of modern technology that created confinement agriculture can also be utilized to replace painful management practices. One alternative to branding is provided by digitized retinal images of cow retinas, images with more data points than human fingerprints. Similarly, cattlemen could employ other biometric identifiers or electronic forms of identification such as microchips. All such methods provide permanent, unalterable forms of identification. These biometric and electronic forms of identification provide the additional advantage of facilitating trace back in the event of disease outbreak. In addition, branding does not prevent cattle theft. In many places, in remote areas, rustlers will drive to ranches with a truck, cut fences, slaughter cattle, and steal them as boxed beef. Inherently conservative, ranchers have resisted moving to alternative methods of identification. If asked to justify the infliction of a third-degree burn morally, cowboys will cite the trade-off involved in living extensively in exchange for a short-term burn pain.

Whereas, historically, few urban people had ever witnessed a branding party, this has changed dramatically with the advent of the Internet, and most people are horrified by it. On one occasion, a speaker at a large California ranch was approached by the wife of a meat buyer for a boutique supermarket chain. She closed the door and began to cry bitterly. She said she had just witnessed a branding, and that was the most horrific event she had ever seen, even though her husband's livelihood came from beef. "Those poor calves," she sobbed, "burned and terrified. It is horrible." Clearly, she thought of it as little more than a sadistic pain ritual! Though sanctified by tradition, branding does not play well to urban audiences and does not win many friends for ranching, despite rancher commitment to husbandry!

Knife castration of beef cattle is another painful management practice originating in antiquity (Rollin 1995). Typically, neither anesthesia nor analgesia is utilized to control the attendant pain. Castration is done to reduce aggressiveness in male animals, thereby minimizing aggressive interactions and danger to humans, as well as to prevent unplanned impregnation of female animals and to improve the quality of the meat. Sometimes castration is accomplished by placing elastic or rubber bands around the testicles, creating ischemia so that the testicles eventually die and shrivel. As a prolonged insult, banding appears to be more painful than knife castration, although bloodless. Ways of mitigating knife castration include raising and marketing young bulls, which has been done successfully, use of local anesthetics and subsequent analgesics to mitigate pain, chemical castration, and immunological castration, which involves using the immune system to interfere with the spermatogenic cascade (Rollin 1995). Castration is particularly irrational economically, as the anabolic growth promotion of the testicles is often replaced by hormonal implants, which do not work as well as endogenous testosterone and which tend to be viewed with suspicion by consumers.

The difficulty of performing knife castration increases with the age of the animal. In Britain, it is permissible to castrate calves until 8 weeks of age without anesthesia. It is sometimes argued that newborn or young animals do not feel pain. This is extraordinarily implausible, given that calves are born precocious, i.e., "hit the ground running" in all biological systems. It defies belief that only the ability to feel pain conveniently does not exist until the animal is 2 months old. What is true is that as the animal gets older, greater vascularization is present, making control of bleeding more of a challenge than in younger animals.

Dehorning is utilized to prevent injury by horned cattle to each other and to humans. When done to adult animals by cutting or gouging out the horns, the procedure is extremely painful and creates a bloody mess. When done on young calves, the so-called "disbudding" of the horn buttons can be accomplished less traumatically but still painfully by the use of caustic paste, electric irons, or cutting. Anesthetics and analgesics are virtually never used. A simple alternative to dehorning is to genetically introduce the poll or hornlessness gene into one's herd (Rollin 1995).

There exist other mutilations that were historically more important than they are now. One was notching wattles of cattle for an additional form of identification. (Wattles are the loose skin hanging from the neck of cattle.) Unique patterns of notching were cut (again with no anesthesia) to represent various ranches to which cattle belonged. In a similar vein, but less invasive, were notches cut into the animals' ears. (A similar form of identification is still used today with laboratory mice.)

A final mutilation brings chills to the average male when they learn of it. In cattle ranching, it is necessary to know when female animals are in heat. There are a variety of methods for heat detection, but one common method was to create surgically "gomer bulls." Gomer bulls are normal males whose penis has been deflected and then surgically attached to the animal's inner thigh. These animals, possessing the normal mating urge, will mount females who are in heat, but are unable to achieve penetration because of the unnatural position of the penis (Rollin 1995).

Summary

It should be evident from the discussion that the beef industry faces the smallest number of ethical issues of any modern animal production system, with small ranching the most pristine and most easily improved. Particularly in terms of sustainability, environmental despoliation, and animal welfare, the beef industry is the cleanest (Fraser and Broom 1990). For this reason, it is ironic that beef is often the whipping boy for well-intended but ignorant public criticism of the meat industry.

Cross-References

▶ Animal Welfare: A Critical Examination of the Concept
▶ Sustainability and Animal Agriculture
▶ *Telos* and Farm Animal Welfare

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Biodiversity

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Synonyms

Biological diversity

Introduction

Current rates of species loss exceed those of the historical past by several orders of magnitude and show no indication of slowing. Major drivers of biodiversity loss on a global scale are land-use changes and agricultural intensification. These processes are threatening ecosystem functioning and services on which humans depend. Biodiversity contributes directly through provisioning, regulating, and cultural ecosystem services and indirectly through supporting ecosystem services to many constituents of human well-being. In consequence, there is deep concern that a loss of biodiversity and deteriorating ecosystem services contribute to worsening human health; higher food insecurity; increasing vulnerability of ecosystems to natural disasters; lower material wealth; worsening social relations by damage to ecosystems highly valued for their aesthetic, recreational, or spiritual values; and less freedom for individuals to control what happens and to achieve what they value (see detailed explanations in MEA 2005). Growing awareness of the importance of biodiversity for human well-being has led governments and civil society to a clear set of conservation targets aiming to significantly reduce biodiversity loss in the near future (see Convention on Biological Diversity; www.cbd.int). One of these targets (target 7 of the recent Strategic Plan for Biodiversity 2011–2020) demands that by 2020 areas under agriculture, aquaculture, and forestry are managed sustainably, ensuring conservation of biodiversity.

This entry addresses the importance of agricultural biodiversity on the one hand and the role of agriculture in the rapid decline of global biodiversity on the other hand. It also presents ways how agricultural production can provide essential goods for a growing world population but at the same time sustain biodiversity and the stability and functioning of ecosystems.

Agricultural Biodiversity

Agricultural biodiversity is an important subset of biodiversity. According to the Convention on Biological Diversity (COP 5 Decision V/5), agricultural biodiversity includes all components of biological diversity of relevance to food and agriculture and all components of biological diversity that constitute agricultural ecosystems: the variety and variability of animals, plants, and microorganisms, at the genetic, species, and ecosystem levels, which are necessary to sustain key functions of the agroecosystem, its structure, and processes. Agricultural biodiversity comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fiber, fuel, and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil microorganisms, predators, pollinators) and those in the wider environment that support agroecosystems (agricultural, pastoral, forest, and aquatic) as well as the diversity of the agroecosystems.

Agricultural biodiversity is a fundamental feature of farming systems around the world. Since the beginning of agriculture some 10,000 years ago, farmers made use of a variety of plants and livestock and have employed numerous practices to enhance diversity in and around their agricultural land. Agricultural biodiversity is an important source of traits to improve crops and livestock, for example, conferring resistance to diseases, pests, and parasites or the ability to withstand high temperatures, droughts, or frost. It contributes to the quality of nutrition and might help to buffer against environmental alterations such as climate change but also against economic adversities. Agricultural biodiversity is also a key asset to improve the livelihoods and productivity of small-scale farmers in developing countries. Smallholders farm on less than two hectares and account for 90 % of farmers worldwide. They strongly depend on a rich diversity of native plant varieties and locally adapted animal breeds for their livelihoods and survival and are increasingly recognized as important stakeholders to guard biodiversity.

In Europe, traditional low-intensity farming practices increased biodiversity for millennia. By altering comparatively low-diversity forests into farmland, new habitats were created and enriched by plant and animal species migrating from neighboring biogeographical areas such as the Asian steppes. For a long time, European agricultural landscapes were thus characterized by a rich diversity of land uses, sizes and shapes of fields, as well as seminatural elements such as hedgerows. Such heterogeneous landscapes support high species richness, both above- and belowground, but are severely threatened today by either agricultural intensification or land abandonment.

Green Revolution and the Loss of Biodiversity

The conversion of land from complex natural ecosystems to simplified agricultural ones and the intensification of agriculture have been and still are major causes of the decline of global biodiversity. Since the advent of the green revolution in the early 1960s, global arable land has increased by 67 million hectares as the result of two opposing trends: an increase of 107 million hectares in developing countries, mainly due to habitat conversion in areas of high biodiversity in the tropics, and a decrease of 40 million hectares in developed countries, mainly due to yield improvements.

Intensification of agricultural systems coupled with specialization by plant breeders and the harmonizing effects of globalization have led to a substantial reduction in the genetic diversity of domesticated plants and animals in agricultural systems. For example, a third of the 6,500 breeds of domesticated animals are currently threatened with extinction due to their very small population sizes (MEA 2005). Moreover, of the several thousand plant species which have been used for human food in history, at present only about 150 are commercially important, and about 103 species account for 90 % of the world's food crops. Just three crops, i.e., maize, rice, and wheat, supply almost 60 % of the calories and proteins derived from plants (FAO 2012). According to the FAO, about 75 % of the genetic diversity of agricultural crops has been lost over the last century, and this genetic erosion continues. It is feared that genetic homogenization decreases the potential of species to cope with short-term challenges such as pathogens and herbivores or to persist in the face of environmental changes such as droughts.

Intensive agriculture relies on external inputs such as chemical fertilizers, pesticides, herbicides, and water for crop production and artificial feeds, supplements, and antibiotics for livestock and aquaculture. These practices are hardly sustainable. They damage the environment, undermine the nutritional and health value of foods, lead to reduced function of essential ecosystem services, and result in a severe loss of biodiversity (FAO 2010). Synthetic production of nitrogen fertilizer has been identified as *the* key driver for the increase in food production over the past 60 years. More than half of all the synthetic nitrogen fertilizers ever used on Earth have been used since 1985, and humans now produce more reactive, i.e., biologically available, nitrogen than is produced by all natural pathways combined. Several studies have shown that aerial deposition of nitrogen into natural terrestrial ecosystems such as heathlands or grasslands leads to a significant reduction in plant species richness (e.g., Kleijn et al. 2009; Maskell et al. 2010).

In many European countries, a serious decline of farmland birds has been observed due to agricultural practices. Of the 58 species classified as being primarily birds of farmland, 41 showed negative overall mean trends across Europe. Cereal yield alone explained 30 % of the variation in bird population trends and can thus be used as an indicator for reduced suitability of habitats and availability of food for farmland birds (Donald et al. 2006).

Challenges for Agriculture and Ways to Counter the Loss of Biodiversity

A major challenge for agriculture in the twenty-first century is the provision of basic goods for a growing world population that will reach approximately nine billion by 2050. It has been predicted that the demand for food and fiber will grow by 70–100 % within the next four decades and that a further 10–20 % of grassland and forestland has to be converted for agricultural uses, leading to a global extinction of species (MEA 2005). This would also mean an almost threefold increase in nitrogen- and phosphorus-driven eutrophication of ecosystems, with phosphorus stocks running out by the end of this century and an increasing demand for water (agriculture already accounts for 70 % of global use). In consequence, an increasing competition for land, water, and energy is expected that, together with predicted climate changes, will affect agriculture in the future.

To counter the loss of biodiversity, agricultural production practices need to change. There are multiple, not mutually exclusive, ways agricultural production can provide sufficient, safe, and nutritious food but at the same time sustaining biodiversity and the stability and functioning of ecosystems. Organic farming is one way to improve on-farm sustainability and is already used by many farmers around the world. Other approaches, for instance, deal with sustainable intensification, multifunctionality, multispecies use, the use of genetically modified (transgenic) crops, and the support of smallholder farming. All of these approaches greatly depend on geographical conditions, national and international policies, consumer behavior, and other factors, and it would be pointless to come forward with one global strategy towards agricultural sustainability. Instead, multiple strategies are needed that take into account the specific conditions of a country or region.

Organic Farming

Organic farming worldwide rose by almost 30 % in the last decade. In 2009, about 38 million hectares of land were organically farmed (FAO 2012). Organic farming is a holistic production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. General principles and requirements for organic farming are defined in the Codex Alimentarius guidelines adopted in 1999. According to these guidelines, an organic production system is designed to enhance biological diversity within the whole system, increase soil biological activity and maintain long-term soil fertility (by minimum tillage or zero tillage operations), recycle wastes of plant and animal origin in order to return nutrients to the land, thus minimizing the use of nonrenewable resources and avoid pesticide and herbicide use.

Research indicates that organic compared to conventional farming significantly increases soil biological activity, biomass, and abundance of earthworms and arthropods, plant species diversity, and microbial diversity (Mäder et al. 2002). Organically manured, legume-based crop rotations utilizing organic fertilizers from the farm itself are efficient in resource utilization, enhance floral and faunal diversity, and are thus a realistic alternative to conventional farming systems. The deficits of organic agriculture, mainly related to lower yields, should not be exaggerated. Lower yields (about 20 %) in organic than conventional farming occur mostly in cash-crop-focused production systems and under most favorable climate and soil conditions.

Sustainable Intensification

The environmental impacts of doubling global crop production until 2050, as predicted, will depend on how increased production is achieved. Agricultural production could be increased by either extensification or intensification. While extensification would imply the clearing of additional land for crop production, intensification would mean to achieve higher yields through increased inputs, improved agronomic practices, improved crop varieties, and other innovations. It has been predicted that, if yield growth did not materialize, an estimated one billion additional hectares of land would be needed to meet current demands. At present, agricultural land expansion takes place especially in countries of sub-Saharan Africa that combine growing needs for food and employment with limited access to technology that could increase intensification of cultivation on land already in agricultural use (FAO 2012). Most of these countries still harbor high biological diversity and are thus especially vulnerable to habitat changes.

A trajectory that adapts and transfers technologies to underyielding nations, enhances their soil fertility, employs more efficient nutrient use, and minimizes land clearing could be a more promising path to environmentally sustainable intensification and equitable global food supplies than extensification. Under the assumption that current trends of greater agricultural intensification in richer nations and greater land clearing (extensification) in poorer nations were to continue, it has been calculated that about one billion ha of land would be cleared globally by 2050, with CO_2-C equivalent greenhouse gas emissions reaching 3 Gt and N-use 250 Mt per year by then. In contrast, if 2050 crop demand was met by moderate intensification focused on existing croplands of underyielding nations, adaptation and transfer of high-yielding technologies to these croplands, and global technological improvements, the analyses forecast land clearing of only about 0.2 billion ha, greenhouse gas emissions of 1 Gt per year, and global N-use of 225 Mt per year (Tilman et al. 2011).

Multifunctionality, Decoupled Farm Program Payments, and Agri-environment Schemes

Modern agricultural policy in Europe addresses the loss of biodiversity in cultured landscapes with an increasing share of direct payments for nonconsumptive services of agriculture, so-called public goods. The decoupling of partly area-related direct payments from production payments to reward multifunctional services represents a substantial reform of the European Union's Common Agricultural Policy. Direct payments should secure the conservation of biodiversity and the sustainable development of traditional cultural landscapes through, for instance, agri-environmental schemes. In the United States, so-called green payments are envisaged that will reward farmers and ranchers for sound land management and resource conservation. Environmental benefits could include sequestering carbon, controlling floodwaters, providing wildlife habitats, recharging groundwater, increasing biodiversity, and providing open space and cleaner air and water.

In Europe, agri-environment schemes are important political instruments to counteract the loss of biodiversity in agricultural land and to foster ecosystem services such as pollination and natural pest control. However, such schemes vary markedly between European countries. In Switzerland, the Netherlands, and the United Kingdom, for instance, they focus mainly on wildlife and habitat conservation, whereas in Denmark and Germany they focus on the reduction of agrochemical emissions and in France on the prevention of land abandonment in agriculturally marginal areas (overview in Kleijn and Sutherland 2003). In Switzerland, farmers can qualify for area-related direct payments if they meet a number of environmental standards. One of these standards, regulated by the Swiss Federal Legislation, demands that farmers have to manage at least 7 % of their utilized agricultural land as so-called ecological compensation areas. Farmers are free to choose the types of ecological compensation areas for their land which encompasses traditional landscape elements (most often extensively managed hay meadows) and elements newly designed for the purpose of biodiversity conservation (e.g., wildflower strips sown with seed mixtures of herbaceous plant species). In alpine regions, farmers are encouraged with the help of subsidies to maintain or reestablish species-rich nutrient-poor grasslands which are currently strongly threatened either by intensification or abandonment.

Agri-environment schemes have been evaluated in several studies, most of them showing positive results for plants, birds, various groups of insects, and vascular plants. In the United Kingdom, agri-environment management has reversed declines in the populations of several bird species of high conservation concern such as the Corncrake *Crex crex* (Wilson et al. 2009). In Switzerland, ecological compensation areas resulted in an enhancement of both pollinator species richness and abundance and pollination services to nearby intensely managed farmland (Albrecht et al. 2007). It has frequently been suggested that there might be a disjuncture between the visual aesthetic quality of landscapes and their ecological value, leading to conflicts in the setting of conservation priorities and management aims. However, the results of recent studies suggest otherwise. Both species richness and structural diversity in grasslands were found to be an important predictor for a positive aesthetic valuation of agricultural landscapes (Lindemann-Matthies et al. 2010).

Plant Diversification in Agricultural Systems

Experiments in which biodiversity was manipulated have shown that diversity influences many ecosystem functions. At eight European field sites, the impact of loss of plant diversity on primary productivity was simulated by synthesizing grassland communities with different numbers of plant species. There was an overall log-linear reduction of average aboveground biomass with loss of species (Hector et al. 1999). Recent results from a long-term experiment in the United States suggest that the use of diverse mixtures of species may be as effective in increasing productivity of some biomass crops as ecologically relevant changes (Tilman et al. 2012). In the experiments, a change in plant diversity from one to 16 species caused a greater biomass increase than the application of 95 kg nitrogen per ha and year or other treatments such as CO_2 enrichment, water addition, and the exclusion of herbivores. A recent meta-analysis also depicts strong evidence of a positive impact of plant diversification on agricultural systems. Herbivore suppression, enemy enhancement, and crop damage suppression effects were significantly stronger on diversified crops than on crops with none or fewer associated plant species (Letourneau et al. 2011).

The Use of Genetically Modified Crops

During the past 20 years, genetically modified crops have become increasingly important in agriculture. The innovation of GM crops was sold as a promising avenue to increase agricultural productivity and thus food supply safety for a growing world population and, at the same time, to minimize the impact of agriculture on farmland organisms and ecosystems by reducing fertilizer and pesticide use. From 1996 (first commercial cultivations) to 2011, the area globally cultivated with GM crops has increased from 1.7 to 160 million ha, especially in developing and newly industrializing countries. Today, GM crops (mainly soybean, maize, and cotton) are cultivated by 16.7 million farmers in 29 countries, with the United States, Brazil, and Argentina as major cultivators (James 2011). Less than 1 % of total commercial releases have been executed in Europe, where use and production of GM crops are met with a growing skepticism among consumers. Moreover, EU policies regard GM crops and food as results of a specific production process and are thus much more restrictive than, for instance, US policies which roughly apply the same regulatory framework to GM as to non-GM crops and food.

The two dominant traits of GM crops are herbicide tolerance and insect resistance which are often combined. Proponents of transgenic crops, mainly representatives of research communities and transnational corporations, argue that herbicide-tolerant crops will enhance farmland biodiversity as herbicides can be sprayed and weeds do not have to be removed by massive tillage operations prior to crop seeding. In consequence, tillage operations are reduced, soil organic matter increased, and erosion and water loss decreased. Likewise, insect-resistant crops are thought to reduce pesticide use and thus contribute to biodiversity conservation.

Ecological arguments against GM crops include concerns that transgenes might escape into wild populations, that the use of herbicide-resistant GM crops might lead to an increase in spraying herbicides, and that toxins produced by GM crops might enter the food web and thus affect nontarget organisms. Cases of intraspecific gene flow have already been reported, for instance, in maize (Piñeyro-Nelson et al. 2009). Moreover, it should be noted that biotechnology cannot design new genes but has to rely on the existing diversity of genetic material to move desirable traits from one organism to another.

Support of Small-Scale Farming in Developing Countries

International organizations such as the FAO, but increasingly also ecologists and other researchers, advise to support small-scale farming and to strengthen its efficiency especially in tropical regions which are hotspots of biodiversity. Small-scale farming allows patches of natural vegetation to remain which provide valuable habitats for pollinators, species that prey on pests or weeds or in other ways contribute to beneficial ecological processes. Moreover, due to the use of multispecies and genetically heterogeneous local landraces, small-scale farming can buffer against environmental adversities and is thus rather resilient to environmental alterations such as climate change.

On the other hand, small-scale farming is highly vulnerable to market developments.

Recently, international investors have been increasingly leasing or buying farmland in Africa, Asia, and Latin America (land grabbing). Main investors are food-importing countries with land and water constraints but rich in capital such as the Gulf States or countries with large populations and food security concerns such as China, South Korea, and India (FAO 2010). They invest in farmland overseas, especially in tropical and subtropical regions, where production costs are lower, land and water more abundant, or climatic conditions more suitable for the production of staple or biofuel crops. As a result, low-intensity smallholder land is converted to intensively managed production units, further diminishing global biodiversity and ecosystem functioning.

Summary

Changes in biodiversity due to human activities were more rapid in the past 50 years than at any time in human history, with agriculture as a major driver of biodiversity loss. Biodiversity loss and especially the loss of genetic diversity in both wild and domesticated organisms are reducing overall fitness and adaptive potential of species and are threatening ecosystem functioning and services on which humans depend. For fear of genetic erosion, biodiversity is now conserved ex situ in gene banks or breeders' materials. The Millennium Seed Bank Project, for instance, wants to insure against the extinction of plants in the wild by storing seeds for future use. In 2009, it reached its 10 % target of banking the entire world's wild plant species.

Both the maintenance of biodiversity and the provision of basic goods for a growing world population are global responsibilities. Organic farming, sustainable intensification, multifunctionality, multispecies uses, and support of smallholders for more efficient, profitable, and sustainable production are just some ways to preserve and use biodiversity better in agricultural areas while meeting increasing demands for food, fiber, and other agricultural products. Making consumers aware about food production that is done in environmentally, socially, and ethically acceptable ways could be another important step towards sustainable agriculture, biodiversity conservation, and global equity.

Cross-References

- ▶ Agricultural Ethics
- ▶ Farms: Small Versus Large
- ▶ Herbicide-Resistant Crops
- ▶ Land Acquisitions for Food and Fuel
- ▶ Multifunctionality of Agriculture and International Trade
- ▶ Pest Control
- ▶ Sustainability of Food Production and Consumption

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Biodiversity and Global Development

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Introduction

There is general agreement that the world's biodiversity is being degraded at a phenomenal rate, perhaps far more rapidly than the popular press has reported. Proponents of conservation suggest that optimism is warranted in that there seems to be universal concern over this surging problem. From the point of view of values and ethics, who can be against the conservation of biodiversity? This *cause celebré* enjoys universal approbation from all sectors of all societies. Yet balancing the costs and benefits of conservation is a complicated issue, and approbation becomes less universal in specific case studies.

For example, local farmers in the Global South may see large mammalian carnivores as threatening to their children. Developers in the Global North may see attempts at preserving a threatened species of snail or fish as threatening to their aspirations. And the fundamental problem of thinking of biodiversity as nothing more than big charismatic creatures living in pristine environments remains a major stumbling block to devising effective programs to engage this truly worldwide problem. Small things like fungi and insects do not get the same attention as elephants and mountain gorillas. Such large charismatic creatures represent a minor fraction of the world's biodiversity, compared to the small things – mites, nematodes, insects, to say nothing of bacteria, the biodiversity of which remains largely enigmatic.

Global development has been uneven since World War II, with some parts of the world having experienced dramatic growth in economies and human wellbeing while others have seen stagnation. Analysis of this pattern is eclectic, complicated, and controversial, but there is agreement that the history of colonialism retains its mark, with neocolonial interference from the richer countries frequently creating barriers to development in the former (and sometimes current) colonies. Most of the poorer areas of the world are in the south and in contemporary discourse collectively are referred to as the "Global South," while most of the richer areas are in the north and are referred to as the "Global North."

There is an important connection between biodiversity and global development. We see this connection from an examination of the key patterns of both biodiversity and development (IAASTD 2009).

Patterns of Biodiversity

Among the global patterns of biodiversity, there are two that stand out as relevant to questions of development. First, species diversity tends to increase with decreasing latitude, a geographic pattern. Second, species diversity tends to decrease as the intensity of management of the ecosystem increases, an intensification pattern.

Examining biodiversity at different latitudes, there is a dramatic difference between temperate and tropical worlds (and thus between Global North and Global South). Forest surveys in the northern Europe, for example, will generally encounter between 2 and 20 species of trees per hectare, whereas such surveys in central Africa will encounter upwards of 300. The bird guide of Colombia lists 1695 species, while in all of North America (an area much larger), there are 700. Butterflies, ants, mammals, and amphibians all show this same pattern. There are exceptions, but the general pattern is one of increasing numbers of species as you approach the equator. The cause of this pattern has been the subject of an enormous amount of speculation and debate in ecology and remains generally unresolved.

Examining different ecosystem management strategies, it is first necessary to distinguish between two concepts of biodiversity. First is the collection of plants and animals that the manager has decided are part of the managed system – rice in the paddies of Asia, corn and beans in the traditional fields of Native Americans, carp in the fish ponds of China, and so forth. This is referred to as the "planned" biodiversity. Additionally in each of these ecosystems, there is a great amount of biodiversity that spontaneously arrives – the aquatic insects and frogs in the Asian rice paddies, the birds and bugs that eat the Native American's corn and beans, and the crayfish that burrow their way into the sides of the Chinese fishponds. This is referred to as the "associated" biodiversity. Frequently the managers themselves are determinedly concerned about the planned biodiversity, especially when dealing below the species level (i.e., genetic varieties of crops). Nevertheless, it is almost certainly the case that the associated biodiversity is the dominant form in almost all managed ecosystems.

The vast majority of managed ecosystems are agricultural. The particular form of agriculture has important impacts on biodiversity through several mechanisms. It has become common to order these mechanisms with the rubric of "intensification." Although the term "agricultural intensification" has a very specific and complex definition in anthropology, in the biodiversity literature, the term "management intensification" is taken to be the transition from ecosystems with high planned biodiversity to low planned biodiversity. The ecology of the agroecosystems is such that the final stages of intensification usually involved the application of agrochemicals to substitute the function of some of the biodiversity that is eliminated. There are two basic patterns of associated biodiversity change that might be expected as a function of intensification. First, it is sometimes the case that with even a small alteration in natural habitat by some management system, associated biodiversity tends to fall dramatically. Second, it is sometimes the case that associated biodiversity declines by only small amounts with low levels of intensification and only after much higher levels are reached do we see dramatic declines. Which of these two patterns (or what combination of the two) exists in particular systems remains largely unstudied.

Patterns of Global Development

Post WWII development has resulted in uneven distribution of prosperity and potential. Popularly referred to as the G8 (in 2013), the three nations of the British Empire (UK, USA, Canada), three western European nations (France, Germany, Italy), and Japan and Russia, these eight nations account for approximately half of the world economic activity. Other European nations are commonly included as members of the Global North. Most tropical countries are thought to be the major elements of the Global South, typified by low GDP, and thought to be in the developmental position due to historical circumstances, largely a result of the age of European Imperialism. More recently the economic changes in Brazil, South Africa, India, China, and Mexico have propelled them to a seemingly intermediate status, codified (as of 2013) as the Outreach Five.

In addition to the evident distinction economically between the Global North and Global South, there is also a distinction of geographic demography. In nations of the Global North, generally less than 35 % of the population resides in rural areas, frequently far less (e.g., 11 % in the UK, 20 % in the USA), whereas in nations of the Global South, generally more than 50 % lives in rural areas (e.g., 88 % in Uganda, 81 % in Cambodia). There are exceptions, but the general rule is that in the Global South, a large segment of the population lives in rural areas, which implies a large segment of the population involved in agricultural activities. From an ethical standpoint, development goals cannot ignore this segment of the population.

Intersection of Biodiversity and Global Development Patterns

There is thus this curious pattern in which the bulk of the world's remaining biodiversity exists in the same areas of the world where underdevelopment and poverty exist. This leads to important contradictions in global goals. On the one hand, conservation of biodiversity must concentrate on the Global South, yet, on the other hand, poverty reduction in the Global South must promote rural development activities, many of which involve the intensification of agriculture, generating precisely the background conditions known to reduce biodiversity. There thus appears to be a contradiction between the goals of conservation of biodiversity and reduction of poverty.

Pursuing a resolution of this contradiction, scholars have proposed a variety of avenues, most of which can be broadly categorized into passive versus active. Of the passive approaches, some scholars suggest lessons from history. The European colonization of eastern North America began with massive deforestation to make way for the expansion of agriculture. Subsequently, through industrialization and related urbanization, agriculture declined and forests returned. The dynamics that drove this process are evident at a broad qualitative level – wealth from agriculture drives local industrialization that, in turn, acts as a magnet for labor, which depopulates the countryside, leaving natural succession to take over. This general view seems historically accurate and has been referred to as the "forest transition model" (FT model). Similar processes have been described for some European countries, the rural US south and most importantly, given its tropical location, Puerto Rico. Based on these and other examples, some scholars suggest that the FT model could be a framework for understanding tropical landscape dynamics in general and even be used for promoting a conservation agenda and, indirectly, poverty reduction through industrialization.

Ultimately, the FT model rests on two quantitative assumptions and a seemingly logical conclusion. The two assumptions are, first, a given population density requires a specified land base to enable productive activities adequate for survival of the whole population and, second, the amount of food required to support that population, divided by current per-area productivity, equals the land area necessary for agricultural production. The logical conclusion is that the total land area minus the area necessary for production is what is available for conservation.

The FT model has been criticized on the basis of many case studies in which the conditions for land abandonment seem to have been met, but the expected urbanization failed to follow.

The second set of approaches, the active approaches, include a variety of forms. One form is the land-sparing versus land-sharing debate. Assuming a certain amount of land will be devoted to food production (agriculture) and the rest to conservation, the question is whether the part devoted to food production should be intensified so as to produce more food per area (and thus have less land required to feed a fixed population, with more to "spare" for conservation) or whether the biodiversity contained in the agricultural land should be taken into consideration ("shared" with the biodiversity). Analyses have appeared supporting both points of view, seemingly dependent on the particulars of chosen case studies (Fischer et al. 2011; Perfecto and Vandermeer 2010; Tschrntke et al. 2012).

Other analysts see a resolution of this contradiction in the combination of recent understanding of the ecology of biodiversity and the grassroots politics of rural sectors of the Global South. Viewing the overall landscape as fragments of natural vegetation in a matrix of agriculture, basic principles of ecology point to the importance of the agricultural matrix as a corridor that provides a necessary connection between isolated fragments of natural habitat that contains much of the biodiversity. The activities of small-scale agriculturalists accord well with the construction of such "high-quality" matrices (Perfecto et al. 2009).

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Biodynamic Agriculture

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Synonyms

Alternative agriculture; Holistic farming; Spiritual farming

Introduction

This entry briefly explains and explores the history of biodynamic farming, including some of its key philosophies and food production practices. Biodynamic farming views a farm as a holistic entity, a microcosm in physical form of the macrocosm of the physical, ethereal, and astral form of the spiritual universe.

Rudolph Steiner

Biodynamics, or biodynamic farming, refers to a specific practice of agriculture that is based upon the work and teachings of the Austrian Rudolf Steiner (1861–1925). In order to understand biodynamic farming, one must first understand Steiner and his metaphysical belief system. Steiner was a prolific researcher and speaker, using his created method of "spiritual science" to study the inherent wisdom of humanity (anthroposophy). His research was based on his own spiritual and visionary experiences and intuitive insights, as well as studies he undertook with Theosophists and readings he undertook in religious literature from around the world. His experiences and active teaching schedule resulted in the publication of over 40 books, and he was invited to give over 6,000 lectures. Before dying, Steiner founded The General Antrhoposophical Society in Switzerland in 1924. Besides providing the inspiration for biodynamics, Steiner was instrumental in creating or inspiring Waldorf Schools, Camphill villages, anthroposophic medicine, and eurythmy. Steiner was also a leading expert on Johann Wolfgang von Goethe's work, and the impact of Goethe on Steiner's thinking was recognized when Steiner designed the Goetheanum in Dornach, Switzerland, which serves as the headquarters of the global Anthroposophical Society.

Steiner's spiritual science is predicated on the belief that each person is on an evolutionary trajectory, occurring by incarnations over many lifetimes, toward self-realization/God-realization. By practicing and cultivating the spiritual insights taught by Steiner, individuals can advance along this evolutionary path and have visionary, gnosis-filled experiences. Thus, anthroposophy is a scientific approach to spiritual experiences of our innate divine wisdom. Steiner's cosmology borrows heavily from Theosophy, Germanic idealism, and Advaita Vedanta Vedic philosophy contained within the *Upanishads*, which speak of an eternal divine spark within each being that is on a path toward liberation via reunion into the Divine/God. Steiner taught that as a soul progresses through physical incarnations, so does humanity and the world. Steiner's view of the human is that the human contains a four-part body. The first is a physical body, based on the mineral world; the second is a life or etheric body, which causes the body to grow and vitalizes it, making it alive, and this body is associated with the plant world; the third is an astral body, which serves as the seat of consciousness and sentience, and is connected to the animal world; and the fourth body is the ego, or self-awareness. Taken together, Steiner's cosmology is of an interconnected, holistic cosmos, where etheric and astral forces emanate from the cosmos and influence the development of all life on earth. This includes the evolutionary growth and development of animal life, plant life, and human spiritual and physical life. It is within this larger cosmology that biodynamics functions.

From June 7 to 16, 1924, Steiner gave eight lectures in German to a group of farmers on the "Spiritual foundations for the renewal of agriculture" at Koberwitz, Silesia (Steiner 2005). . These farmers had expressed concern about noticed losses in yields and soil health, so Steiner was invited to provide insights into how to create remedies to this scenario. The mechanization and use of chemicals in agriculture was also about to begin, so Steiner's teachings became the basis of an alternative to what became the Green Revolution, and it is upon these lectures that biodynamic farming is based.

Biodynamic Farming Practices

Key insights from Steiner's lectures became the basis for biodynamics, and most every biodynamic farmer builds their own practice of farming upon these teachings. These include the teaching that a farm is a self-contained microcosm that mirrors the macrocosm. Thus, a farm should be managed as a holistic entity while recognizing that astral and etheric forces from the cosmos influence plant, animal, soil, and human health. It is upon this key teaching that unique biodynamic farming practices are built. The most unique of these is the creation and casting of biodynamic preparations, or "preps." In essence, biodynamic preps (BD preps) are a kind of homeopathy for the soil, bringing etheric and astral forces into the soil within which plants grow and upon which animals then graze and consume. The preps are meant to help a farmer create a microcosm of the macrocosm, where, by using the preps, astral and etheric forces are amplified on the farm, resulting in healthier, more spiritually dense and pure products. As these products are consumed, the human becomes more spiritually pure, and their evolutionary process in this lifetime is thus sped up.

Another key insight is the significance of cows, which Steiner saw as being in tune with astral and etheric forces, and especially cows with their horns intact; the horns act as a receiver of astral and etheric forces, and cows fed in grains and grass grown via biodynamic practices are seen as being the embodiment of health, so that their manure becomes the base of biodynamic composting.

Steiner spoke of various biodynamic composts and elucidated specific ways to make them. The composts are a mix of naturally occurring plants, mainly herbs, who possess etheric and astral properties that when potentized by rapid stirring in clockwise motion for 50 s, followed by 10 s counterclockwise, repeated for 60 min, are ready to be applied sparingly to a field. It is believed that by stirring them this way for such a long time, a spiritualized homeopathic tincture is created that activates the plant's etheric forces with the astral forces of the cosmos that are called in the vortex that is created while stirring. While he did not name them, the names BD 500–507 are how they have become to be known. These composts form the basis of biodynamic farming and are as follows:

- BD 500 – this is the basic "starter" compost tincture and works on building microbial activity in the soil, aids in root growth, and helps form soil humus. BD 500 is made by filling old cow horns with fresh cow manure and burying this under the ground for the winter months. Once dug up, the dung has been reduced to a fermented compost, and a pinch of this is added to pure water (ideally rainwater or from a pure spring or stream), potentized, and is spread over the fields in the spring as soil life forms resume activity after the winter (Mäder 2002).
- BD 501 – this is ground quartz silica that is buried in cow horns over the spring and summer months. Quartz silica was seen by Steiner to be a very potent mineral. A pinch of silica is potentized in pure water and spread over growing plants. It is believed that this adds vitality and strength to plants and aids plant photosynthesis, thus allowing plants to hold off pests and blights.
- BD 502 – this is made from dried yarrow potentized in pure water and is added to plants as needed so that plants can attract trace elements and minerals from the soil, thus aiding in their growth and health.
- BD 503 – this is made from dried chamomile potentized in pure water and is added to compost piles and to the soil, as it is believed to increase soil life and health and thus stimulates plant growth.
- BD 504 – this is made from dried stinging nettle potentized in pure water and is believed to enliven the earth and soil, helping each individual plant obtain the nutritional components they need to be healthy.
- BD 505 – this is made from dried valerian potentized in pure water and is added to compost piles so that phosphorous will be properly used by the soil.
- BD 506 – this is made from dried dandelion potentized in pure water and stimulates the relationship between silicon and potassium, allowing them to work together to attract astral forces into the soil.
- BD 507 – this is made from oak bark potentized in pure water and provides healing qualities so that plants can combat harmful diseases.

Typically, 500 and 501 are made and added directly to the soil and plants 502–507 are potentized either in water or by stirring the dried herbs in fresh manure from healthy cows (ideally from cows with horns) for an hour, at which point they are added directly into a compost pile. The compost pile sits for a summer and over a winter, allowing the preps to become active homeopathically throughout the compost, and this compost is added to the fields the following year.

Key Figures and Developments

Steiner inspired his close contemporary, Ehrenfried Pfeiffer, who was instrumental in the development and dissemination of biodynamics. Other key figures in the development of biodynamic farming practices include Maria Thun, who developed a planting calendar based on the position of certain key celestial bodies (a similar calendar is produced every year by Stella Natura); Alex Podolinsky, who is instrumental in bringing biodynamics to Australia, which has thousands of hectares currently devoted to biodynamic wheat and cattle (Podolinsky 1996); Josephine Porter, who formed the Josephine Porter Institute for Applied Bio-Dynamics, from where most North American biodynamic farmers receive the ingredients for BD preps; and Hugh Lovel. These and others have been instrumental in including the use of various rock powders on biodynamic fields (Stalin 2010); and making connections between insights from fractal and chaos thinking and applying these to developing unique biodynamic methods of stirring water.

The Demeter label began in 1927, at which point they became the standard bearer of marketing biodynamic foods, and they have overseen international biodynamic standards since 1992. These standards regulate biodynamics in the production and marketing of grown food, cosmetics, manufactured textiles, and brand labeling. The International Biodynamic Association was founded in 2002, and they currently own and globally protect the trademark of Demeter and Biodynamic. Biodynamic wine is gaining in popularity, and overall acreage of grain crops grown with biodynamic methods has steadily been increasing. Biodynamic farming practices are now found in many of the world's farming regions, and an exciting recent development in biodynamics was the introduction of biodynamics to China, where BD preps and methods are used at the Phoenix Hills Commune outside of Beijing.

Summary

This entry provides a brief foundation about what is biodynamic farming, its key historical figures, and some of its key growing practices. If interested in learning more, the interested reader should consult some of the below literature (Mason 2011; Pfieffer 2011; Tompkins and Bird 1998), purchase and consume biodynamic products, attend a workshop or training on biodynamics, and/or visit a biodynamic farm.

Cross-References

► Agricultural Ethics
► Community-Supported Agriculture
► Farm Management
► Food-Body Relationship
► Metaphysics of Natural Food
► Natural Food
► Sustainability and Animal Agriculture
► Trade Policies and Organic Food

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Bioethics at Purdue University

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History

Since 2006, the Purdue *Lectures in Ethics, Policy, and Science* (formerly the *Bioethics Seminar Series*) has led Purdue's efforts in and around bioethics, a field broadly conceived as the study of questions of the moral relationships with the living world. The permeation of bioethical questions throughout philosophy, policy, and the sciences speaks to the vivacity of the concept in everyday lives. These lectures provide a framework for integrating a diverse range of existing institutional strengths in disciplinary ethics, responsible conduct of research training, and philosophical ethics. They give philosophers, policy makers, and scientists the opportunity to discuss current issues and establish a strong rapport, building opportunities for engagement between philosophy, policy, and science at a campus-wide level, and to raise awareness of the ethical implications of biotechnological development both locally and globally.

In light of the contemporary development of federal requirements for ethics education for scientists, like those requirements set forth by the National Institutes of Health (NIH)'s and the National Science Foundation (NSF)'s responsible and ethical conduct in research requirements, the *Lectures* was conceived to focus on the increasing importance of bioethics at Purdue, an institution with recognized strengths in science, technology, and bioengineering but also important foci in philosophy and the liberal arts. The *Lectures* seeks to distinguish itself from existing regional resources in ethics, focusing primarily on environmental, technological, design, and nonhuman moral issues.

In addition to providing a service to the University community, the lecture series is also an excellent opportunity for professional networking, connecting Purdue students and faculty to some of the leading thinkers in this area. Most visitors remain for 1 or 2 full days and attend dinners with interested faculty and graduate students after their talks, enabling closer interaction with the Purdue community. When possible, the graduate student facilitators work to schedule meetings the day of the talk with interested faculty and researchers. This networking allows the benefits of the series to extend well beyond the main lectures, including allowing relevant departments to make a positive impression on leading scholars about research and teaching activities in these areas.

Cofounders Jonathan Beever and Nicolae Morar developed an initial formal proposal for the project. The 2010–2011 academic year marked an evolution of the series as Beever and Morar, both approaching the end of their doctoral programs in philosophy, proposed a sustainability plan for the series that included a multiyear funding strategy for future graduate student facilitators. Purdue's new Global Policy Research Institute and the Office of the Provost awarded their efforts with funding for two 3-year extendable graduate student appointments to facilitate future iterations of the series. Beever and Morar also put in place a faculty oversight committee to help guide future graduate student facilitators. Current graduate student facilitators present annual reports to a group of 18 sponsoring organizations, both programs and departments from within Purdue's academic community and also centers and institutes from its renowned Research Park, whose support of the *Lectures* remains vital to its success. Not only do these sponsors supply the entirety of the annual budget, but also they are involved with attracting audiences and proposing speakers. Along with the formal proposal, support for the *Lectures* was achieved and is maintained through personal meetings with sponsors to discuss goals and purpose. The wide variety of sponsorship works for the series on many levels. Not only does it increase attendance and audience diversity, but also it enables the series to advertise more widely and efficiently across the University community. Finally, the wide range of sponsors for the series demonstrates the universal nature of the questions that it is intended to raise.

Major Activities

Each year, the *Lectures* focuses on developing between four and eight seminars on a range of topics that are pertinent to their audience and relevant to current University and global affairs. Scholars who have an international reputation and are intimately involved with the topic at hand are sought out as speakers, chosen by the graduate student facilitators each of whom is a young researcher in and around bioethics. The *Lectures* also seeks out collaborative projects and events across programs and institutions, having to date worked closely with several organizations both internal to the University and within the state and region more broadly. These collaborative ventures help to establish the *Lectures* – and Purdue – in the broader context of regional ethics education.

The goals and objectives of the *Lectures* project seek to:

- Facilitate interdisciplinary discourse on “hot” issues in science, ethics, and policy
- Promote ethically responsible development of science, technology, and policy at Purdue
- Establish connections between Purdue’s science and technology community and other regional science policy institutions around the development of ethical thought and action
- Involve philosophy in policy and ethics decisions at a campus-wide level
- Build opportunities for engagement for students and faculty
- Broaden the scope of bioethics to include issues related to the environment, energy, and nonhuman animals
- Involve nationally recognized scholars in diverse discussions of bioethics
- Develop a sustainable online e-resource of expert perspectives in this broad view of bioethics

The success of the seminar series is due in part to an extensive advertising system. An advertising flyer is developed by a professional graphic artist and distributed before each talk by the facilitators. They strategically distribute electronic versions of these posters, utilizing networks of contacts to create mailing lists, contacting individual faculty members, and relying on colleagues in philosophy and other relevant departments inside and outside liberal arts to help advertise the series and the individual talks. Finally, the facilitators work with faculty instructors to integrate seminars into classwork, drawing undergraduate students to the *Lectures*. As the series continues to grow, word of mouth has become also a valuable manner of advertising. Faculty and administrators have praised the *Lectures* for its professionalism and high quality, for attracting world-class speakers on a diverse range of topics to Purdue, and for building invaluable links between and among the liberal arts and the sciences.

Landmark Contributions

The *Lectures* project was the independent initiative of two graduate students in philosophy, Jonathan Beever and Nicolae Morar, who together initiated, led, and developed the series from 2006 to 2012. Since its inception, the *Lectures* has grown steadily and sustainably. The original *Purdue Bioethics Seminar Series* developed out of a University Fellowship awarded to Morar in the Fall of 2006. The project accomplishes two goals. First, it has established an annual series of ethics seminars by distinguished speakers, who each focus on key issues in bioethics – from health and disease to climate change. Second, it established a website dedicated to these seminars at www.purdue.edu/bioethics that hosts streaming media and supplemental resources for those topics. To date, the *Lectures* has hosted over 30 events and speakers on a wide range of issues, from Bernard Rollin on animal pain to Norman Daniels on healthcare and Henry Shue on global climate change. In that first year of the program, more than 250 students, faculty, staff, and members of the at-large community attended these seminars. The series noted continuous growth since then, with an average of over 110 participants at each event.

The *Lectures*’ website, www.purdue.edu/bioethics, bolsters the project’s longevity and reach by providing an initial resource library for the topics of the seminars, cataloging bibliographies of speakers, and streaming media recordings of all lectures given after the first year. In that first year, more than 1,107 people visited the website and over 6,000 web pages were loaded. Since that time, use and visibility of the website has continued to expand, registering over 10,000 annual page loads with close to 3,500 annual unique visits. The resource base the facilitators continue to build will become an active record of the seminars and topics of this series – and a growing resource for education and research in bioethics.

To date, bioethics at Purdue continues to facilitate connections between philosophers, policy makers, and scientists around important themes in bioethics. It has fostered the development of Purdue's first undergraduate bioethics club, facilitated research and pedagogical projects, and cosponsored a variety of other campus-wide ethics events and initiatives. In so doing, the *Lectures* likewise fosters professional development for the graduate student facilitators, leading to further research and teaching opportunities.

Major Areas

Areas of focus for the *Lectures* include environment and climate, biotechnologies, use of nonhuman animals, medicine, health, and public policy: all conceived under the umbrella of bioethics.

For More Information

To learn about upcoming events, watch past events, and learn more about the *Lectures*, please visit www.purdue.edu/bioethics or contact the Purdue Lectures in Ethics, Policy, and Science at Purdue University at bioethics@purdue.edu.

Cross-References

- ▶ Agricultural Ethics
- ▶ Animal Welfare in the Context of Animal Production
- ▶ Animal Welfare: A Critical Examination of the Concept
- ▶ Biodiversity and Global Development
- ▶ Biofuels: Ethical Aspects
- ▶ Biotechnology and Food Policy, Governance
- ▶ Centre for Animal Welfare and Ethics
- ▶ Climate Change, Ethics, and Food Production
- ▶ Environmental Ethics
- ▶ GMO Food Labeling
- ▶ Nanotechnology in Agriculture
- ▶ Oxford Centre for Animal Ethics
- ▶ Systemic Ethics to Support Wellbeing

Biofuels: Ethical Aspects

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B

Synonyms

Agro-energy; Biodiesel; Bioenergy; Bioethanol; Food versus fuel; Fuel crops

Introduction

Oil is one of the drivers of Western industrial societies. Our pattern and (increasing) quantity of oil consumption, however, is becoming more and more problematic for a number of reasons. First, oil and other fossil fuel stocks are finite and will at some point run out or become prohibitively costly to mine, both in economic and in environmental terms. Second, burning fossil fuels releases greenhouse gases into the atmosphere, thereby contributing to global climate change. Third, dependence on oil implies dependence on oil-producing countries – countries that might not always be politically stable or well disposed toward oil-importing countries and thus threaten the importing countries' energy security (Landeweerd et al. 2009).

Biofuels have been hailed as a replacement that had the potential to address all those problems. First, biofuels are made from plants or algae ("fuel crops") that can be cultivated indefinitely, rather than coming from a limited stock. Second, biofuels were initially considered to be "carbon neutral," where the amount of carbon emitted during combustion would be the same as the amount stored in the plant during growth, leading to a net carbon emission of zero (however, see section "Land Use"). Third, fuel crops can be grown anywhere, though conditions in the (sub)tropics favor certain kinds of crops such as oil palms, which means that it lessens dependence on oil-producing countries.

Biofuels: Ethical Aspects, Table 1 Kinds of biofuels by source (classification according to NCB 2011)

Generation	Type	Examples	Promises
First	Food crops	Palm oil, soy oil, rapeseed oil (biodiesel); corn ethanol, wheat, sugar cane (bioethanol)	Renewable, carbon neutral, no dependence on oil-producing countries
Second	Nonfood crops	Switchgrass, *Miscanthus*, willow, *Jatropha*, "waste" materials (stalks, leaves, etc.)	Does not take up farmland, can grow on marginal soil
Third	Nonfood organisms	Algae	Does not take up farmland, relatively efficient photosynthesis compared to plants

In addition, two arguments are often mentioned in favor of using biofuels rather than alternative energy sources for the transport sector: First, biofuels can be blended with fossil fuels and thus can utilize our existing infrastructure, whereas the switch to electric cars or a hydrogen economy would require massive infrastructural changes. Second, heavy-duty vehicles such as airplanes cannot as yet be powered by fuel cells or batteries but could be powered by biofuels (Nuffield Council on Bioethics 2011, 19, hereafter the NCB). In practice, however, many types of biofuels have not lived up to their promises or even exacerbated problems and created normative, practical, and political challenges besides. This entry aims to give an overview of ethical issues of biofuels and their treatment in the literature.

In particular, after giving an introduction on what biofuels are, this entry presents an overview of ethical challenges on two levels: the practical and policy level, where concrete ethical problems arise and are addressed by governments and advisory and regulatory bodies, and the theoretical level, where the choice of theoretical framework influences which problems and possible solutions are highlighted. Issues related to GM agriculture and intellectual property are not addressed here as those topics are covered elsewhere.

Biofuels and Ethical Frameworks

What Are Biofuels?

Biofuels are liquid fuels derived from biomass, which can be bioethanol (made from fermented plant sugar) or biodiesel (made from plant oil); this entry focuses on their use as transport fuels. Biofuels are usually categorized as belonging to the "first," "second," or "third" generation; while categorization may differ, this entry adopts that of the NCB (2011) by type of source used. Here, the first generation consists of fuel derived from food crops such as rapeseed, soy beans, and corn. The second generation consists of fuel derived from inedible plants such as switch grass or *Jatropha* or "waste material" such as stalks and leaves. The major promise of these types of crops is that they do not require farmland and grow on marginal soil and so do not compete with food crops. The third generation consists of fuel derived from algae that would not require farmland, as they could be grown in ponds or bioreactors. Third-generation biofuels are still in an early phase of development, and little has been written on their ethical aspects (exceptions are McGraw 2009; Biello 2011). An overview of the generations, some examples, and their related promises can be found in Table 1.

Biofuels in Practice: Concrete Issues

This section discusses how biofuels have fared so far compared to their promises and what new issues have arisen. As different kinds of biofuels tend to have different costs and benefits and the promises of second- and third-generation biofuels are mostly tied to anticipated developments, this entry abstains from giving a normative judgment regarding which kind of biofuel is "best." Rather, the section is structured as a descriptive account of different issues and value trade-offs that occur in the context of biofuel production and use.

Food Versus Fuel

The strongest critique against first-generation biofuels, and also the strongest driver to develop subsequent generations, is the very idea of using food crops for fuel. Jean Ziegler, United Nations special rapporteur on the Right to Food, has called first-generation biofuels a "crime against humanity" as they threaten the human Right to Food. Several arguments have been given why using food crops for fuel is problematic. First, though biofuel production cannot straightforwardly be said to lead to rising food prices (NCB 2011, p. 30), selling food crops on the fuel market could influence the food market in various negative ways (Gomiero et al. 2010). This is exacerbated by the fact that cars require lots of biomass to go on: the common example cited in the literature is that filling the 25-gal tank of an SUV with pure corn-based ethanol would require over 450 lb of corn, which contains enough calories to feed one person for a year (e.g., Gamborg et al. 2011). Considered on a larger scale, this equation means that using food for fuel is in a sense throwing food in a bottomless pit, where even processing huge amounts of food crops will only offset a small percentage of our transport fuel consumption (Biello 2011; Gamborg et al. 2011). Many authors therefore stress that biofuels are by no means a comprehensive solution to the problems caused by oil dependence, but rather might have a place in an "energy portfolio" alongside other renewable energy sources, together with efforts to conserve energy and make existing usage more efficient (NCB 2011).

Proponents of second- and third-generation biofuels are quick to point out that their proposed crops cannot be used as food and will thus avoid the food versus fuel trade-off. Indeed, one argument for converting "waste" plant material such as stalks and leaves into fuel is that it would be a more efficient use of existing food crops. However, another trade-off lurks here: in a sense there is little or no "waste" in agriculture as unused plant material is often composted or left on the soil. This serves a variety of purposes, such as preventing soil degradation and erosion, maintaining soil ecology, and converting arable land into carbon sinks, offsetting carbon emissions (Gomiero et al. 2010). Therefore, Gomiero et al. claim that there is a clear limit to how "efficiently" arable land can be used and suggest that a precautionary approach should be adopted in removing plant material (and the nutrients contained therein) for fuel conversion.

Both the food versus fuel debate and the problem with using waste material for fuel stem from a broader question, namely, "What is the best possible use that these crops (this farmland) can be put to?" Compared to possible applications such as food, biopharming, and chemicals, biofuels are a low-value, low-priority application of biomass, given the high energy costs and huge quantities needed for fuel production, meaning that this question will rarely straightforwardly be answered with "biofuels." Indeed, some companies that started developing algae-based biofuels have remained in business by switching to producing more profitable food supplements and chemicals (Biello 2011).

Land Use

Closely related to the food versus fuel debate is the issue of land use. The problem is basically that there is a finite amount of arable land to go around and land used to grow fuel crops cannot be used to grow food crops (though food and fuel crops can be combined, e.g., through intercropping or planting fuel crops in hedges around food crop fields; also, crops like corn or soy can be sold either for food or for fuel). Thus, food can compete with fuel even though the fuel is made from nonfood crops.

One way to deal with this problem is to convert non-arable land (e.g., forest, savannah) into arable land. This land can then be used for food crops displaced by biofuel crops (which is called "indirect land use change" or ILUC, itself a problematic concept; see, e.g., Gamborg et al. 2011; NCB 2011, pp. 31–33). Another option is to use this land for the biofuel crops themselves ("direct land use change"), thus adding to the total amount of arable land. Not only can this be detrimental to local ecosystems and biodiversity, however, land conversion can also release great amounts of carbon into the atmosphere, essentially offsetting the emission gain of biofuels for tens or even hundreds of years (Gomiero et al. 2010).

Another way to deal with the problem of land availability is to grow fuel crops on non-arable land directly. It has been promised that second-generation biofuel crops can grow on marginal land that is otherwise unsuitable for growing food crops. However, it is generally the case that biofuel crops grow *better* on arable than on marginal land, giving farmers and businesses a strong incentive to plant their fuel crops on arable land. To this can be added the fact that marginal land, being marginal, generally has little or no infrastructure and is only sparsely populated, which raises the costs of planting, harvesting, and transport. An additional conceptual problem is that "marginal land" and "wasteland" are ill-defined terms (Guariguata et al. 2011), and land that is designated "marginal," and thus fair target for acquisition by biofuel companies, may be home to poor subsistence farmers and endangered flora and fauna and otherwise provide valuable resources for local communities. Indeed, the designation of land as "wasteland" and the fact that local inhabitants often only have customary rather than legal land rights have repeatedly led to land grabbing by large corporations and forced eviction of its users (e.g., Kumar et al. 2012).

Global Biofuel Trade: Opportunities and Threats

Biofuel production and use practices have become increasingly globalized (Mol 2007): while the United States produces most of its own corn ethanol, the EU imports a sizeable amount of its biofuels from (sub)tropical countries, e.g., palm oil from Malaysia and Indonesia. There are several reasons for this. First, those countries have potentially more arable land available than the already intensively farmed EU. Second, some biofuel crops such as oil palm and *Jatropha* only grow in a (sub)tropical climate. Third, ideally, the global biofuel trade could boost developing countries' economies as well as the economic situation of their poor farmers, especially if processing and refining would also take place locally (Mol 2007). The global biofuel trade, however, gives rise to its own ethical issues.

The crucial responsibility for importing countries is to make sure that the costs of biofuel production (e.g., exploitation of local workers and the local environment) do not outweigh its benefits (e.g., reduced carbon emissions and increased energy security). Especially for first-generation biofuels, the drive for global sustainability and ambitious biofuel targets has often diminished what Mol (2007) calls "local sustainabilities" by way of deforestation, exploitation of workers, land grabbing, etc. According to Smith (2010), the global biofuel trade has involved the transfer of risks to the Global South and especially its poor, such as environmental and new market risks. This has led various organizations such as the NCB (2011) to propose criteria for sustainable biofuel production; it has also been suggested that a wide reflective equilibrium process should be used in order to achieve a fair biofuel policy (Jordaan 2007). Yet while criteria setting and certification (such as Fairtrade) are generally regarded favorably, some issues remain overlooked (Guariguata et al. 2011) or unanswered (Partzsch 2011) by it. For example, power inequalities among stakeholders or underrepresentation of stakeholders in developing countries can bias the criteria-setting process. In addition, there is a discussion on whether to adopt a global certification system, which would facilitate global trade and implementation or to adopt local frameworks that could be better tailored to local situations (Guariguata et al. 2011).

Ethical Frameworks: Toward a Systematic Ethics of Biofuels

This section analyzes the relation between ethics of biofuels and broader trends within environmental and agricultural ethics. It has been noted that biofuels have often been discussed in a piecemeal way, lacking systematic ethical analysis (Buyx and Tait 2011). However at the same time several researchers have tried to integrate the debate about biofuels into broader ethical frameworks. One can distinguish approaches that focus on the value of nature (section "Biofuels and the Value of Nature") from those that focus on sociopolitical aspects of biofuels (section "The Politics of Biofuels"). Finally, this entry discusses first attempts to develop an overarching framework based on (a combination of) ethical principles and material values (section "General Ethical Principles and Biofuels").

Biofuels and the Value of Nature

The debate on biofuels can be placed in the broader debate about the role of nature in industrialized societies. Early environmental ethics argues that most ethical systems are anthropocentric (i.e., centered on the needs and values of humans) and that these systems therefore tend to ignore the value of nature. What is needed is, however, an ethics of responsibility in which nature is central. This implies reevaluating the values of nature, the role of wilderness or "untouched nature," the appropriate treatment of nature in agriculture (Thompson 1994), and the ethical status of plants and plant life integrity (Pouteau 2012). Ever since Heidegger's influential essay on technology, philosophers complain about the tendency to regard nature as a mere resource for human needs and describe countervisions of living in harmony with nature, or analyze ways to treat the land with respect, as an end in itself (Jasanoff 2010).

Thompson has pointed out that public views on farming contain an interesting tension: on the one side farming is a primal form of technology, "yet the farm is, for many, a paradigm of nature" (2009, p. 1257). Agriculture makes thus the distinction between nature and culture more difficult, as plants and human coevolve and as farming is one of the oldest cultural techniques. As Karafyllis (2003) observes, the reputation of biofuels in the public debates benefits from the image of renewables as being part of the organic cycle of nature and thus exhibiting the "aura of naturalness." This is in striking contrast to the role biotechnology and genetic modification plays in current and expected future production of biofuels. Karafyllis thus argues that also the acceptance of biotechnology should be included in technology assessment reports of biofuels.

The Politics of Biofuels

Recently the debate about biofuels has been put in the context of the classical debate between *technological determinism* and *social constructivism*. It has been argued that generally speaking engineers tend to embrace technological determinism, while researchers from a social science background often lean toward a social constructivist perspective. While technological determinism sees technology as bringing about societal changes, social constructivism rather sees society as bringing about technological changes. Biofuels can then be seen as an attempt to find a technological solution – a "techno-fix" – to a societal problem, being "therefore a classic example of engineers explicitly pushing for societal change" (Landeweerd et al. 2009, p. 539). A social constructivist perspective would, however, point out that not only a change in technology is needed but first and foremost also a social reorientation of our lifestyle. There seems to be a consensus that a middle ground between determinism and constructivism should be sought, even though there is disagreement as to what this middle position would be (Boucher 2011). Most authors in the debate highlight that it is therefore important to become aware of the underlying values of policy decisions in the field of biofuels (see also section "Global Biofuel Trade: Opportunities and Threats").

As such, it has been suggested that global biofuel policy is subject to two different types of questions: (a) *whether* it should encourage biofuel production at all (b) and, *if* so, by which means it should reach this aim (Ng et al. 2010). Even if biofuels help reducing GHG emissions, one could ask whether climate policy should be technology neutral. Economic support for biofuels might redirect investment away from other competing alternatives; therefore non-favoring approaches such as a carbon tax system might be more desirable. Assuming policy should favor biofuels, one can debate which means are most efficient to foster their production and usage. Wiesenthal et al. (2009) have compared tax reduction measures and legal obligations to fuel producers to blend conventional fuels with biofuels. While the consumer will not be burdened in the case of tax exemption, there will at the same time be loss of tax revenue for the state; obligations to fuel providers on the other hand are more far-reaching instruments that require public acceptance.

General Ethical Principles and Biofuels

Next to debates that link biofuels to environmental ethics or ethics of agriculture (section "Biofuels and the Value of Nature"), researchers have suggested to use classical ethical frameworks to investigate moral aspects of biofuels. Gamborg et al. (2011) contrast deontological and consequentialist perspectives. The latter focuses on costs and benefits and tries to evaluate potential risks, such as environmental degradation or higher food prices. Deontologists will also try to account for the intentions of the actors and stakeholders, which complicates the ethical evaluation, as it is not clear whose intentions to take into account, how to distinguish collective from individual intentions, and how to account for unintended consequences.

Next to these two classical ethical perspectives, philosophers from various traditions have investigated ethical issues of biofuels in the light of different moral and social traditions. These approaches include religious perspectives (Rasmussen et al. 2011), reflections on intercultural difference (e.g., Landeweerd et al. 2012), or gender aspects (Rometsch 2012). The most comprehensive ethical evaluation thus far has been presented by the NCB (2011). The authors suggest evaluating biofuels in light of humans, nature, and society: biofuel production should be in line with (1) human rights and (2) environmental sustainability and achieve substantial GHG reduction (3). Principles 4 and 5 address socioeconomic issues such as just rewards (4) and an equitable distribution of costs and benefits (5). The authors conclude that there is an ethical duty to develop biofuels, but only if these principles are met.

Conclusion

Although there is much to criticize about biofuels, the conclusion should not be drawn that there is no future for them. Indeed, the oil consumption-related problems which biofuels were supposed to relieve still stand, and while large-scale production and use of biofuels has often led to large-scale problems, this does not mean that there cannot be local niches for production and use. Nor does it mean that there should be no further research on biofuels, whether or not this is considered an ethical duty. Indeed, many open questions with regard to biofuels would benefit from attention from scientists of all kinds, including the social sciences and the humanities, as the Ethical Frameworks section has shown. It does mean, however, that biofuel production and policy setting should proceed with caution. Clearly, its effects on food security, land use, and local communities and ecosystems should be carefully monitored, lest the cure (again) be worse than the disease.

Summary

Biofuels have gained much attention in the last decades as a supposedly sustainable alternative for fossil fuels. However, their production has been accompanied by numerous ethical problems. This entry presents an overview of those problems. First, it explains what biofuels are. Next, it goes into practical issues such as the food versus fuel trade-off, problems with land use for biofuels, and social consequences of the global biofuel trade. Finally, it gives an overview of different ethical frameworks that have been used to evaluate biofuels, including frameworks explicating the value of nature; political and social aspects of biofuels; and classical ethical frameworks.

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Cross-References

- ▶ Agricultural Ethics
- ▶ Biopharming
- ▶ EU Regulatory Conflicts over GM Food
- ▶ Fair Trade in Food and Agricultural Products
- ▶ Intellectual Property and Food
- ▶ Land Acquisitions for Food and Fuel

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Biopharming

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Synonyms

Gene pharming; Molecular farming; Pharming

Introduction

Biopharming is the production and use of transgenic plants and animals genetically engineered to produce pharmaceutical substances for use in humans or animals. It often involves the insertion of gene constructs derived from humans. Biopharming exists on a spectrum of activity and is not clearly demarcated from its nearest neighbors. For example, genetically modified yeast, bacteria, and animal cell cultures have for some time been used to produce pharmaceutical substances in enclosed bioreactor systems, but are generally not included in the definition of biopharming. On the other hand, plant cell cultures, a newer development but also involving enclosed bioreactors, are typically included together with whole-plant methods in plant biopharming. While animals are also being genetically modified to alter their nutritional composition, to make them better models for human disease, and to provide more compatible organs for transplantation into humans, these are typically excluded from the definition of biopharming.

There has been little scholarly discussion of biopharming from an ethical perspective; two exceptions are Birnbacher (2007) and Rehbinder and colleagues (2009). Animal biopharming typically receives brief mention in analyses of the ethics of genetically modifying animals, although public debate and controversy around biopharm animals have attracted some scholarly attention (Taussig 2004; Väliverronen 2004). Plant biopharming is often assumed not to raise specifically ethical issues, although some attention has been given public views of the technology and its use (e.g., Einsiedel and Medlock 2005; Milne 2010). This entry examines important ethical issues in animal and plant biopharming, focusing particularly on the exaggeration of benefits, the potential for harm, and the (in)adequacy of regulatory oversight, among other issues.

Background

The pharmaceutical compounds intended to be produced through biopharming are a subset of the class of pharmaceuticals known as biopharmaceuticals. Biopharmaceuticals are medicinal drugs derived from living organisms and requiring biotechnological intervention; they are distinguished from those produced through chemical synthesis or by direct extraction from a native (non-engineered) biological source. They are typically manufactured using microorganisms and cell cultures in indoor facilities. Biopharming is thus an alternative method for the production of biopharmaceuticals.

Biopharming has been carried out experimentally for more than 20 years. As of this writing, three biopharming-produced pharmaceuticals have been approved for use in humans in the USA and/or EU (produced in transgenic goats, transgenic rabbits, and transgenic carrot cell cultures). A number of others, using both plants and animals, are in clinical trials. A very wide range of plants and animals are used as biopharming production "platforms" or "living bioreactors."

Biopharming has not been widely discussed in the popular media, even though it has been implicated in several genetic-modification controversies. The animal who became known as Stier Herman (Herman the Bull), the first transgenic bovine, was a biopharm animal produced in the Netherlands in 1990 and modified with the human gene for producing lactoferrin. The subject of great controversy, he was created in the hope that he would confer on his female offspring the capacity to produce recombinant human lactoferrin in their milk. The company that created him, Gene Pharming Europe, declared that Herman and his offspring were being produced solely for biomedical research purposes. This was permitted under Dutch legislation that allowed the genetic modification of animals only in exceptional circumstances, one of which was supplying products for medical use in humans that could not otherwise be supplied. The controversy escalated when it was discovered that the research had been funded by a company that intended to use the lactoferrin in baby formula (Taussig 2004).

In 2002, US government inspectors found that ProdiGene had failed to comply with protocols for field trialing corn genetically modified to produce an experimental pig vaccine. As a result, "volunteer" plants sprouted the following season, when soybeans were grown on the site, and were not removed, enabling them to contaminate the commercial cornfields that surrounded the experimental plot. In a second location, where the same thing had occurred, ProdiGene was found to have harvested the soybeans together with the volunteer biopharm corn, despite assuring the regulator that it had destroyed the corn plants prior to harvesting. Despite having been levied a very hefty fine for this, and agreeing to a new compliance program and audit requirements, ProdiGene was found to have violated protocols again in 2004, failing to monitor for volunteer plants from a field trial of biopharm corn. Volunteer corn plants were found by government inspectors growing and flowering within the fallow zone surrounding the field trial and in a nearby sorghum field. They also found that oats growing in the border rows immediately surrounding the biopharm corn had been harvested, contrary to requirements (APHIS n.d.). Partly as a result of these incidents, actors ranging from the Union of Concerned Scientists through the Grocery Manufacturers of America to the Editors of *Nature Biotechnology* called for the exclusion of food crops from biopharming.

The Promise and Promotion of Biopharming

In the 1990s and early 2000s, biopharming's promoters painted a picture of dairy farmers sending their milk off to the drug company and crop farmers growing large quantities of therapeutic proteins as easily as they grow wheat, corn, or soybeans. In the public sphere, biopharming has been described as a way to produce new treatments for human diseases, to reduce the cost of drugs to consumers, to improve the economic viability of farming and rural regions, and to increase developing countries' access to medicines. On the last point, the idea of the edible vaccine was given prominence: food plants such as bananas would be engineered to contain the vaccine in their fruit, which would obviate the need for the temperature-controlled, hygienic conditions required by conventional injectable vaccines. To potential investors, biopharming has been promoted as a method able to outcompete conventional production methods, based on the notion that agricultural practices and infrastructure are less costly and more easily upscaled or downscaled than the kinds of production facilities required by microorganism and cell culture production.

As has become typical of biotechnological innovation (Brown 2003), this promotion of biopharming was characterized by what could be called "hype." Early claims and promises were not well grounded in reality and far outstripped actual achievements. Although the original promises can still be found in some pronouncements about biopharming and in debate around its regulation, expectations for the technology appear to have shifted considerably over the past 10 years.

The need to protect the quality and purity of pharmaceutical substances from environmental contamination and to protect the environment from pharmaceutical contamination casts serious doubt on the adequacy and acceptability of utilizing existing agricultural practices and infrastructure for drug production. Much research on plant biopharming now focuses on "indoor" versions, using plant cells, algae, or duckweed grown in full containment. The biopharm goats that produce the drug ATryn are kept in dedicated indoor production facilities owned and run by the biotechnology company that developed them – a far cry from the dairy farmer's "pharma herd." The excitement over edible vaccines has also ebbed, as problems of quality and dose control become apparent. It is now widely accepted that while vaccines may be produced in plants, they will need extraction and some degree of processing before they can be administered, whether orally or through injection (Rybicki 2010).

The business case for biopharming has also run into difficulties. Production costs are a very small part of overall drug costs, and pharmaceutical companies have not been eager to take on the risks of the new production method in the hope of economizing on what is already a relatively minor cost. Drug prices are brought down, in general, not by lowering production costs but by loss of patent protection and the introduction of competition. Production costs would be more relevant for the biopharmaceutical equivalent of generic drugs, so-called biosimilars, but these face much greater challenges than chemically synthesized drugs when it comes to demonstrating their equivalence to the original patented product. In addition, the biopharming process is much more difficult to set up than the production of generic chemically synthesized drugs; it therefore seems that biopharmaceutical producers are less likely to attract competitive generic producers. Meanwhile, conventional VAT bioreactor technology has not stood still, with developments improving productivity, scalability, and cost-efficiency.

Nonetheless, all types of biopharming still have their promoters, and research is still being pursued by competing groups using a range of animals (large and small), outdoor plant production, indoor plant production, and plant cell cultures. The proponents of each argue that their platform has advantages in productivity, scalability, speed of response, safety of drug produced, cost, or suitability to particular conditions. A significant amount of this research is publicly funded.

Animal Biopharming

Considerably less attention, both public and scholarly, has been paid to biopharm animals than to transgenic animals intended for food or as organ donators to humans (xenotransplantation). As biopharm animals are a subset of transgenic animals, however, they raise many of the same questions: for example, does biopharming inflict suffering on the animals? Can this suffering be justified? What does such intensified instrumentalization mean for humans' relationship with animals and humans' understanding of themselves? Is it foolhardy, or hubristic, to intervene in complex systems about which we have limited understanding?

Many biopharm animals are currently created through cloning, with implantation into another animal for gestation. Most cloned embryos fail to develop to term, and of live births, many suffer from crippling or fatal abnormalities, the causes of which are not understood. Gestating animals also suffer health problems: for example, bovine gestators of cloned animals are much more than normally prone to dystocia due to oversized calves ("large calf syndrome") and to hydroallantois, caused by a defective placenta; both of these cause pain and suffering and can be fatal.

Cloned animals are more prone to musculoskeletal abnormalities and, perhaps particularly significant for biopharming, compromised immune systems. Abnormalities may not reveal themselves before the animal enters a production system, while some epigenetic aberrations may not show themselves in any obvious phenotypical way (Laible and Wells 2007). Cloned animals can also pass on pathological abnormalities to their offspring.

Aberrant transgene integration and its effects are poorly understood. Further, according to Rehbinder and colleagues (2009), "[s]tudies of welfare issues arising from making transgenic animals are still in their infancy" (p. 196). These and other unpredicted and undesirable results highlight for some the degree to which intervention outpaces understanding and for others the riskiness of the endeavor: How can nonobvious, unanticipated, and deleterious changes be identified in transgenic animals (or plants) if one does not know what to look for? And how can the risk of such outcomes be evaluated when understanding is so limited?

While these problems are associated with cloned transgenic animals in general, particular to biopharming is the problem of the effect on the animals of the bioactive pharmaceutical substance their cells have been engineered to produce in high concentrations. This would vary depending on the nature of the pharmaceutical substance and appears to be both a potential animal-welfare hazard and a limitation of animal biopharming (i.e., certain kinds of substances may not be producible in animals because of their deleterious effects on the animals producing them).

When it comes to assessing the acceptability of using animals in this way, the harms to the animals are often weighed against the potential benefits to humans of the drugs produced. However, it is also necessary to ask: are there alternatives? While it is sometimes claimed that animals could potentially be used to produce drugs whose particular characteristics make them difficult or impossible to produce in other ways, this is not the case for the uses to which biopharm animals are currently being put. The same drugs can be, and are being, produced through conventional biopharmaceutical production and/or through biopharm plants or plant cells. Whether or not one views the harms suffered by biopharm animals to be justified may depend, at least if one takes a utilitarian or consequentialist approach, on how much faith one places in these claims to future indispensability.

There are fewer concerns about keeping biopharm products out of the food supply than in the case of plant biopharming, due to the fact that the relevant animals are easier to monitor than pollen or seeds. However, there has already been at least one case of possible inadvertent contamination of the food supply by animal biopharming. Between 2001 and 2003, the University of Illinois released 356 pigs, which were part of their transgenic biopharming experiments to produce certain proteins in the milk of sows, to livestock dealers. The university argued that the pigs did not contain the transgenes of their parent stock nor were they old enough to be lactating; however, investigations by the FDA found that records were inadequately kept and they were unable to verify this (FDA 2003).

As this incident suggests, biopharming operations will have an incentive to derive some value from animals or animal materials produced by the operation but not utilizable for biopharming – for example, offspring who do not exhibit the desired traits or are surplus to requirements. It is not unlikely, therefore, that biopharm operators will seek approval for excess animals to be permitted in human food or animal feed (U.S. National Research Council 2002). This would create pathways for potential contamination of the food supply through animal biopharming.

Risks of contamination of the environment and adverse impacts on other organisms appear to be lower than with biopharm plants because biopharm animals are easier to contain than, e.g., pollen from biopharm crops. However, outdoor animal biopharming (or careless management of indoor biopharming) could potentially impact on organisms in the environment such as soil microorganisms, animals and plants that feed on animal waste, and blood-sucking insects. Through horizontal gene transfer, biopharm animals producing antibiotic substances (or therapeutics with antimicrobial properties, a common trait of pharmaceutical substances not intended to be used as antibiotics) could potentially aggravate the problem of antibiotic-resistant bacteria by encouraging resistance in populations of soil bacteria or bacteria that are the animal's natural commensals. The degree to which this may be a problem will depend, inter alia, on the substances produced and the scale and location of the biopharming operation.

A recognized concern is the possibility of passing on zoonotic diseases (diseases that can be transmitted from animals to humans) through drugs from biopharmed animals. These include prion diseases, that is, transmissible spongiform encephalopathies, including bovine spongiform encephalopathy (BSE), variant Creutzfeldt-Jakob disease (vCJD), and scrapie. The company producing ATryn sourced its original (non-GM) goats from New Zealand because that country has been declared scrapie-free. There is also a risk that the animals will contract zoonotic diseases through exposure to infected organisms in their environment. It is likely for this reason, rather than to prevent contamination of the environment, that the goats producing ATryn are kept in an indoor facility. Keeping animals in indoor facilities may, however, raise other animal-welfare issues, depending on the animals and conditions in which they are kept. While these conditions will almost certainly be more hygienic than those characterizing many food-animal operations, they may still, through confinement, prevent the animals from expressing their natural behaviors.

Plant Biopharming

Plant biopharming is argued to pose fewer risks to the recipient of the biopharmed drug than animal pharming, because plant diseases are generally not seen as a threat to human health. While plant-biopharmed drugs cannot pass on zoonotic diseases, they potentially pose greater allergenicity and immunogenicity problems, due, in simple terms, to differences between plants and animals in protein production processes (i.e., in the "post-translational modifications" that occur after the RNA has been translated into protein). Much research in this field aims at making the therapeutic proteins produced by biopharm plants more human-friendly.

All biopharmaceuticals require extraction and purification. While a challenge for animal biopharming is the detection and removal of zoonotic disease, for outdoor plant biopharming, the purification process must be able to remove assorted environmental contaminants in and on the plant material, such as pesticide residues (including from pesticide drift), insect parts, bird feces, etc. This would presumably warrant changes to existing purification processes and protocols.

A major concern associated with plant biopharming is the possibility of the unintentional contamination of food with bioactive pharmaceutical substances. Some developers are focusing on nonfood plants, such as tobacco, or on plant cell cultures, algae, or duckweed, but a large variety of food plants continue to be used as bioreactors, including major food crops, such as rice, maize, and potatoes. Those who use food plants, especially major food crops, argue that this is justified by the fact that more is known about their physiology, agricultural needs, and protein-expression mechanisms (Sparrow et al. 2007).

Contamination can occur through a number of pathways, including cross-pollination with non-biopharm crops, seed dispersal, the germination of residual seed, postharvest mishandling (e.g., commingling in storage), the use of agricultural and transport machinery on both biopharm and non-biopharm crops, and the inappropriate disposal of biopharm crop waste. The risk of contamination is obviously increased when food crops (or nonfood crops used in processed foods, such as cotton) are used as bioreactors and open-air production methods are used. While a number of technical measures and production protocols have been proposed for these situations, it is acknowledged that even with these measures in place, the risk of contamination cannot be eliminated entirely.

Open-air plant biopharming also appears to pose, at least potentially, significant risks to other organisms in its environment. Birds, insects, rodents, and other animals may feed on parts of the plant producing the pharmaceutical substance. In addition, farmworkers (and close neighbors) may be adversely impacted through inhalation of pollen containing pharmaceutical substances. Soil microorganisms will also come into contact with biopharm plants. As with biopharm animals, biopharm plants producing antibiotic substances (or therapeutics with antimicrobial properties) may exacerbate problems of antibiotic resistance.

Regulation

Regulatory frameworks for biopharming have been slow to develop and have lagged well behind the development and application of the technology itself. This applies both to the production and handling of biopharm plants and animals and to the production of drugs derived from them (Rehbinder et al. 2009; Fischer et al. 2012). What might be called the liminality of biopharm plants and animals poses challenges for regulation. For example, agriculture and medicines are typically subject to different governance regimes, yet biopharm plants and animals belong to both categories (or to neither). Different regulatory agencies may have different cultures and be embedded in different power relations, which can pose problems for effective cooperation.

Biopharming activity is generally being governed through regulatory frameworks developed for other purposes, and this can result in regulatory gaps and poor fit. The development of biopharm plants has occurred in North America and Europe within regulatory frameworks designed for so-called first-generation GM food and fiber crops (e.g., those intended to produce Bt toxin or to be herbicide-tolerant); this appears likely to continue (APHIS 2008; EFSA 2009). While these frameworks may enable characteristics specific to biopharm plants to be considered in, for example, a case-by-case risk assessment, their use may still entail the importation of inappropriate assumptions into biopharming regulation (Goven and Morris 2012). These frameworks rely heavily on their established approaches to risk assessment and risk management; Rehbinder and colleagues (2009, p. 196) argue that biopharm plants and animals differ sufficiently from other GMOs to pose new, as-yet unidentified risks, raising difficulties for the identification of hazards and for the evaluation of their likelihood within these frameworks.

Protecting the welfare of biopharm animals may also encounter category problems. For example, some jurisdictions distinguish between experimental animal trials and the use of animals in production. Biopharm animals do not unambiguously fit either category: the distinction between animal trials to produce new knowledge, on the one hand, and breeding and production activities, on the other, is in their case not clear-cut. Moreover, many of the welfare problems associated with biopharming result from experimentation on embryos rather than the animals themselves, thus possibly falling outside the regulation of animal trials. This misfit is at least partly a result of legislation on animal trials generally having been developed with the safety testing of chemicals in mind. Biopharming animals may also fall outside the protections extended to farm animals, because they do not serve agricultural purposes. (On these issues, see Müller-Terpitz 2007, Rehbinder et al. 2009, Chap. 8). In another example of categorical difficulty, the USA in 2008 decided that biopharm animals themselves would be regulated as drugs (specifically, "new animal drugs").

Regulation of drugs produced through biopharming was also adapted rather than purpose-built. Good Manufacturing Practice (GMP) guidelines for biopharm drugs were originally modeled on those for animal cell cultures. These, however, are seen as too restrictive by those working with whole plants (rather than plant cells); established guidelines on the removal of contaminants in production from cell cultures, for example, provide immediate challenges for outdoor-biopharmed plants, as types of likely and possible contaminants differ significantly from those found in cell culture production, as do methods for their removal. Standards for containment, hygiene, and batch-to-batch consistency developed for animal cell production cannot be met by outdoor biopharm plant production, whose proponents have instead argued for a different approach, one which "borrow[s] much from the concepts already in place for genetically modified food crops" (Fischer et al. 2012, p. 437). Current guidelines in the EU and USA indicate that regulators are shying away from specifying in advance the kinds of production processes that are acceptable (in terms of, e.g., organism used or degree of containment) and instead will decide on a case-by-case basis whether to accept drugs produced through different platforms.

Overarching Ethical Issues

Hype and Its Ethical Effects

Inflated benefit claims, both financial and humanitarian, are seen as characteristic of biotechnology (Brown 2003) and have featured in the promotion of biopharming (Väliverronen 2004; Milne 2010, 2012; Bloomfield and Doolin 2011). Scholarship within the subfield known as the sociology of expectations (see Borup et al. 2006 for an overview) has emphasized the key role played by the creation of expectations of future achievements in mobilizing support for technoscience. Claims of expected benefits can influence not only investment (including public investment) but also regulatory decisions. Although not uniquely, the history of biopharming raises questions about the ethics of promoting new technoscience through poorly grounded claims. As Brown (2003) has argued in relation to xenotransplantation research, unrealistic benefit claims may be weighed up against harms such that, for example, a degree of animal suffering is permitted that would not otherwise be. This suggests that humanitarian claims (e.g., that biopharming will enable the development of therapeutics for currently untreatable diseases or that it will provide safe, low-cost medicine to developing countries) should receive greater scrutiny. It also suggests that the ethics of making such claims be considered. The reliability of benefit claims is also crucial to our consideration of whether it would be ethical *not* to pursue biopharming in any or all of its forms.

Inflicting and Exposing to Harm

As indicated above, the cloning of biopharm animals inflicts pain and suffering on (some) animals. The actions of the biopharmed substance within the body of the animal can also cause harm. Protecting the biopharmaceutical from contamination may require housing the biopharm animals in a controlled, indoor environment, which could include isolation of individual animals from each other (to prevent the spread of infectious disease). Some would argue that, at least for some animal species, this in itself would inflict harm.

Biopharming has the potential to expose a range of others to harm. Despite the efforts of drug regulators to prevent it, patients, and those in contact with them, may contract zoonotic diseases passed on through biopharm animals; patients may also be harmed by novel contaminants that have not been removed through purification processes. This may call for a discussion of whether patients should be informed of the sources of these drugs (Rehbinder et al. 2009). Open-air biopharming may also inflict harm on its wider environment, specifically on those organisms that come into contact with biopharm plants or animals or their residues. These may include humans, whether farmworkers or those who consume food that has been contaminated through open-air biopharming, and will certainly include other species. This would amount to a deliberate introduction of harm or potential harm where none existed before, and thus requires justification.

Weighing Costs and Benefits: The Role of Alternatives and Cost Savings

A common approach to the question of justification is to weigh harms and potential harms against benefits and potential benefits. This brings us back to the reliability of benefit claims but also to the question of alternatives. Biopharming is being pursued simultaneously across a wide range of "platforms." Given this and the uncertainties that still characterize the technology, it would seem to be difficult to argue that there is no alternative to any one particular platform. Choice of platform appears to be driven by economic and intellectual-property considerations more than technical feasibility (Fischer et al. 2012). This substitutability is as relevant as potential benefits to ethical discussions of the acceptability of inflicting harm (on biopharm animals or other organisms) by the use of, e.g., animal biopharming or outdoor plant biopharming.

Because expectations of cost savings are such an important driver of biopharming, the problem of whether monetary benefits (through cost savings) can outweigh the infliction of harm is likely to arise. Cost savings must then be examined further: who will benefit? If cost savings simply add to corporate profits, is this sufficient benefit to outweigh, e.g., the infliction of suffering on animals or of added risk on human populations? How can we know in advance how cost savings will be distributed, if they do eventuate?

Regulatory Values

As noted, biopharming regulations have largely been derived from existing regulations developed for other purposes. Regulatory approaches institutionalize priorities and so embody values. For example, outdoor plant biopharming has largely been assimilated into regulatory regimes for other types of GM plants. These frameworks place a high priority on producer freedom of choice and market-driven innovation for economic competitiveness. This is reflected in the fact that an economic actor's desire to develop, use, or buy a technology is in itself taken as evidence of benefit; no further benefit need be demonstrated. This does not appear to allow the kind of ethical querying of the nature and distribution of benefit, or consideration of the existence of alternatives, discussed above (Goven and Morris 2012).

Hubris, Irresponsibility, and Wisdom

Like other technological interventions characterized by a large degree of both uncertainty and ignorance and a potential to inflict irreversible damage on individuals and ecosystems, biopharming, or at least some of its forms, might be considered to embody a hubristic and irresponsible meddling with life (Fiester 2008). Biopharming (also not uniquely) may raise concerns that we do it "because we can" rather than because it is necessary or wise. This in turn raises questions about the ethics of our technoscientific system and its regulation. Where in the process is there an opportunity to ask "Is it wise? Should we do it at all?" rather than "How can we minimize its risks without discouraging its development"?

Summary

Biopharming involves genetically engineering plants and animals, typically with human gene constructs, to produce biopharmaceuticals. It has thus far received little attention within bioethics or among social scientists. The nature and scope of the potential opportunities represented by biopharming remain unclear. The potential hazards associated with biopharming are wide-ranging and vary according to the "platform" used. Regulation of biopharming has not kept up with technological development and is arguably under-specified. Biopharming raises ethical issues in relation to the performative effects of inflated benefit claims, the infliction of harm and potential harm on biopharm animals and other organisms (including humans), the opportunity to consider alternatives and the significance and distribution of cost savings when evaluating biopharming's acceptability, the values embedded in regulatory frameworks, and the proper response to uncertainty regarding far-reaching effects.

Cross-References

- ▶ Agricultural Sciences and Ethical Controversies of Biofuels
- ▶ Animal Welfare: A Critical Examination of the Concept
- ▶ Biotechnology and Food Policy, Governance
- ▶ Industrial Food Animal Production Ethics
- ▶ Transgenic Crops

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Biosecurity and Food Systems

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Synonyms

Agroterrorism; Biosafety bioterrorism; Biosecurity; Food quality; Food safety

Introduction

Securing food systems against deliberate attack from malevolent actors is perhaps an overlooked issue in discussions of ethics of food and agriculture. This entry raises biosecurity of food systems as an issue of ethical importance, with the aim of showing how biosecurity, understood in a national security context, is relevant to discussions of food ethics and philosophy. A basic point of this entry is that deliberate attacks on food systems have the potential to cause widespread harm to people and severe economic damage to food systems. Biosecurity is understood in this entry as having a focus on deliberate acts of harm. Understanding biosecurity of food systems in this manner does not garner typical discussion in food and agriculture studies. A partial explanation for this is multiple contrasting meanings of similar terms like food security, food safety, food biosecurity, biosecurity, and biosafety. Given the potential high impact of a deliberate attack on a food system, this entry will present biosecurity of food systems as an issue of importance, and one that needs to be understood alongside discussions of food security and food biosecurity, more generally construed.

The entry shows that biosecurity, understood with reference to deliberate harms, is an important ethical issue. Following a brief background discussion, the entry gives a general overview of relevant terms. Modeling of an act of agricultural terrorism, the deliberate poisoning of a food supply with botulinum toxin as with potentially devastating results, is used to show the high impact of an attack on a food system. In order to explain this high impact, common features of modern integrated food systems such as collection, centralization, and combination of food products are raised as making food systems vulnerable targets of attack. Finally, food traceability and response systems are raised as necessary elements in reducing vulnerability and limiting impacts.

Background

For the majority of people in the developed world, perhaps uniquely in human history, a relatively high proportion of the population typically do not worry about where their food is coming from: the supply of food is assumed to be reliable (Thompson 2010, p. 6). Such confidence applies not only to people’s ability to reliably *access* cheap food and in large amounts, but also that people can generally feel that the *quality* of food itself is assured: people do not typically worry whether their food will make them seriously ill. This entry focuses on the latter point, an assumed safety of food products. This entry looks at the problem of people deliberately targeting the food system for attack.

Though food industrialization has certainly increased the likelihood of food safety – a perception of total safety of food processes is contestable. Eric Schlosser writes that the "industrialized and centralized system of food processing has created a whole new sort of outbreak, one that can potentially sicken millions of people" (Schlosser 2003, p. 195). Aspects of the food production system have the potential to place many people at risk of illness from consuming contaminated food products. Paul Roberts states "[T]here are also undeniable parallels between these shifts in food-borne disease – the kinds of pathogens circulating, the patterns of outbreaks and the difficulty in treatment – and the emergence of a food system geared toward high volume, low costs, and rapid, worldwide distribution" (Roberts 2008, p. 178). The integrity of food supply chains can be lost through the actions of agents at key points in a food supply chain. Consider, for example, the "European horsemeat scandal" of 2012–2013, in which horsemeat was found in European beef products (Traynor et al. 2013). Inputs to food supply chains are not always assured. This is something that can be exploited not only by negligence or personal gain but also through the deliberate actions of malicious actors.

Food-borne diseases are typically covered in relation to food safety. However, when considering things from a point of national security, food production systems present targets for malicious actors to disrupt and perhaps harm large sectors of society. Modern food systems frequently collect inputs from a wide range of producers and sources, mix these inputs together in centralized processes, and then distribute widely to a large number of consumers locally, nationally, and increasingly internationally (Schlosser 2003, pp. 225–252). It is this model of collection, concentration, combination, and distribution that makes food processes a potential target for malicious actors. As with events of accidental food-borne illness, if a malicious actor was to get certain toxins into a food supply chain at key steps in the process, this could result in an outbreak of illness, causing public fear and death.

Food Security, Food Safety, and Biosecurity

The focus of this entry, biosecurity and food systems, imports a model of food biosecurity from a national security vocabulary that may be outside typical discussions in agriculture and food science. Given the nonstandard usage, a general overview of key terms and their multiple uses is presented here. The particular intended meaning of biosecurity and food systems as a national security concern is explained.

Firstly, a distinction must be made between food security and food safety. Food security can be understood as a political/economic concept. With reference to the aims of global actors such as the United Nations (UN), the World Bank, and the Food and Agriculture Organization (FAO), food security "should be envisioned as a project of economic and developmental globalization that is designed to help poor and underdeveloped countries. . .[and focuses] on how growth will be most beneficial to the global poor" (Schanbacher 2010, p. 3). The typical concern is with "the just and fair supply of food to human beings" (Coff et al. 2008, p. 8). With concepts such as globalization and poverty underpinning the motivations and methods of groups like the FAO, food security for the world's poor is something to be achieved through economic programs (Schanbacher 2010, pp. 2–23). While individual health and survival are chief concerns of food security, the problem is, roughly, one of creation and distribution of resources, and so the discussions are primarily in areas of political philosophy, economic theory, trade, and the like. This is discussed in more detail in the food security entry in this encyclopedia.

Contrast this model of food security with food safety: "Food safety deals with the safety of the food: food should not endanger the health of consumers due to pathogens or pollution present in the food. There are ongoing discussions about what is safe enough and whose definition of safety should be followed" (Coff et al. 2008, p. 8). Rather than creating and distributing enough food resources for people, particularly the world's poor, food safety is about ensuring that the food that people consume will not harm them. In what follows, I look into three different ways of conceptualizing biosecurity.

In contrast to food security and fitting under the umbrella of food safety, food *bio*security is often concerned with ways to keep agricultural systems and/or food productions systems free from pests and diseases. A first focus of food biosecurity within agricultural systems is the protection of production/producers from pests and other diseases and ways of limiting the impact of such pests. Ronald Atlas, the former president of the American Society for Microbiology and co-director of the Center for Health Hazards Preparedness at the University of Louisville, writes: "New Zealand, for example, published in August 2003 a biosecurity strategy aimed at economic, environmental, and health protection from pests and diseases. . .In this case biosecurity means trying to prevent new pests and diseases arriving and eradicating or controlling those already present" (Atlas 2005, p. 122).

A second understanding of food biosecurity is concerned with the defensive measures to be used and developed against agents that pose biological risk following consumption of the food: "The primary goal of biosecurity is to protect against the risk posed by disease and organisms; the primary tools of biosecurity are exclusion, eradication, and control, supported by expert system management, practical protocols, and the rapid and efficient securing and sharing of vital information. Biosecurity is therefore the sum of risk management practices in defense against biological threats" (National Association of State Departments of Agriculture 2001). The key difference between the first and second conceptualization is that the first conceptualization is primarily focused on risks to *producers*, while the second is focused on risks to *consumers*.

A third way of conceiving food biosecurity is in reference to *deliberate* attacks on the food supply, with attacks having intent to disrupt or harm society. For instance, the Biosafety in Microbiological and Biomedical Laboratories (BMBL) Manual 3 defines biosecurity as "the protection of high-consequence microbial agents and toxins, or critical relevant information, against theft or diversion *by those who intend to pursue intentional misuse*" (Atlas 2005, p. 122, emphasis mine). Rather than conceiving food biosecurity by reference to the concerns of environment or agriculture, broadly construed, some discussions of food biosecurity focus instead on food production as a national security concern. In the context of national security measures, biosecurity means protecting biological resources against acquisition by terrorists.

Given these multiple conceptions around security and food, food security, food safety, and food biosafety, their use typically varies upon on the given area of discussion. That is, those concerned with equal distribution of resources are most likely to use references to food security, and those concerned with issues of quarantine and defense against pests are likely to consider references along the lines of food safety, while those interested in national security and protection against deliberate malicious use are most likely to be interested in food biosecurity.

On this third conceptualization, food biosecurity is concerned with acts of terrorism, warfare, or other malicious intent, which seek to disrupt and/or harm society and individuals through deliberate addition of toxic and/or disease causing agents into the food production system. It is this particular conceptualization that will be the focus for the remainder of the entry. Wherever convenient, however, in order to make the national security focus distinct from standard discussions in agriculture, the entry will refer to biosecurity of food systems, rather than food biosecurity.

Bioterrorism and Food Systems

The reason for a focus on biosecurity of food systems is that toxins and pathogens in food systems can cause massive social disruption and can potentially harm or kill large numbers of people. The initial claim is that food and food supply chains are potential targets of bioterrorist activity. Coupling the potential lethality of certain food toxins and pathogens with the broad distribution from centralized processing points means that aspects of the food industry offer potential ways to "weaponize" food and/or its food delivery systems. Some claim that using food as a delivery method could produce the highest number of casualties of any bioterrorist act (W. Seth Carus, quoted in Von Bredow et al. 1999, p. 169).

An initial point to cover is if there is actually cause for concern about attacks on food systems. Seven days after the World Trade Center attacks of September 11, 2001, there was bioterrorist attack using anthrax spores that killed five people and infected another seventeen (N.P.R. 2011). While few deaths occurred, the so-called "Amerithrax" attack raised the specter of deliberate use of harmful microbial agents. In terms of targeting food systems, while the number of deliberate attacks on food systems is extremely low, there is at least one known bioterrorism attack on a food system. As described in the chapter "Influencing An Election: America's First Modern Bioterrorist Attack" (McCann 2006, pp. 151–158), a group following the "guru" Bhagwan Shree Rajneesh attempted to change the outcome of a local election in the US town of Dalles in the state of Oregon. Starting on August 29, 1984, two city officials were intentionally poisoned with *Salmonella typhimurium*. Following this, 751 people were poisoned by *Salmonella*, intentionally placed in salad bars in ten Dalles restaurants. The ultimate aim of the attacks was to make enough people sick that such that their votes in the local election would bring about the culprit's desired outcome. What the Amerithrax and Dalles examples show is that there are people with the motive to harm using biological agents, and there is proof of concept – food systems have been targeted.

In their discussion of potential tools of bioterrorism, Seumas Miller and Michael Selgelid discuss research programs that may confer resistance to antibiotic or antiviral agents, enhance pathogen virulence, increase the transmissibility of a pathogen, alter a pathogen's host range, and enable the weaponization of a biological agent or toxin (Miller and Selgelid 2008, pp. 19–26). Food systems present a potential delivery system for bioweapons and as such figure in an analysis of potential tools of bioterrorism.

Taking the threat of bioterrorism seriously, Lawrence Wein and Yifan Liu sought to predict the results of a deliberate poisoning of a milk supply equivalent to California with botulinum toxin. Botulinum toxin is not a standard food biosecurity concern. However, on Wein and Liu's analysis, if left undetected, 1 g of the toxin could cause around 100,000 casualties, and 10 g could cause up to 568,000 casualties (Wein and Liu 2005, p. 9985). Furthermore, Wein and Liu's modeling of botulinum in the milk supply "are applicable to similar food products, such as fruit and vegetable juices, canned foods. . .and perhaps grain based and other foods possessing the bow-tie-shaped supply chain" (Wein and Liu 2005, p. 9984). With such massive disruption and harm, food systems thus figure in national security discussions and are relevant to discussions of biosecurity.

Food System as Targets

Essential to the biosecurity concerns is the capacity for toxins in food to be rapidly and easily consumed by large numbers of people. Central to this are the methods of the industrial food process that allow toxins to be distributed to large numbers of people at a national and international level. In these systems, the food type (i.e., mince for hamburgers or dairy milk) is progressively concentrated into central processing plants, which then distribute the food product progressively out to more and more consumers. The key point here is what is called the "bow-tie-shaped supply chain" (Wein and Liu 2005, p. 9984), in which food supplies are concentrated and mixed at central processing points and then distributed out, forming a bow-tie-like shape.

The "bow-tie" model of food production refers to processes, whereby the initial food inputs are concentrated, centralized, and combined prior to broad dispersal. This bow-tie shape Schlosser argued (Schlosser 2003, pp. 195–197) was a key element in food-borne illnesses arising from consumption of hamburgers. A similar set of industrial processes have been implicated in the emerging information on the European horsemeat example in which horsemeat was effectively mixed through large numbers of food products and then distributed widely (Traynor et al. 2013). The relevance of these examples of food illness and food quality is to show that the bow-tie processes present certain food systems as a potential point of terrorist attack. Wein and Liu's (Wein and Liu 2005) investigation showed that adding the botulinum toxin at key points in the food production system could have devastating impact.

Prevention of Bioterrorism: Food Traceability

In addition to problems of harm and food chain integrity are issues of national and international oversight. In one well-known example of food-borne illness, an *E. coli* 0157:H7 outbreak in 1992 killed four and sickened 600 people (Roberts 2008, p. 182). Another outbreak of *E. coli* strain O104:H4 in Europe in 2011 had 3816 reported cases and included 54 deaths (Frank et al. 2011). This was ultimately linked to the consumption of uncooked vegetable matter, in particular, uncooked fenugreek seeds (European Food Safety Authority 2011). The 2013 European horsemeat scandal includes horsemeat from a Romanian abattoir, which was shipped to the Netherlands, and then a French processing plant, which was shipped to the UK for human consumption. These multination food transport chains were initiated at a French meat fair, and the meat was traded by a company registered in Cyprus (Traynor et al. 2013).

Food chains are becoming increasingly complex – not only are food-borne illnesses spread across large populations, but also the distribution chains and ownership of the trading partners can cover a number of different countries, each with a different set of laws. This can make it very hard and time consuming to track down the source of contamination. Often the harms can be mitigated by rapid and coordinated responses, but the more complex the practical and legal frameworks, the greater the security risks. The basic concern here is that the complexity of the systems of food production and distribution increases vulnerability of the systems to deliberate attack: the more steps there are, the greater the potential points of attack. Further, the increased complexity could increase the impacts: rapidly identifying the causal biological agent and the malicious actor(s) are both essential to mitigating the impacts of attack, and this identification is made much harder by the complexity of the systems and the pluri-jurisdictional nature of the modern food industry.

Essential to harm reduction is through rapid identification of the causal agent – here meant as the specific toxin that is harming people. Wein and Liu's analysis suggested that, given the existence of a botulinum antitoxin, the harms from a botulinum outbreak in the milk supply can be mitigated through rapid identification of the toxin (Wein and Liu 2005). However, despite the importance of rapid organized responses, Schlosser describes the slow response of public health officials in the face of hamburger poisoning. Importantly, Schlosser shows that in response to the 1992 *E. coli* outbreak, Jack in the Box updated their safety practices and have since been free of any major repeats (Schlosser 2003, pp. 210–221). Control and verification would include checking of employees and the potential for malicious actors to access food production systems. Finally, consumers and indeed other government emergency and security agencies need to be rapidly and effectively informed of given risks resulting from malicious actions.

Underpinning these responses is traceability in food chains, traceability that operates rapidly across national and international regions. Food traceability is common in food production industry and is commonly required by national and international laws (Coff et al. 2008, p. 3).

The benefit of working with existing food traceability processes to aid in securing against deliberate attack is that this "retrofitting" can build from established practices and could plausibly reduce industry and worker opposition to additional oversight mechanisms. This is not to say that traceability systems are a panacea to biosecurity risks in food systems – given the relatively low likelihood of terrorist attack, such systems could divert resources from the likelihood of non-malicious contamination. Secondly, any oversight mechanisms and processes would need to be appropriate to the given sector of the food industry – preventing the addition of botulinum toxin to a milk supply is going to require very different oversight to securing a salad bar against *E. coli*.

That said, general methods that improve supply chain integrity, such as defining hazard analysis and critical control points (HACCP) (Roberts 2008, p. 183; Schlosser 2003, pp. 215–222), are likely to be useful across a range of practices. Moreover, such HACCP standards would need to include risk assessments of potential malicious activity. However, as the horsemeat scandal shows, such supply chain integrity and the capacity for rapid response to concerns are not currently assured (Traynor et al. 2013). Secondly, following Wein and Liu's analysis, basic food safety training may not be enough – food supply chains need effective security measures too, to prevent against deliberate acts of harm. A problem here is who takes official responsibility for oversight, an issue made more complex by the frequent multinational supply chains. Finally, given the low levels of actual food bioterrorism, there are issues of whether the cost of securitizing the food chains through new HACCP protocols against deliberate attacks outweighs the risks of not responding.

Summary

This entry has raised biosecurity of food systems as an important area in the ethics of food and agriculture. It compared and contrasted food security with food safety, discussed different ways of conceptualizing food biosecurity, and focused on biosecurity understood in a national security context. The entry then looked at biosecurity of food systems and showed why food systems are particularly concerning as targets of attack. It finally raised issues of food traceability and how biosecurity of food systems can figure in more traditional accounts of traceability.

Cross-References

▶ Corporate Social Responsibility and Food
▶ Food and Health Policy
▶ Food Legislation and Regulation: EU, UN, WTO and Private Regulation
▶ Food Security
▶ Food Security and International Trade
▶ Food Security and Rural Education
▶ Food Security in Systemic Context
▶ Food Standards
▶ International Food Quality Standards

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Biotechnology and Food Policy, Governance

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Synonyms

Controversy; Genetic technology; Governance; Policy; Public perceptions; Regulation; Risk

Introduction

When the public in Europe turned against GM foods following first large-scale marketing of a GM crop – soy shipped from the USA – in 1996, many were taken by surprise. For once a political process had been launched while the controversial technology was still in the pipeline. Moreover, the resulting regulation was widely believed to provide a social contract between the critical publics in Europe and those in favor of GM foods.

This contribution discusses the changing focus of political processes addressing biotechnology and GM foods. Starting with the first call for a regulation of biotechnology in the USA in the early 1960s, it tells a story about how policies in North America and Europe regarding a new and controversial technology have developed. Differences between Europe and North America regarding biotechnology policy styles and interpretations of "precaution" are addressed.

A key storyline is how policies reflect dominant framing of biotechnology as a hope, a risk, and a moral or ethical problematic technology. A mismatch between the way GM food was framed in the European biotech policies, excluding the ethical concerns of the European publics, is thus suggested as an explanation of Europeans resistance towards GM foods in 1996.

From Facilitation of Hope to Governance of Risk

Until the late 1960s the politics addressing what is today loosely referred to as "modern biotechnology" reflected an inherited framing of these technologies. During this period modern biotechnologies were important elements of a modernization project in which the new technologies were seen as a future source of material prosperity and hope for society. Thus, private sponsors and public funding organizations in North America and Europe focused on funding research in biotechnology, facilitating the many promises. The technology itself lived a relatively unnoticed life, primarily in research facilities based in universities. The governance of these research activities was outside the public eye. As has been noted, the public policies that emerged in the 1950s remained largely uncontroversial until the late 1960s: modern biotechnology, together with other new and promising technologies, was a new domain that would ideally facilitate economic development in society (Gottweis 1998).

This was true of the area of biotechnology concerned with DNA. Genetic biotech includes a range of different technologies working at the molecular level, manipulating or cloning existing hereditary material. After Watson and Crick's discovery of the structure of DNA in 1953 genetic technologies – or recombinant DNA technology, as it was referred to then – lived silently in the research laboratories. Although it was recognized that this new scientific domain provided insights into some fundamental questions about life and living organisms, genetic technologies were rarely if at all problematized in the public sphere or taken up in political discussions.

This changed when US scientists showed in the early 1970s that it was possible to join DNA from distinct species in a host cell and thus potentially manipulate the hereditary features of any living organism. The first reaction to this discovery came from some of the scientists involved. One of these was the US biochemist Paul Berg, who together with colleagues published what has become known as the "Berg letter" in *Science* in 1974 (Berg et al. 1974). In the letter they voiced their concern at the risk of creating novel types of infective elements with unknown and unpredictable properties with the technologies they themselves were involved in developing. The Berg letter called for a voluntary moratorium in rDNA research until proper safety procedures and regulation were in place. The following summer, rDNA technologies were once again debated at a conference in Asilomar, California. The outcome of this meeting was, on the one hand, a decision to lift the self-imposed moratorium and resume research in rDNA techniques and, on the other hand, a list of recommendations on safety procedures when handling rDNA in laboratories.

Although these early discussions addressed neither GM foods nor ethical issues, it is fair to say that the Berg letter and the recommendations produced at the Asilomar conference had huge impact GM food governance in the decades to come. The previous framing of genetic technologies as an instrument of modernization was extended now; it came to include a critical component questioning the risks of negative impacts on human health and the environment. This new, additional risk framing influenced policy discourse significantly in the years to come. Thus, safety concerns were mirrored in the first efforts in GM regulation, namely, the guidelines for publicly financed research involving rDNA issued by US National Institutes of Health in 1976. Ten years later, the OECD issued guidelines on the way member states should handle biotechnology, expanding the concerns to cover consequences for the environment.

In the decades after the mid-1970s, new techniques, such as cloning and stem cell technology, were added to the portfolio of genetic technologies. The technologies moved from the research laboratories towards industrial application and marketable products. And following this the content of the risk discourse has changed – going beyond the initial concern about new health hazards due to infective elements, it has come to include concerns about the risks presented by, for example, GM plants and animals released (or escaped) into the environment and by unintended gene transfer between manipulated and wild species. Thus, risk became, and still is, an important part of the politics and regulation of the genetic technologies. This was reflected in political discussions in the 1980s which preceded the regulation of genetic technologies in the EU as well as its member states. These policy processes generally took place within a frame in which genetic technologies were seen as a useful technology with potential risks that needed to be regulated (Torgersen et al. 2002). The risk focus is evident also in two EU directives on contained use and deliberate release of genetically modified organisms adopted in 1990. In these directives the concerns addressed were limited risks to the environment and human health. Later, in 2003, the UN Cartagena Protocol on biosafety confirmed the importance of risk framing, taking the regulation of risks to the environment and human health to an international level (Secretariat of the Convention on Biological Diversity 2000).

At first glance, risks may seem to have been, if not the only, then the dominant framing of biotechnology policies in the 1980s. It is important to remember, however, that this new problematizing discourse existed alongside other policy discourses rooted in the framing of biotechnology as promise. Although these other frames were not as manifest as the risks, a great deal of biotech policy in both Europe and North America was still about facilitating research and development. Within the European Framework Programs supporting research and development, for example, massive sums were reserved for the research and development of genetic technology and other biotechnologies. An important element in this was financial support for basic research and its applications in the food industry.

In addition to direct financial support of the research and development of biotechnologies in the agri-food sector, policies have also addressed the barriers to industrial applications and to the marketing of ingredients and food products based on research results. In part, such policies have been aimed at settling intellectual property rights and in that way securing investment in the research and development of food biotechnologies. At the core of these discussions lay questions about the interpretation, or nature, of inventions and about whether living organisms are patentable. The questions were first settled within the national and supranational patent institutions and only later in EU directives.

A key event in the patent disputes was the Chakrabarty case in the USA. In 1982 the Supreme Court ruled that patentability depends on human intervention. This decision paved the way for the patentability of genetically manipulated plants and later animals. Likewise, in 1983 the European Patent Office granted Ciba-Geigy the right to patent seeds genetically manipulated to be herbicide resistant. During the following years the patentability of genetically manipulated living organisms was the subject of intense policy discussions in the EU. These finally ended with the adoption of a Patent Directive in 1998 which stated "Inventions which concern plants or animals shall be patentable if the technical feasibility of the invention is not confined to a particular plant or animal variety" (European Parliament and Council 1998). The Chakrabarty case, the Ciba-Geigy decision, and the EU directive all mark a break with the so-called "product-of-nature" doctrine that had previously informed people's thinking. According to the product-of-nature doctrine, patentability cannot be granted to objects found in nature (Davis 1995).

Reframing GM Foods as an Ethical Issue in EU

In the early 1990s regulatory systems had been set up on both sides of the Atlantic in order to mitigate side effects on human health and the environment. In the USA, regulation of GM foods was based on the fundamental principle that genetic technologies are comparable with other technologies and do not themselves raise particular concerns. Following this logic, risks were handled in the USA within the existing regulatory framework, which focused on products. This so-called "product-based" regime was different from the more "process-based" regulation in Europe (Jasanoff 2005). Hence, Europe exercised a more precautionary approach – and one presupposing that genetic technology, in its nature, differs from other technologies and requires specifically tailored regulation. The process-based regulatory strategy resulted in the adoption of two EU directives specifying how member states should ensure the regulation genetically modified organisms. One directive regulated the deliberate release of GMOs into the environment (e.g., in agriculture). The other regulated enclosed use of GMOs in, for example, industrial facilities.

It is characteristic that in Europe as well as in North America, policy discourses on GM foods and agriculture largely excluded wider ethical or moral concerns until the mid-1990s. The omission of ethics in the political discourse cannot be explained by an absence of ability, or will, to discuss ethical aspects of modern technology. Other uses of technologies directly involving humans – e.g., in vitro fertilization and abortion – engage a long tradition for concern about the ethical aspects of medical technologies. Similar observations could be made about genetic engineering, where wider ethical questions had largely been reserved for applications involving humans. By contrast, applications for use in agricultural and food production were by and large kept within the risk frame.

The situation in the early 1990s in Europe was that a regulation believed to meet the concerns of the public, and at the same time facilitate the use of the new genetic technologies in agriculture and food industry, was in place before the first large-scale marketing of GM foods in Europe. To some extent, this may have been a lesson from the introduction of nuclear power, the other major and controversial technology developed and applied in the postwar years, and one that appeared a few decades before GM. In many countries nuclear power was introduced without taking public concerns about the risks into account – and the result was, in many cases, lasting social conflict. Thus, the directives can be seen as part of a between a concerned European public and the agri-food sector, hoped to ensure a peaceful application of the technologies.

In the autumn of 1996, the spell was broken. This happened when the first large-scale marketing of GM foods in the shape of GM soy took place in Europe. Despite the fact that the shipments only contained about 2 % of Monsanto's Round-Up Ready Soy, genetically manipulated to resist the herbicide Round-Up, consumers in several European countries reacted with demonstrations and consumer boycotts. In spring 1997, shortly after the soya issue peaked, the birth of Dolly, a cloned Dorset ewe, was announced. Although, strictly speaking, Dolly was a medical application of biotechnology, the mere fact that scientist now had demonstrated that cloning was possible revived and fuelled controversy over GM foods, particularly in Europe.

In many ways, the second half of the 1990s marked a transition away from a European political discourse on GM foods, which, at the programmatic level, now also included some of the concerns previously excluded. It is striking that there were almost no studies of public perceptions in the 1980s. Up to, and indeed following, the reappearance of the controversy, several qualitative and quantitative studies showed that, beyond risk and usefulness, public concerns now centered on ethical issues, as well as questions about transparency in democratic decision-making (e.g., Marris et al. 2001; Lassen and Jamison 2006; Gaskell and Bauer 2002). Some studies even found that the ethical concerns had a veto-like nature (Wagner et al. 1997 and Ten Eyck et al. 2001). Others stressed the existence of a strong public voice demanding evidence of the specific societal usefulness of GM foods before they could be accepted – economic benefits to companies and individuals were not enough (Lassen et al. 2006).

Irrespective of the way public concerns over GM foods were analyzed, many of the studies supported the conclusion that the reappearance of the European controversy over GM foods was the result of a mismatch between national and EU policies and the nature of the public concern. At the political level the controversy, and the reframing of GM foods, resulted in a de facto moratorium in which a decisive majority of member states blocked approval of new GM foods in the EU in 1999 (Levidow and Carr 2010). The moratorium was lifted in 2004 following a revision of the EU regulation requiring traceability introducing a possibility of requesting nonmandatory consultation of the Commission's committees on ethics.

Although this development illustrates the reframing of policy discourse on GM foods, the fact that the results of ethical consultation are not legally binding does not seriously challenge science-based decision-making over GM foods which still focuses on risks. Meanwhile the EU Commission has proposed a revision of the existing legal framework, making it possible to combine science-based risk regulation "with freedom for Member States to decide whether or not they wish to cultivate GM crops on their territory" (European Commission 2010). Although the Commission stresses the importance of securing coexistence for GM, conventional and organic production systems, and what they call the member states' "regional and national specificities," it is far from clear to what extent the proposed revision would enable member states to include wider ethical concerns.

Transatlantic Battles over the Precautionary Principle

GM foods are not only subject to national regulation in individual countries and legislation at EU level but also governed by the treaties regulating international trade. Once GM foods arrived at the market, during the 1990s, and exported, it was clear that the national and EU regulations were not necessarily in accordance with the principles of international trade laid down in treaties within the WTO system. These tensions were demonstrated in the dispute between the USA, Canada, and the EU over North American exports of beef from cattle treated with recombinant growth hormones to EU markets in 1998. They arose again in 2003 when the USA, Canada, and Argentina challenged the de facto EU moratorium imposed following the soya crisis. Both cases demonstrated a conflict between European governance of GM foods, stressing precaution, and the American, less precautionary, approach (see Anker 2012 for an elaboration of the WTO controversies and the role of the precautionary principle).

In essence, the precautionary principle stresses that in cases where the available scientific data do not allow a complete evaluation of the risks, decisions should respect the uncertainty. With reference to the precautionary principle, the EU banned the import of recombinant bovine somatotropin (rBST) meat in 1987, claiming that some uncertainty existed regarding the risks it presented to humans – a decision opposed particularly by the USA, who successfully challenged the import restrictions before the WTO in 1997. The complaining countries insisted that existing risk assessments cleared the rBST meat of risks to humans and demanded that the EU give up the ban. Similarly, the EU was challenged before the WTO on the de facto moratorium. Although both cases challenge the EU's right to regulate GM foods using the precautionary principle, this does not mean that the precautionary principle is not accepted outside EU. Both the Rio Declaration and the WTO system include interpretations of the principle (Anker 2012). Thus, the disputes are rather about the level of uncertainty required before a nation, or region, can claim a right to regulate trade and production and whether the alleged uncertainty is purely theoretical or has scientific backing.

Involving the Public

During the 1980s genetic technologies moved from the stage of basic research towards applications in agriculture and the food industry. The first applications, illustrating what was to come, were seen in the 1980s; they included uses of the genetic technologies in enclosed industrial facilities producing, for example, enzymes and other processing aids for the food industry. Also field trials of manipulated plants with new properties, such as crops that were resistant to pesticides, took place during the 1980s. This move from the laboratory to applications in the agri-food sector happened alongside increasing political awareness of the necessity to govern science and technology.

As noted above, discourses about science and technology were, in the years following the Second World War, generally positive. Optimism prevailed and science and new technologies were typically framed as means to wealth and societal progress. This resulted in a laissez-faire policy. During the 1960s and 1970s, an increasing number of reports, however, documented negative impacts of the industrial society on health, the environment, working conditions, and so on. Following this, it was gradually recognized that technological developments were in some cases accompanied by risks and undesired side effects that had the potential to cause social controversies.

Following this awareness of potential societal conflicts over technologies, technology assessment emerged as a new discipline during the 1970s. Technology assessment was seen as a tool facilitating the development of adequate policies for handling, or preventing, the negative impacts of new technologies. In assessing and predicting positive as well as negative consequences, the aim was to improve the basis of decision-making and, not least, to identify potential areas of future controversy. Since this took place while genetic technologies were migrating from the research labs towards industrial and agricultural application, these new technologies were subject to intense monitoring and assessment.

Initially, technology assessment of genetic technologies was based primarily on expert consultations. The US Office of Technology Assessment, established in 1972, led this trend. For example, it introduced “consensus conferences,” at which groups of scientific experts were gathered and asked to reach a consensus on a given issue. During the 1970s and 1980s, most assessments of genetic technologies followed this expert trend. The interpretation of public reservations about genetic technologies, and thus the explanation of the pending controversy, was that the public were laboring under scientific illiteracy. This “knowledge-deficit” approach resulted in recommendations urging policies which, besides stimulating research and regulating the risks, aimed at informing and educating the public about the “true nature” of genetic technology. The expectation was that increased information would fill in the knowledge gap and result in acceptance of the technologies – an idea that has been challenged by survey results indicating that opposition is often greater in countries with high levels of knowledge (Biotechnology and the European Public Concerted Action group 1997) – suggesting that the relation between attitude and knowledge is more complex.

Critics of expert-based assessments and the knowledge gap, however, argued for a technology policy that also included lay assessments (Schot and Rip 1997). During the 1980s this resulted in the development of technology assessment into a more participatory discipline, and since genetic technologies were among the most hyped and controversial technologies at this time, they were assessed in terms set by this new discipline. The new, more participatory approach to technology assessment that was applied in many countries all over the world was initiated and first institutionalized in European countries with a stronger tradition of participatory democracy. Thus, institutes like the Dutch NOTA, later the Rathenau Instituut, and the Danish Board of Technology were the nexus of developments of a number of participatory tools involving the public more or less directly in decisions about genetic technologies and other technologies. In addition to existing sociological methods only facilitating indirect participation by means of focus group interviews, or surveys, these institutions developed new methods that see participation as an interaction between decision makers and the public. Rather than changing and educating the public, this new approach aims to accommodate the genetic technologies to public concerns.

By 1996, as the soya case hit Europe, it was clear that there was a mismatch between risk-focused policies and the worries people had in many European countries. Among the many participatory initiatives launched over the following years, as means to understand and handle this situation, were genuine participatory activities, like public hearings, citizen forums, Delphi studies, and consensus conferences, inviting the public to participate in a more direct way in the policy process. One of the more noticeable activities was GM Nation, launched in the UK in 2002. The aim of GM Nation was, on the one hand, to promote a deliberative process leaving the framing of GM issues to the public and, on the other, through this, to inform the Government’s decision-making.

While it is hard to pinpoint any direct and measurable effects of the participatory activities on GM food governance, there is little doubt that there has been an indirect impact. Thus, participatory methods have given the public concerns a voice in the policy discourse on GM food and contributed to discursive changes. Earlier ethical concerns were largely confined to policy discourses covering in vitro fertilization, human cloning, gene therapy, and other human or medical applications of the genetic technologies, while policy discourses on GM foods were limited to risks and benefits. Since the mid-1990s, particularly in Europe, GM foods have been framed increasingly as an issue also including ethical aspects. Thus, although risks and economic benefits remain the dominant frame, new aspects addressing naturalness, integrity, distributional justice, and responsibility pop up from time to time alongside discussions demonstrating a tension between sheer economic and broader societal benefits.

Governance "Making GM Foods Happen"?

From their humble beginnings in the 1960s, the policy processes around GM foods have been, in effect, a means of making biotechnology happen (Jasanoff 1995). Apart, perhaps, from the first anxious reaction of scientists in 1974, the genetic technologies have rarely if ever been seriously challenged in the policy process. Rather the aim has been to find a way to tailor the technologies to society by setting up regulations shaping their use and by making sure that public concerns are met. It can be argued that this has been carried out with some success with the construction of science-based risk assessments. However, it remains uncertain to what extent public concerns about issues other than risks can be handled. Despite attempts to manage these ethical issues, they are still largely left to market-based governance, and as long as the regulation of ethics rests with the market, the risk of controversy reemerging must surely loom large.

Summary

The governance of genetic technologies used in food production has, since its beginning, aimed to facilitate the development and application of these new and promising technologies as part of an ongoing modernization project. On the one hand, this has been realized by policies supporting research and development and paving the way for the food business. On the other hand, policies have addressed the many concerns about unwanted side effects of the technologies and established regulatory frameworks controlling these. This governance of side effects has moved from a focus on safety and human health in the early 1970s, over risks to health and the environment in the 1980s, to include broader ethical concerns in the years following 1996.

Although the overall aim of facilitating the development and application of GM food technologies has been shared by policy makers in North America and Europe, the regulatory setups are different across the Atlantic. In the USA, for example, regulation of GM foods is based on the fundamental principle that genetic technologies are similar to other technologies and should be handled within the existing regulatory framework. This product-based regime is different from the process-based approach taken in Europe, which sees genetic technology as different from other technologies and thus as something requiring its own regulatory framework. In addition, Europe has taken a more precautionary approach to governance than the USA. And Europe, unlike the USA, has striven to include ethical aspects in regulation. So far, however, this has not resulted in binding regulations. By and large, ethical concerns have been left to be regulated by markets on either side of the Atlantic – leaving the door open to a revival of the public controversies of the 1980s and 1990s.

Cross-References

▶ Agricultural Ethics
▶ Canada, US-EU Beef Hormone Dispute
▶ EU Regulatory Conflicts over GM Food
▶ Herbicide-Resistant Crops
▶ Intellectual Property and Food
▶ Multilateral Trade Organizations, Food, and Agriculture
▶ WTO Dispute Settlement and Food and Agricultural Trade

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Body Image, Gender, and Food

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Synonyms

Consumption; Embodiment; Identity; Representations

Introduction

While human bodies must consume food to live, lives are organized around the actual harvesting, gathering, preparing, and eating of food. These practices, particularly consumption, are deeply cultured and gendered. The ranges of appropriate body sizes and shapes are also highly gendered. In the USA, men on average are 5.5 in. taller and 29.3 lb heavier than women (CDC 2012b). Though not all men are larger nor all women smaller, they are expected to be based on feminine and masculine body ideals. Most people strive for socially and culturally normative body sizes.

The presentation of self as a gendered person is achieved through the use of markers and symbols, including clothing, hairstyles, and jewelry. Humans manage their interactions with others using behavior and physical activities considered appropriate for one's sex category (Goffman 1959). Internal and external body image, its size, shape, contours, and ornamentation, is inextricably tied with the essential biological need to consume food as well as the validation of body presentation. Globally in heterogeneous cultures, bodies are dichotomously depicted and presented as male, whereby a body will be muscular, hairy, large, tall, and solid, or as female, whereby a body will be slender, smooth, hairless, petite, and slight. Those falling outside of the gendered descriptions of body size and appearance are often in the challenging position of sculpting, controlling, starving, or enhancing their bodies for the preferred male or female presentation of self. This entry covers the definition and ethics of body image, gendered relationships with food, disordered eating across the globe, Pro-Ana Movements, and Fatness Studies.

Body Image

Body image is defined as a person's self-perception of his or her own body. Internal body image refers to the way someone feels about his or her own body; this is psychological. External body image is how others perceive and react to bodies; this is sociological. There is an ongoing interaction between the psychological and sociological perspectives of body image, which are inextricably linked: a person's internal body image can be vastly different from their external body image. The disconnect between what is perceived about the body and how the body publically appears has largely been accredited to sociological factors, particularly different media representations of the ideal body (Grogan 2008).

People absorb revered and stigmatized images of different bodies through friends and family or via media including television, magazines, and the Internet. Constantly bombarded with these images of bodies, individuals are influenced to judge and consider their own perceived flaws and develop body projects (Brumberg 1997) to manage these "problems." Men and women work to achieve an idealized body image and reap the rewards of prestige, attention, or accolades in the form of positive social sanctions. One of the primary ways individuals discipline human bodies to better reflect the "ideal" body type is through the selection of food and eating habits.

The consumption of food and management of weight and body size are how body image is regulated. Furthermore, part of maintaining an acceptable body image goes beyond one's physiological shape and involves bodies acting in a culturally and socially regulated way through table manners, portion control, and expression of tastes. Seemingly trivial movements such as the way one walks or holds a fork are not merely how the body functions but also cultural imprints which adapt to norms of gendered, racialized, and classed bodies (Bordo 1993).

Gendered Relationships with Food

Food is one of the ways to express identity and group membership – as cultured or raced, as gendered, and as part of a social class. Although consumption is universally human, the ways people eat and what they chose to eat are not universal; eating practices and preferences are culturally produced (Lupton 1996; Kluger et al. 2004). Food advertisements take advantage of the need for food in ways that appeal to specific groups of people. Men and women have been socialized to eat differently. Originating with prehistoric ideas of men as hunters and women as gatherers (Sobal 2005), eating habits and ideas transcend generations by the actions and diets of older men and women which are passed down to their children and then to their children's children. Individuals often mimic the performances that receive favorable reaction and engender generations of similar performances (Goffman 1959).

Gender can dictate the type of food that a person eats. Men are shown overwhelmingly to eat more meat and protein-based diets, in part because many societies prioritize their nutrition over that of women (Adams 2000; Lockie and Collie 1999; Rogers 2008; Nath 2011). Men also are shown and expected to eat more meat because of what animal flesh symbolically represents.

Eating meat has come to represent human's superiority over other animals because of its representation as a masculine food (Adams 2000). Eating animal flesh is used as a display of power over other animals, supposedly proving human's strength (Fiddes 1991). Though these ideas are perpetuated daily, researchers have found flaws in their fundamental accuracy. Meat as a representation of masculinity, power, and strength contradicts with what meat actually does to the human body. Despite new scientific studies that connect the consumption of red meat to coronary heart disease, eating meat, is still dominantly considered a means to strength, health, and virility (Nath 2011; Lockie and Collie 1999). The consumption of meat has moral implications beyond its masculine representation. Philosophers debate the ethical concerns of eating meat and other foods (Kaplan 2012).

It is no coincidence that the foods marketed to women are often described as healthier and are associated with weight loss. The grand narrative of advertising food to women in high-income countries is thinness. One of the most common foods targeted at women is yogurt. Yogurt is largely considered a healthy food option. Yogurt commercials often feature dessert flavors: Boston crème pie and strawberry cheesecake. Dieting women routinely deny themselves such foods as pie and cheesecake in order to maintain the elusive "perfect body." This denial of food is culturally specific, often resonating in upper- and middle-class women whose food supply has never been jeopardized (Lupton 1996; Counihan 1998; Allen and Sachs 2007).

Feminist scholars suggest using social, historical, and physical environment factors to explore gendered food and body image issues. Women and girls' relationship to food and their bodies have many influences beyond being ultratin, including participation in sports, stress, and access to food (Yancey et al. 2006).

Disordered Eating

Eating disorders, disordered eating, and eating disturbances are terms used to identify clinical manifestations of skewed body images and psychologically categorized pathological eating practices. In the USA, the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) describes four main categories of eating disorders. These disorders include anorexia nervosa, self-starvation; bulimia nervosa, bingeing and compensatory behaviors such as self-induced vomiting; binge eating disorder, recurrent episodes of eating significantly more food in a short period of time than most people would eat under similar circumstances; and eating disorders not otherwise specified (EDNOS), any combination of signs and symptoms typical of anorexia and bulimia (American Psychological Association 2013).

It is estimated that up to 24 million people in the USA suffer from an eating disorder, including anorexia nervosa, bulimia nervosa, and binge eating disorder (ANAD 2013). Up to 70 million people suffer from eating disorders around the world (Renfew 2003). Surprisingly, in industrialized countries, eating disorders have the highest mortality rate of any psychiatric illness, yet they garner the lowest funding towards prevention, education, and research (NEDA 2013). Many insurance companies do not cover treatment. Insurance that does cover treatment often has strict regulations for qualification that are not met until the eating disorder is highly developed. This time lag is especially problematic because studies overwhelmingly show eating disorders are harder to treat the longer they are present (Dias 2003; Peebles et al. 2012).

Most people who are clinically diagnosed with the illness never fully recover (Boero and Pasco 2012). Studies of eating disorders largely focus on women, and erroneously there are long-held beliefs that men do not have eating disorders. Men comprise 10–15 % the total number of anorexia and bulimia cases in the USA (ANAD 2013). Studies have shown that men and women suffer from binge eating in similar numbers. Men seem to be more dissatisfied with their bodies when their body weight and height fall below average (Strother et al. 2012). Their body image dissatisfactions and how they suffer from these disorders reflect larger societal pressures (Weltzin et al 2005).

Men are more likely to become obsessed with exercise because muscular toned bodies are the hegemonic masculine ideal. Muscle dysmorphia is characterized by preoccupation or obsession with muscularity and most prevalent in men, resulting in the use of anabolic steroids and growth hormones. One study suggests that the percentage of men using these substances is similar to the percentage of women with anorexia and bulimia (Strother et al. 2012).

Women in other countries, both developed and undeveloped nations, are influenced by the US standards of ideal body size. Globalization has been blamed for body image dissatisfaction and eating disorders in countries outside of the USA. Women in Fuji idealized the ultrathin body for what it represents – material wealth and a consumer lifestyle – but they did not find the thin body attractive in itself (Edmonds 2012). A study in highly Westernized Belize found that despite the high prevalence of US media, the country had no clinically significant eating disorders. A local tradition of caring for one's own body may protect young girls from eating disorders (Edmonds 2012).

Even though there are countries that defy the assumption that Westernization causes body image problems and eating disorders, there are many studies that show an increase in eating disorders outside of the USA. A study in Navarra, Spain, found that in an 18-month period, 4.8 % of a 2,509 sample of women ages 13–22 developed an eating disorder (Lahortiga-Ramos et al. 2005). Most research of eating disorders and body image is conducted within the USA, a country thought of as the root of global body dissatisfaction. Significantly, Argentinians and Brazilians have increasing rates of body dissatisfaction. It is estimated that 10 % of Argentine adolescent girls suffer from some sort of eating disorder. Brazil has the highest per capita use of diet medication in the world (Forbes et al. 2012).

There are many difficulties in studying the epidemiology of eating disorders because individuals suffering from eating disorders often hide their struggle and attempt to conceal their illness from doctors, families, and friends. This secrecy and shame makes community studies of eating disorders challenging and often inaccurate. Therefore, researchers base their analyses on medical records to ascertain the incidence and prevalence rates. While this technique may provide some information, it is likely that statistics about eating disorders are underestimated (NEDA 2013; Smink et al. 2012).

Studies of cultural, ethnic, and racial determinants of eating disorders and body image, mostly conducted on US-based populations, largely focus on comparative analysis of white and black women. One notable difference in body image revolves around perception. White women are found to be dissatisfied with their bodies when their weight falls into average or below average categories. Black women do not have eating disturbances until they are in overweight categories, if at all. White women suffer from anorexia and bulimia more commonly, and black women suffer from binge eating and obesity.

Many researchers believe that part of the reason black women are often heavier than white women is because they are fighting multiple oppressions and are comforted by food (Lovejoy 2001; Feinson 2011). Overall, researchers find that black communities are more accepting of different body types as attractive, resulting in fewer black women being driven to extremes to achieve unattainable thinness (Kelch-Oliver and Ancis 2011). There also seems to be less pressure from family, friends, and romantic partners to conform to Western standards of beauty (Jefferson and Stake 2009).

A study of adolescent Ecuadorian girls explores the pressure felt to both be "Western beautiful" and beautiful within their own culture. In interviews, the girls gave descriptions of beauty coinciding with Western ideas. Only women with very light or white skin and Caucasian features are recognized as the ideal beauty. The participants judged real women less harshly than models and celebrities, using the Ecuadorian word "arreglada," meaning "well groomed," to describe beauty. As long as the woman puts effort into her appearance and has a good heart, she is generally thought of as beautiful (de Casanova 2004). The Western hegemonic depictions of unrealistic ultrathin models have the potential to affect women and girls globally, resulting in body image dissatisfaction and confusion.

Pro-Ana Movements

Open dialogue websites made and used by women suffering with eating disorders have become a subject of interest over the past decade. The websites often include advice, images, discussion boards, videos, and audio that explain and encourage a lifestyle that integrates eating disorders. Part of engaging in these websites involves developing an online persona. These websites, referred to as "Pro-Anorexia" or "Pro-Ana," have been deemed problematic because of their positive reinforcement of eating disorders. Many images of models and celebrities are presented as "thinspiration." These images are often criticized as harmful and triggering, yet Pro-Ana websites are only one of many places that pictures of extremely thin models are displayed (billboards, magazines, etc.). Importantly, many women who are often very secretive about their eating disorders in public are very open about it online, resulting in two different identity performances.

These websites, accessed by anyone with the Internet, provide a space for them to discuss their issues with others who have similar problems, free from judgment (Borzekowski et al. 2010). Many of the websites have disclaimers before entering, stating that they are only meant for people who have eating disorders. Weigh-ins, posting photographs, and food journals are all used to discourage less involved users. The users of these websites struggle with bringing their real-life bodies into a disembodied space. The community is built by those who successfully display themselves as "real" anorexic bodies (Boero and Pasco 2012).

Women with eating disorders are often thought of as "irrational" and "in denial" of their behavior. The narratives on Pro-Ana websites contradict these statements. Many women claim to be self-aware and are making attempts to address their disordered relationship with food. Women realize the "perfect body" is virtually unachievable, yet still aspire to it. Treatment for eating disorders is highly flawed in the USA.

Fatness Studies

The proliferation of an idealized thin body type is completely incongruent with real-life global bodies. According to the World Health Organization, over 50 % of the women in the regions of North America, Europe, and Eastern Mediterranean are overweight. The majority of the world lives where more people die from issues associated with obesity rather than malnourishment (WHO 2013). Fat bodies receive a comparable amount of attention as thin bodies, but in very different ways. Fat bodies are harshly criticized in the media, by the medical industrial complex, and within the general population. While fat bodies are regularly seen in public, they are rarely seen in the entertainment media, and when represented they appear as the abject body. These bodies are medicalized as unhealthy and layered with stigmatized terms such as lazy, careless, and stupid.

Fat bodies have not always been depicted as unhealthy and undesired. They once symbolized wealth and prosperity, signifying access to an abundance of food rather than having to struggle for it. Somewhere between the 1880s and 1920s, messages about fatness changed from healthy and beautiful to unhealthy and unattractive (Rothbum and Solovay 2009). Since then, fat bodies have seen a steady increase of negative attention (Gilman 2008). Fat bodies are considered a risk to themselves as well as a drain on limited public resources, as fatness is associated with illness and disease such as diabetes and heart conditions. Individuals who are fat have reported being denied healthcare or forced to pay a higher medical premium. They are also subject to discrimination in the workplace, often not hired for physical jobs and/or jobs that interact with the public (Berg 2008).

Personal responsibility overshadows class, ethnic, and social explorations of body size. Many of the determinants that foster weight gain are rooted in industries and everyday life practices that are difficult to challenge. Many people work at jobs that require them to sit at a desk for the majority of the day without any physical activity. Food industries supply readily available, very cheap, and very unhealthy food (Lupton 2013).

Though being extremely overweight, or in medical terms "morbidly obese," can cause some health problems, the obsession with fat bodies as a sign of unhealthiness is often unbalanced. Researchers opposing the medicalization of fat bodies explain that there is no statistical evidence that equates fatness with ill health or disease and there is no evidence that losing body fat improves a person's health status (Lupton 2013). Fat bodies are constantly bombarded with images of ultrathin women and how they got to be that way. Diet and fitness magazines never display fat bodies but are always talking about them (Kent 2001).

In popular culture, fat bodies are consistently kept invisible. They are only shown if they are trying to become thin: "before" pictures in dieting ads and in the newly popular weight loss television series. Fat bodies are never shown as "normal" media characters or as successful, sexy, or in charge (Kent 2001). Yet, over one-third of the US population is considered obese and 69.2 % of Americans are considered overweight (CDC 2012a). The lack of positive images of fat bodies serves a purpose. Fat bodies are left to feel isolated and unworthy. When they are displayed, it is only to show that there is a way to change: to choose this diet, to buy this supplement.

The stigmatization of fat bodies is justified by the idea that thinness is preferred, healthy, universally achievable, and natural. Even if eating healthy and exercising regularly were an infallible way of achieving a thin body, there would still be challenges. Healthy food costs more money and time than unhealthy food. Food insecurity is described as the inability to acquire nutritionally adequate and safe foods (Smith and Bloomberg 2008). It has been acknowledged that lower socioeconomic areas lack access to healthy, affordable foods (White 2007). These areas often have limited access to large supermarkets, causing people to rely on smaller shops, convenience stores, and fast-food restaurants. The food obtained at these places may relieve hunger, but often lack nutritional value (Smith and Bloomberg 2008).

To counter the oppression of fat bodies, a movement of size acceptance has emerged out of feminist and queer liberation movements. Feminists have been advocating for fat bodies for decades, discussing why fat bodies should not be disparaged (Kent 2001). Acknowledging that fat bodies are not necessarily unhealthy would also help in the acceptance of larger and different bodies. A grassroots movement of healthcare workers, researchers, consumers, and activists has been trying to shift the idea of what a healthy body looks like. Health at Every Size (HAES) emphasizes healthy everyday practices and body acceptance. The actual weight and size of a body is not as important as its overall health (Burgard 2009; Lupton 2013). Many groups and individuals protest the discrimination of fat bodies. They believe size diversity among humans is natural and should be celebrated (Berg 2008).

Summary

Body image is continuously changing throughout the world. A person's external appearance converges with his or her eating practices to help form an identity. Eating and producing food is not as simple as acquiring nutrients; its symbolism is powerful and morphs and adapts through time.

Cross-References

- ▶ Eating Etiquette
- ▶ Ethical Assessment of Dieting, Weight Loss, and Weight Cycling
- ▶ Ecofeminist Food Ethics
- ▶ Food Addiction
- ▶ Food and Choice
- ▶ Food-body Relationship
- ▶ Gender and Dieting
- ▶ Gender Norms and Food Behavior
- ▶ Obesity and Responsibility

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Brazilian Agriculture

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Synonyms

Agriculture in emerging economies; Brazilian farming; Farming in the global south; Latin American agriculture; South American agriculture

Introduction

Brazil is one of the world's largest agricultural producers and exporters. Vast areas of arable land, rich natural resources, sophisticated research and technology, and highly developed domestic and international markets nurture a highly modernized agriculture industry. This agricultural juggernaut exists alongside (and competes with) a vibrant peasantry that persists in the Brazilian countryside and produces much of the food that is consumed domestically. Brazil's primary commercial crops include soybeans, sugarcane, beef, poultry, cotton, orange juice, and coffee. Important domestic food crops include manioc, wheat, corn, rice, and a vast array of fruits and vegetables. Agricultural production has risen dramatically in the last two decades, particularly in the soy and sugar sectors, as global demand for animal products and biofuels has skyrocketed. These changes in the agricultural economy in Brazil have raised a number of ethical issues. One of the most contentious within Brazil is access to and distribution of land between big agriculture and the peasantry. Violent conflicts over land often grab headlines in the Brazilian media. The illegal use of slave labor on large farms has also become a very public issue, and while the federal government has stepped up enforcement in recent years, tens of thousands of workers are still estimated to be working under slave-like conditions. Finally, Brazil is home to over 60 % of the Amazon rainforest, and the country's agricultural frontier presents a constant threat to the integrity of that ecosystem. Because the Amazon is considered the "lungs of the world," and because so many countries depend on Brazilian exports for domestic food security, many of these ethical questions are considered global issues by the international community. This essay will discuss these issues in the context of some of Brazil's most economically important agricultural commodities: coffee, sugar, soy, cattle, and horticulture. Each case provides a unique perspective on the ethical controversies described above and reveals the complexity of Brazil's agricultural landscape in a different way.

Overview of Brazilian Agriculture

There are three main commercial agricultural regions in Brazil, each with its own production profile and political-economic structure. The southern region is dominated by medium-sized commercial farms that produce crops primarily for the domestic market. The northeast produces mostly horticultural products (fresh fruits and vegetables or FFV), sugar, and coffee. The center-west is home to massive sugarcane and soybean farms (which increasingly intercrop with corn) that almost exclusively serve the export market. Alongside large-scale commercial or *latifundio* agriculture, small family farms (*minifundio*) remain an important part of the Brazilian economy. According to the Ministry of Agrarian Development, "family farming produces 70 % of food consumed in Brazil, occupies 25 % of the country's cultivated area, generates 75 % of jobs in rural areas and accounts for 84 % of establishments in rural Brazil" (Ministerio do Desenvolvimento Agrário 2012).

The tension between large-scale, export-oriented farming and smaller-scale, domestic-oriented (or even subsistence) farming is one of the main animating dynamics of the Brazilian agricultural system. These two agricultural paradigms have coexisted since colonial times but are often locked in conflict over access to land and government resources, as well as social legitimacy and justice. Brazil's two different ministries of agriculture (the Ministry of Agriculture, Livestock, and Food Supply and the Ministry of Agrarian Development) exemplify the political division between the two modes of production. Though separated in the Brazilian political structure, these systems profoundly impact one another, and their relative contributions to functions and priorities in Brazilian society are a matter of fierce debate.

Brazilian agriculture also finds itself at the center of global environmental and human rights debates. Brazil is one of the last places on earth with significant amounts of undeveloped land that could be converted to agriculture. However, those same areas also boast some of the most biologically diverse and sensitive ecosystems on the planet. As "food crises," or dramatic spikes in food prices that occur due to commodity speculation and supply disruption, have become increasingly frequent and severe over the last decade, Brazil has become a focal point for the debate over the future of the global food system. In 2009, the UN predicted that global food production would have to double by 2050 in order to keep up with the rising global population and, perhaps more importantly, rising incomes and the increased consumption of animal protein that often results (United Nations 2009). As people around the world eat more meat, Brazil responds by producing greater quantities of soybeans and corn to feed livestock. Expanding demand for biofuels puts similar pressure on sugar markets, and the continuing profitability of cotton and beef intensifies the competition for land among these primary industrial commodities. These large monoculture *fazendas* run on hired labor, and although the vast majority of *fazendeiros* treat their workers fairly, every year the Brazilian government continues to find thousands of rural workers being held against their will in slave-like conditions (Associated Press 2012). All of these controversial questions, which will be discussed in more detail below, shape the dynamics and trajectory of Brazilian agriculture and render the sector one of the most important sites of social inquiry today.

A Brief History of Brazilian Agriculture: Colonialism to Industrialization

While comparatively little is known about precolonial agriculture in Brazil, there is evidence that indigenous peoples cultivated manioc and maize, as well as a wide variety of fruit, nut, and vegetable crops in the Atlantic and Amazon forests (Filho and Gamboa 1993). The earliest colonists were primarily interested in extracting and exporting brazilwood for the red dye that it produced. However, as colonies were established, so was an economy based on tropical agriculture. The first colonial cycle was dominated by sugarcane, which lasted from 1530 until 1700. The coffee cycle that followed lasted from the 1830s to the 1930s (Eakin 1997). Even after industrialization of agriculture began to take hold and the sector diversified beyond coffee and sugar, the Brazilian economy remained heavily dependent on tropical agriculture, which was responsible for an average of 55 % of exports until the 1960s (Pereira et al. 2012).

In 1964, a military coup overthrew the democratically elected government, and the regime that ruled Brazil for the next 20 years pushed industrialization and urbanization that would change the face of Brazilian agriculture. The impact on agriculture of the push for industrialization was twofold. First, capital investments in agricultural production were encouraged through government subsidy programs that gave farmers cheap credit to purchase machinery. Second, the pull of developing cities contributed to a rural-to-urban migration that mirrored the process of rural depopulation that was simultaneously occurring all over the developing world. In Brazil, the rural population decreased from 64 % of the country's total in 1950 to 32 % in 1980 and 16 % in 2010 (Pereira et al. 2012).

With a declining rural population, a national political emphasis on industrialization and modernization, and the worldwide spread of agricultural technology and research prompted by the Green Revolution, agriculture in Brazil underwent a major transformation in the mid-twentieth century. One of the most important changes was the conversion of the *cerrado* – a mixed savannah and forest ecosystem that dominates the central plains – to agriculture. Prior to the 1970s, it was widely believed that the *cerrado* was unfit for agriculture due to the acidity of the soil. However, the country's agricultural research agency Embrapa discovered soil amendments – namely, phosphorus and lime – that would release the nutrients in the acidic *cerrado* soils and render the region the largest unexploited agricultural frontier in the world (Warnken 1999).

Despite Brazil's tremendous agricultural productivity, the country remained a net recipient of food aid well into the 1980s. Today, however, Brazil is one of the largest exporters of agricultural goods in the world and is largely self-sufficient in food. Agriculture is responsible for 35 % of the country's exports and 6 % of its GDP (Economic Research Service 2012). The following section discusses in detail some of Brazil's major crops and some of the ethical questions associated with particular sectors and with large-scale agriculture in general.

Major Crops

Coffee

Coffee is the commercial crop with the longest and perhaps most complicated history in Brazil. It has been a powerful engine of economic growth but is also directly implicated in the environmental, human rights, and land access controversies described above. During and immediately following Portuguese colonization, coffee plantations dominated the vast Paraíba Valley of São Paulo state, setting the stage for the industrial development that later made São Paulo Brazil's economic center of gravity. Though coffee's economic importance has diminished relative to other agricultural products in recent decades, it remains an important source of foreign exchange revenue, and Brazil remains the largest coffee producer in the world, responsible for over one third of total exports.

The coffee plantations that drove economic growth in Brazil throughout the nineteenth century were the beginning of Brazil's *latifundio* system wherein vast coffee plantations were operated by a small number of very wealthy landowners. These plantations subsisted on imported slave labor, and conditions were notoriously brutal. Brazil was the last country in the western hemisphere to officially outlaw slavery (in 1888), but illegal slavery continues today on many of the country's large monoculture farms.

Brazil's early coffee plantations also dramatically changed the ecosystem of the Atlantic region. While much of today's attention is focused on deforestation in the Amazon, in the nineteenth century, coffee plantations devoured Brazil's extensive – and biologically rich – Atlantic rainforest. Very little of this unique ecosystem exists today, as the method by which coffee plantations were established caused profound erosion of delicate soils and rendered the land forever dependent on the application of fertilizers.

As the ecological impacts of coffee cultivation have become better understood, environmental groups are encouraging "shade-grown" coffee, a system where coffee bushes are planted underneath a diverse forest canopy. This system allows the forest canopy to remain largely intact, providing habitat for migratory birds and other wildlife. However, shaded systems have significantly lower yield than sun systems, which means that shade-grown coffee tends to be a specialty product marketed to "conscientious consumers" willing (and able) to pay more. Similarly, as labor abuses on large Brazilian coffee plantations have gained publicity (in 2007 the UN estimates between 25,000 and 40,000 workers may be working under slave-like conditions in Brazil), some consumers are demanding "relationship coffee" or coffee that is bought directly from small farmers rather than through brokers that market the coffee grown on large plantations.

Coffee was the first agricultural product to be marketed under the "fair trade" designation, which grew after the collapse of the International Coffee Agreement that controlled the global coffee trade from 1962 to 1989. While the "fair trade" market has grown significantly over the last decade, controversies are widespread over the certification process and the benefit to farmers. Some argue that the significant markup that retailers can charge for fair trade coffee in western markets is not passed along to farmers, and others claim that the sheer number and often remote location of small coffee farms raises questions about the ability of certifying agencies to guarantee that growers are complying with fair trade standards.

Sugar

Sugarcane was the first crop to be produced by Portuguese colonists in Brazil on a large scale. Since its introduction in the sixteenth century, sugar has remained an important export, and today Brazil produces around 25 % and exports around 40 % of the world's sugar. While sugar is produced from sugar beets in colder countries like the USA, sugar in Brazil comes from cane, which is milled shortly after harvest in the hundreds of mills concentrated in the central-south region of the country. The sugar industry employs over a million people and is responsible for 2 % of the country's GDP. As global interest in biofuels grows, the market for Brazilian sugar (and ethanol) is booming. While the environmental and social controversies around sugar production have long histories, those debates are heating up as demand for ethanol surges worldwide.

Sugar was the economic engine of Portugal's very earliest colonies, and despite being displaced first by coffee and later by the growth of industrial agriculture, sugar has never fallen far from the top of Brazil's most cultivated crops. In colonial times, sugar production was concentrated in the northeast and central-south regions of the country where the tropical climate is conducive to its cultivation. The extant states of São Paulo, Paraiba, Pernambuco, Bahia, and Sergipe were the epicenter of sugarcane production during those times, but with the conversion of the cerrado, cane cultivation has spread rapidly and decisively to the west. With the increasing global demand for ethanol, sugarcane has once again begun to compete with soy, cattle, corn, and other industrial crops for valuable acreage. In fact, acreage planted to sugar almost doubled in Brazil between 2004 and 2010.

As with soy, much of this expansion has happened on what was formerly pasture land, and many argue that this only pushes cattle ranching deeper into the Amazon region, resulting in deforestation. Ramping up production also means tougher working conditions for the (often migrant) laborers who cut cane. These issues are thrown into even sharper relief by the worldwide scramble to find an alternative liquid fuel for the global transport fleet.

Brazil has perhaps the oldest and best-developed ethanol industry and infrastructure in the world. The oil crisis of the 1970s prompted the Brazilian government to introduce a program called PROALCOOL, which provided incentives for the production and distribution of sugarcane ethanol as an alternative transport fuel (Borges 1990). Once the oil shock passed and gasoline prices dropped, the ethanol industry began to suffer. International sugar prices were on the rise in the 1990s, which made Brazilian ethanol less competitive in the consumer market. However, by this time the infrastructure was in place (many gas stations have two sets of pumps that dispense gasoline and pure ethanol), and government mandates to blend ethanol into gasoline kept the program alive. The invention of flexible fuel vehicles, which can run on gasoline, ethanol, or any blend of the two, significantly reinvigorated the industry, and by 2011, though only 4 % of Brazil's light vehicle fleet had all-alcohol engines, flex-fuel engines were present in more than 50 % of the existing fleet and in more than 90 % of new cars sold (UNICA 2013). Despite falling short of domestic demand, Brazil exports a significant amount of ethanol, and the USA is the biggest customer. Import tariffs combined with a hefty subsidy for corn-based ethanol significantly limited Brazilian imports for decades. However, in 2012 the US congress suspended the 30-year-old subsidy and did away with the tariff in a single piece of legislation. The Environmental Protection Agency's mandate to blend more than 13 billion gallons of ethanol into all gasoline sold in the USA kept demand high and prompted significant imports from Brazil.

The ethical implications of the growing biofuels industry are well documented (Thompson 2008; Buyx and Tait 2011; Macer 2011; Shortall and Millar 2012). Many argue that it is unethical to devote farmland to fuel production when so many in the world remain food insecure. In addition, the environmental benefits of biofuels versus fossil fuels are controversial, and biofuel production is driving foreign land acquisitions that some say threated the food sovereignty of hungry nations. In some parts of Brazil, the march of sugar plantations is seen as a threat, both to the environment and to small farmers who compete with sugar producers for access to land. The controversies over sugar are perhaps only eclipsed by one even more ethically charged crop: soybeans.

Soy

In 2012, the soybean complex (beans, meal, and oil) surpassed iron ore to become Brazil's single most valuable export. Until the 1980s, soy production was concentrated mostly in the southern states and served primarily the domestic animal feed and cooking oil market. The central-west part of the country is today's soy epicenter thanks to the research of Embrapa (mentioned above) that rendered the *cerrado* soils suitable for agriculture and developed soybean varieties adapted to the subtropical climate of the region. The challenge of growing soybeans under these conditions continues because, although the seed can be inoculated with bacteria that allows the plants to fix nitrogen into the soil (thereby reducing the need for nitrogen fertilizers), the warm and wet conditions create a perfect incubator for fungus and insects that have taken up residence in the vast monocultures of soy. Producers must use increasing amounts of fungicides and insecticides to keep these threats at bay, and the long-term consequences of these chemical applications are unknown. However, so far, farmers have managed these problems, and soy continues to spread across the vast plains of the central-west. Within a decade of the first forays of soybeans into the *cerrado*, the central-western states of Mato Grosso, Mato Grosso do Sul, and Goiâs and the westernmost part of Bahia were outproducing the traditional agricultural centers in the south (Peine 2009). Today, Brazil is the world's largest producer and exporter of soybeans.

This dramatic expansion has brought economic growth and prosperity to both the central-west and the country as a whole, but it has not happened without ethical controversy. The main critique leveled at the soybean boom is that it has been responsible for the dramatic expansion of deforestation in the Amazon and *cerrado* ecosystems. As Brazilian soybean production skyrocketed throughout the 1990s and early 2000s, the rate of deforestation in the Amazon region accelerated as well, reaching a record high of 10,722 mile^2 in 2004. While soy farmers argue that the majority of new land converted to soy farms is degraded pasture left behind by cattle ranchers and *not* newly deforested for the purpose of planting soy, environmental activists counter that this expansion of soy cultivation *pushes* cattle ranchers farther into the rainforest, indirectly contributing to both the release of carbon dioxide that results from burning and clearing land and also the loss of what is perhaps the largest "carbon sink" in the world.

Pressure from international environmental organizations prompted transnational agribusinesses to sign onto the Round Table on Responsible Soy (RTRS) in 2006. This voluntary agreement seeks to prevent the purchase of soy grown on land that was deforested after the year of implementation (among other provisions). While the direct impact of the RTRS on deforestation has not been measured, the trend in deforestation since its inception has been dramatic. In 2012, just 7 years after reaching a record high, the rate of Amazonian deforestation in Brazil fell to a record low: just 1,798 mile^2.

Cattle

Anyone who has traveled to Brazil is familiar with the famous *churrascarias*, where waiters roam cavernous dining rooms bearing enormous skewers of different cuts of beef. Brazilians eat more beef per capita than consumers in the USA (lagging behind only Argentina), and 80 % of the beef produced in Brazil is for the domestic market. In the USA, "grass-fed beef" is a niche product for those concerned about the animal rights, human health, and the environmental consequences of concentrated animal feeding operations, or CAFOs, which are the source of most of the beef, pork, and poultry in the US market. In Brazil, however, most beef cattle graze on open pasture until slaughter, or with a short "finishing period" (on average about 7 % of the total life span) in a feedlot. Cattle in the USA can spend up to a third of their lives in a feedlot. Because Brazilian cattle spend more time on grass and therefore grow more slowly, they are also usually around twice as old as their US counterparts at slaughter (Millen et al. 2011; USDA 2012).

Beef is a centerpiece of the Brazilian diet, and until the last decade, domestic production could barely keep up with demand. In 2003, however, Brazil overtook Australia as the world's top beef exporter, and the largest beef processing company in the world – JBS – is a Brazilian company that began with just one slaughterhouse in 1953. Over the past decade JBS has acquired many of the world's best-known meat companies (Swift, Five Rivers Ranch, and Smithfield Beef, among others) and has a slaughter capacity of 74,000 head a day in Brazil alone.

This significant and rapid growth in production has meant more land in pasture, but the productivity-to-area ratio has not been one-to-one. This is partly due to improved genetics in Brazil's beef herd, but also because of the increased use of feedlots. Feedlots have made Brazilian beef production more efficient by providing an alternative to pasture during the dry season when cattle would otherwise lose weight (Steiger 2006). While only 4 % of the 2011 Brazilian beef herd was raised in feedlots, many analysts predict that this strategy will become more common in the years to come, particularly as pressure to limit deforestation continues and demand rises for competing crops. The environmental trade-offs of feedlot versus pastured beef are certainly not straightforward. While the land pressure of grazing is clear, grain-fed cattle produce significantly more methane than pastured cattle. According to the US Environmental Protection Agency, the "greenhouse effect" of methane gas is much more severe than carbon dioxide, and agriculture – particularly beef and dairy cattle – is the main source of methane in the USA. Grass-fed beef is also leaner and richer in omega-3 fatty acids than grain-fed beef and is therefore often believed to be healthier. However, as mentioned above, global demand for beef is rising, and Brazil is stepping up to meet that demand. Whether increased production happens on pasture or in feedlots, it will undoubtedly have important – and complicated – environmental implications.

Horticulture

Fruits and vegetables are one of the few agricultural sectors in Brazil where both small-scale and large-scale farmers work to serve both the export and domestic markets. Pineapples, peaches, grapes, cashew nuts, lemons, mangoes, melons, coconuts, papaya, and bananas are all economically important export crops for Brazil (though they may be dwarfed in total value by the behemoth sectors of soy, sugar, cattle, and coffee). Because the FFV (fresh fruits and vegetables) market is high value and tends to be more labor intensive, it is often seen as an important development strategy for small farmers in Brazil's impoverished northeastern region. Although intense concentration in the retail food sector worldwide, increasing capital requirements of "high-tech" production, and stringent quality standards create barriers to entry into global markets for many small-scale producers, horticulture has been shown to be a more profitable sector for these farmers than commodity crops (Selwyn 2013).

The social, political, and market dynamics of the export grape industry in the São Francisco valley have been the subject of much scholarship (Selwyn 2009, 2013; Collins 1993; Bonanno and Cavalcanti 2011). The valley is located in what is known as the *sertão*, a traditionally drought-stricken area that has been transformed by extensive government investment in irrigation infrastructure. It serves as a rich case study of agricultural development because of the active role of the federal government in constructing, not just the physical infrastructure for irrigated agriculture, but also the social organization of farming for a specific political purpose. As Selwyn (2013) describes, the region was first transformed in the 1970s through damming and irrigation that disrupted traditional livelihood strategies and land tenure. The government redistributed land and provided irrigation services to encourage production for the domestic market as a strategy to combat food insecurity. Later, when domestic food security faded as a concern and paying down international debt took its place as a major national priority, the government began to encourage production for the export market. This prompted a shift in the valley from basic food crops to high-value horticultural crops for the international market. This shift has had serious implications for land access in the region, and many small producers are forced to become farmworkers as a result of land consolidation. Today, more than 40,000 workers are employed in irrigated agricultural production, and the valley's main crops are mangoes, bananas, coconuts, and grapes (Selwyn 2013). Because the sector is so labor intensive, both jobs and workers' rights abuses are produced here. Perhaps the most visible social movement for rural workers' rights has occurred in Brazil's fresh grape sector.

Small-Scale, Family, and Subsistence Farming

As shown above, agriculture is big business in Brazil. However, the majority of the food that Brazilians eat every day still comes from smaller farms, and the 2006 Agricultural Census categorizes two thirds of Brazil's 4.1 million family farmers as "subsistence" (Berdegue and Fuentealba 2011). Small-scale farming is crucial for providing food, employment, and economic resources for Brazil's rural population, but small farmers often lack secure access to or tenure over the land on which they depend for their livelihoods. Since Brazilian independence, land tenure has been a politically volatile issue, as land ownership has historically been a prerequisite for citizenship (Wittman 2009). As the Brazilian countryside has been restructured as an export platform, those who still work the land for subsistence – and those who have been driven from the land for the sake of agricultural consolidation – struggle to secure their livelihoods in the face of marginalization and often outright violence. For the last 30 years, the Movimento dos Trabalhadores Rurais Sem Terra (the landless rural workers' movement, or MST) has been enacting grassroots land reform through land occupations with the aim of securing legal rights to otherwise "unproductive" land. The movement identifies land held by speculators or absentee landlords and organizes landless families to occupy the land and put it into production. The constitution that was drafted after the end of the military dictatorship in 1988 declares that land must serve a "social function" or risk being expropriated by the government for the purpose of agrarian reform. The MST uses this provision as legal justification for its occupations and often is able to gain legal title to the land and establish permanent settlements. Since its inception, the MST has legally settled more than 370,000 families on 7.5 million hectares of land. There are

900 active encampments, with 150,000 people living in precarious conditions (MST 2013). The organization sees the current government of Dilma Rousseff as pro-agribusiness and indifferent to grassroots land reform. According to MST leadership, Rousseff's administration has "frozen" land reform in the interests of land consolidation for large-scale agribusiness (MST 2013).

As long as ownership of valuable farmland continues to be highly concentrated in the hands of a relative few, and as long as Brazil's rural population continues to struggle to provide for their own (and the nation's) food security on small plots of land for which they have no secure title, land conflicts will likely continue, and land politics will likely be a volatile and divisive issue.

Summary

Brazil is an agricultural powerhouse that has been profoundly shaped by the larger historical processes of colonialism, industrialization, and liberalization. Today, Brazil's agricultural sector is bifurcated; large-scale industrial producers of commodity export crops compete for land and resources with smaller-scale farmers growing food for the domestic market and their own subsistence. Of course, this dichotomy is an oversimplification of a much more complex and varied landscape that cannot be reduced to such discrete socioeconomic categories. Within each subsector, ethical, environmental, economic, cultural, and social issues present a challenge to policy makers, consumers, and farmers alike. Commodity crops like soybeans, sugar, coffee, and beef provide a crucial economic resource and source of employment, but all are fraught with ethical controversies. The employment of slave labor on some large farms has foiled the federal government's attempt at eradication, and every year thousands of workers are "freed" from bondage. Because Brazil's agricultural frontier exists at the interstices of the cerrado and the Amazon, large-scale production of soy and sugarcane has become an environmental lightening rod. Finally, Brazil's peasantry is vibrant, productive, well organized, and unwilling to be cast aside for the sake of export growth. The ethical issues that arise over access to land promise to continue as global demand for Brazilian commodities intensifies. In short, Brazilian agriculture sits squarely at the intersection of some of today's most pressing ethical questions. How does society balance economic growth and environmental protection? How does society structure the food system to provide the best food for the most people at the lowest social, environmental, and economic cost? These questions will be addressed through policy and research, but also by grassroots social movements demanding equity and consumers demanding a healthier and more just food system. Brazilian agriculture stands as a bellwether for the future of food and agriculture around the world.

Cross-References

► Absentee Landlords and Agriculture
► Access to Land and the Right to Food
► Biofuels: Ethical Aspects
► Corporate Social Responsibility and Food
► Economy of Agriculture and Food
► Fair Trade in Food and Agricultural Products
► Land Acquisitions for Food and Fuel
► Sustainability of Food Production and Consumption

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Brillat-Savarin and Food

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Synonyms

Physiology of taste

Introduction

Jean Anthelme Brillat-Savarin (1755–1826) is the author of *La Physiologie du goût* [*The Physiology of Taste*]. Appearing in Paris in 1825, this delightful record of a lifetime's observations has remained continuously in print, unrivalled as the core gastronomic text. While the book is more quoted than read and lacks an authoritative edition or analysis in either French or English, it provides a seemingly inexhaustible supply of insights that includes a hedonic theory of history.

La Physiologie du Goût

"Tell me what you eat, and I shall tell you what you are," Brillat-Savarin is well known for announcing. This is the fourth of twenty aphorisms that he intended "to serve as a prolegomenon to his work and as a lasting foundation to the science," by which he meant gastronomy. The aphorisms announced an ontology: "The universe is nothing without life, and all that lives nourishes itself" (Aphorism I). They recommend hedonism: "The Creator, obliging people to eat to live, invites them through appetite, and compensates them through pleasure" (Aphorism V). This hedonism is bounded: "Those who stuff themselves or who intoxicate themselves know neither how to drink nor how to eat" (Aphorism X). It must also be shared: "To have invited someone is to take responsibility for their happiness for the whole time they are under our roof" (Aphorism XX).

The bulk of *La Physiologie du goût* comprises 30 meditations. Often described as disordered, the meditations follow a broad plan, namely: senses and taste (meditations 1–2); gastronomy (3); foods and drinks (5–9); end of the world (10); gourmandise (11–13); table pleasure (14–15); physiology – digestion, rest, sleep, dreams, dietary influences on these, obesity, treatment of obesity, thinness, fasting, and death (16–26); and history of cooking and culminating in restaurants (27–29). After "Bouquet" (30), which proposes a fanciful public ceremony in favor of a new, tenth muse, Gastérea, and a summary "Transition," a collection of anecdotes, recipes, and poems under the heading "Varieties" conclude with a brief "Envoy to the gastronomers of the two [Old and New] worlds."

The book is evidence in itself that meals lead to poetry, charming encounters, and fond memories. However, revealing "what you are" requires wide study: "To fulfil my self-appointed task, I had to be physician, chemist, physiologist, and even a little erudite" (Preface). Moreover, the "Preface" made clear that he spoke in two registers – conversationally and as a "professor" – so that he also left more formal findings on a range of topics that include obesity and death. More effectively than any other work, his book sets out a complete worldview grounded in meals and supported by a field of inquiry with its program, style, and method.

Arguably the work's most systematic contribution is a hedonistic theory: that in the service of the *stomach*, the exceptional *taste ability* of humans has lent itself to the practice of pleasurable eating or *gourmandise*, which attracts the more complete *table pleasure* (incorporating not merely the physical pleasure of eating but the whole circumstances, including settings, memories, and conversations) and which drives the *political economy* that requires the *sciences*, the peak of which is *gastronomy*.

Brillat-Savarin devoted himself to meals in revolutionary times, politically, religiously, and intellectually (Teulon 1998). As food changed rapidly and the wider society and culture with it, facilitating the capacity of "the aesthetic pleasures of eating . . . to transform food into language" (McLean 2012, p. 50), so that he contributed greatly to gastronomy becoming its own cultural field (Ferguson 2001).

After a description of the author, the book, and its reception, this entry outlines Brillat-Savarin's hedonistic argument. Section numberings accord with M.F.K. Fisher's translation (and these numberings follow an anonymous translation in 1884; both remain identical with the first edition until the original §86, when they become one higher, after §119 two higher, and after §132 five higher; Anne Drayton's translation is the same as a French edition [1923?], and these run one higher than the anonymous/Fisher numberings between §60 and §86).

Biography

Jean Anthelme Brillat-Savarin was born on 1 April 1755 in the attractive town of Belley on the edge of the Alps. He studied law and some medical subjects at Dijon University from 1774. A provincial lawyer elected to the National Assembly in 1789, he was mayor of his hometown in 1793, when forced to flee the Reign of Terror to Switzerland and eventually America, where he spent 2 years teaching French and playing violin in a theatre orchestra. Among other adventures, he transmitted knowledge of the *fondue* gained on the run in Switzerland to the smart French restaurateur in Boston, Julien, who subsequently rewarded him by organizing a rump of Canadian roebuck (Varieties 13).

Returning to France in 1796, Brillat-Savarin was soon appointed a judge of the Court of Cassation in Paris, a position he held the rest of his life. He wrote on other matters, including books on public administration (*Vues et projets* *d'économie politique*, 1802) and duels (*Essai historique sur le duel*, 1819), but gastronomy was a long-term, secret project, although "more than one friend has already guessed your secret" (Dialogue). He published *La Physiologie du goût* at his own expense at the end of 1825 (dated 1826), and he died shortly after in Paris on 2 February 1826. His anecdotes reveal him to be well connected with the medical, scientific, and philosophical communities. He remained unmarried; biographer Giles McDonogh (1992) reports that some decades later, his family destroyed records of liaisons.

La Physiologie du goût is a collection of bon mots, reports of findings, close observations, and theoretical sketches; he explicitly contributed "in the midst of these solemn meditations, a piquant anecdote, a pleasant memory, or some adventure of an active life" (§15). Virtually every commentator admits to being captivated by the wit, and he has been held up as a model stylist. For Charles Monselet, when introducing the book in 1879, Brillat-Savarin commanded the anecdote's "real secret, elegance, and tone." A meal is recalled with charm, science delivered with mock seriousness, and profundity delivered with puckish humor. Such features are illustrated in the touching prefatory "Dialogue between the author and his friend." The friend (eminent physiologist Anthelme Richerand) entreated the author not to leave publication of so much labor until after his death. But people who only know the book by the title will think me trivial, responded the author, ultimately relenting, but only so that he could expose his friend's sole vice. Pressed, Brillat-Savarin announced: "You eat too fast!" (Dialogue).

"Yet to see Brillat-Savarin solely as a stylist is to underestimate the philosophical depth of the work," Michael Garval warns (2001, p. 659). Brillat-Savarin chatted about life's imperatives – "The Creator has imposed on people six great and principal necessities, which are: birth, activity, eating, sleeping, procreation and death" (§122). After contented sleep, a person "goes back to society without once regretting the lost time" (§98). Dreams usually lack taste and smell, so that we see feasts without tasting them (§87). As to the "end of the world," he suggested filling idle moments by imaging what would happen if, say, a stray comet caused global warming. His only hint is that "real danger tears down all social ties," as when husbands closed doors on their wives during a yellow fever epidemic in Philadelphia in 1792 (§54).

As an empiricist of the table, he observed the organs of taste, the psychology of the meals, and social conventions. Should coffee by pounded or ground in a mill? He purchased some good mocha, divided it into two samples, and tested the results on devout connoisseurs, who supported pounding (§46). The suspicion that the truffle contributed to sexual pleasures necessitated further, "undoubtedly indelicate" research. His respondents decreed: "The truffle is not a positive aphrodisiac; but it can, in certain situations, make women more tender and men more agreeable" (§44).

As a founding member of the Society for the Encouragement of National Industry, he demonstrated to the board his invention of the "irrorator" – a pocket pump for perfuming the air. With droplets raining, the learned heads bowed "under my irroration" (Preface). "Playing the scientist"– that's how Roland Barthes depicts Brillat-Savarin; he took science "seriously and ironically at the same time; his project of founding a science of taste, of stripping culinary pleasure of its habitual trademark of futility, that was certainly heartfelt; but he carries it out emphatically, that is to say, ironically" (Barthes 1975, pp. 14 & 28). For Brillat-Savarin, too, empirical studies of taste were merely the start, "for it is, above all, from its moral history that this restorative sense gains its importance and its glory" (§15).

Some scholars have argued that Brillat-Savarin plundered, without acknowledgement, from Grimod de la Reynière (1758–1837). Michael Garval sets sentences from Grimod alongside seven of Brillat's aphorisms. Where Grimod had written: "A great dinner without hors d'oeuvres is as valueless as a woman without rouge," Brillat-Savarin decreed: "A dessert without cheese is like a beautiful woman missing an eye."

However, such quips and ideas do the rounds of dinner parties, and Garval concludes: “Grimod’s manic energy, his discoverer’s exuberance, lay the foundation for Brillat’s greater sobriety, maturity of judgement, and stylistic sophistication” (2001, pp. 60–61). Anticipating food journalism, Grimod’s gastronomy is more closely related to the now widespread marketing version – that is, to the promotion of high-quality products, retailers, restaurateurs, and regions – than to Brillat-Savarin’s ambitions for gastronomy to become a total, supervisory discourse.

A succession of important writers have introduced French editions, starting with his physiologist compatriot, godchild, and friend Richerand in the fifth edition of 1838, Charles Monselet in November 1879, Jean-François Revel in November 1981, and no more sustained interpretation is available than Roland Barthes’ to an abridged edition in 1975. The most devoted responder has been US writer M.F.K. Fisher (1908–1992). In her first book, *Serve It Forth*, Fisher wrote that *The Physiology of Taste* “is as near perfection as we yet know it, and a constant wonder.” Even better than quoting from it, she wrote, is “the companionship of the book itself.” She went on in 1949 to a greater tribute, her translation with copious notes (Brillat-Savarin 1971).

A neuroscientist examining flavor, Gordon Shepherd, dots his book with such statements as “Amazingly, Jean Anthelme Brillat-Savarin already knew this . . .” (2012, p. 125). Philosopher of taste Carolyn Korsmeyer is equally supportive: “The book . . . remains a worthy model of a study of taste that is serious yet light-hearted, moderate without moralism, speculative yet sensible. It is also a monument of its kind to what can be accomplished through amateur research and thoughtful introspection” (1999, p. 69).

The Core Argument

Brillat-Savarin left convincing testimony of the ethics of companionship, demonstrating the care for others typical of a good meal. This companionship must be based on self-interest because, as he wrote, gourmandise motivates the great care taken by hosts, employing all their knowledge and tact, just as it stimulates the guests’ gratitude. Brillat-Savarin shunned “those stupid diners who swallow with culpable indifference the most distinguished morsels, or who inhale with sacrilegious inattention a fragrant and limpid nectar.” In turn, he advised encouraging others by expressing appreciation not merely of exceptionally intelligent arrangements but any attempt to please (§59). However, his etiquette of conviviality is not spelled out as consistently as his argument for meal-centered pleasure, which occupies the remainder of this entry.

From the title, the book concerns “taste.” However, it is about the “pleasure of the table,” he announced (Preface), and he also wrote with two purposes always before him – to redeem gourmandise and to establish gastronomy (Transition). In support of this last, the *Physiologie du goût’s* original subtitle was *Méditations de gastronomie*; it was dedicated to the *Gastronomes parisiens*; he signed off as the author of the “Méditations gastronomiques.” The compound word, “gastronomy,” spans from the most natural (*gaster* – ancient Greek for “stomach”) to the most cultural (*nomos*, “law”). In all, had gave prominence to the stomach, taste, gourmandise, the pleasure of the table, and the science of this, and these topics are considered here in turn.

While the stomach is basic and he assembled a “polite” depiction of ingestion and digestion (Meditation 16), the stomach is shared with other animals. The human species is marked by its exceptional taste abilities. Throughout the processes of chewing, including the tongue movements “of *spication*, of *rotation* and of *verrition* (*verro*, Latin, I sweep),” and swallowing, “there is not a single particle, a drop or an atom, which has been not been submitted to the appreciative power” (§14). From “direct” through “complete” to “reflective” sensation, taste aesthetics are sequential (§11), which Kevin Sweeney (2007) finds philosophically interesting, also noting how refined meals would soon shift from massed display (*service à la francaise*) to sequential (*service à la russe*).

Brillat-Savarin emphasized that the pleasure of taste is the only one that everyone can enjoy, possibly even two or three times a day, that can console for the absence of other pleasures, that is "not followed by regret," and that is more lasting and more subject to our will; "finally, in eating we experience a certain indefinable and particular well-being, which arises from instinctive consciousness; that, by us eating, we replace our losses and prolong our existence" (§13).

The appreciative power of taste is the basis of gourmandise, which is "a passionate, considered, and habitual preference for whatever pleases the taste" (§55). He defined gourmandise with precision to distinguish this social grace once and for all from the "gluttony and intemperance with which it has for so long and so unfortunately been confused." For zealous moralists have found excess when they could have found the "intelligent enjoyment of the earth's treasures, which were not given to us to be trampled underfoot" (Transition).

Gourmandise in this other sense ("gluttony" in English) has remained a cardinal sin of the Catholic Church. To such strictures, Brillat-Savarin responded: "When gourmandise turns into gluttony, voracity, or debauchery, it loses its name, its advantages, and all its powers, and falls to the moralist, who can preach upon it or the doctor who can cure it with prescriptions." He therefore asked any translator of his "instructive book" to use the French "gourmandise" (§59), so avoiding the misleading implications of the English "gluttony" and also showing respect for the French development of both "*La Coquetterie* and *La Gourmandise*, those two great improvements which extreme sociability brought to our most imperious needs" (§59 note).

Hedonism

The gourmand has a sacred trust, obeying the "rule of the Creator, who, having ordered us to eat in order to live, invites us to do so with appetite, encourages us with flavor, and rewards us with pleasure" (§56). People are to enjoy everything that the earth produces, he stated repeatedly. It is for human beings that the quail fattens, that mocha (coffee) has a sweet perfume, and that sugar benefits health. Human beings are granted dominion, and so: "Why not take advantage, at least with appropriate moderation, of the good things which Providence offers, especially if we continue to accept that they are short-lived, especially if they excite our gratitude towards the Author of all things" (§66). Based on the epidemiological research of Dr Villermet, who found that human mortality diminishes in direct proportion to the standard of living, "good living is far from being destructive to good health." All other things being equal, "gourmands live much longer than other folk" (§68).

As well as responding to appetite, hunger, and thirst (§79), people could seek consolation in hedonism: "Humanity is incontestably, among the sentient beings that populate the globe, that which is inflicted with the most suffering." People have unprotected bodies, poorly shaped feet, an inclination to war and destruction, and a mass of maladies such as gout, toothache, acute rheumatism, and strangury. The fear of all this pain makes people give themselves up to the "small number of pleasures which nature has allotted" (§70).

Engaging with all levels of reality, people experience full-blown "table pleasure" (*plaisir de la table*) (Meditation 14). "The pleasure of the table is the reflective sensation that arises from the various circumstances of deeds, places, things, and people that accompany the meal." That is, on top of being blessed with a relatively intense experience of taste, human beings use their other senses and also enjoy company, not least through conversation. Brillat-Savarin carefully distinguished between the pleasure of *eating* and the more comprehensive pleasure of the *table*. Unlike eating pleasure, table pleasure is largely independent of the drive for food; it is a *reflective* pleasure known only to the human race (§72). This relates to his distinction that "Animals feed; people eat; only those with wit know how to dine [*l'homme d'esprit seul sait manger*]" (Aphorism II).

Under the influence of table pleasure, the diner's brain is refreshed, the face lights up, color heightens, eyes shine, and a "sweet warmth" spreads through the body. It is far from a mere physical pleasure, since also, morally, the diner's spirit grows more perceptive, the imagination flowers, and clever phrases fly from the lips. "Effectively, as the result of an appreciated meal, both body and soul enjoy a special well-being" (§73).

Brillat-Savarin listed twelve requirements for peak table pleasure. The maximum number of guests should be 12, so that conversation may remain "general" (everyone sharing the one thread). The room temperature should be between 13 and 16° Réaumur (around 60–68 °F). The progression of dishes should proceed from "the most substantial to the lightest" and so on. But that was for fashionable dinners, and Brillat-Savarin often preferred simplicity. So, the minimum requirements for table pleasure are passable food, good wine, amiable companions, and sufficient time. The most careful preparations and sumptuous accessories are to no avail "if the wine is bad, the guests gathered without discretion, the faces glum, and the meal consumed in haste" (§75).

English translators have rendered *plaisir de la table* mostly as the plural "pleasures of the table." Yet positive sensations, memories, and ideas and feelings of togetherness come together as a single *table pleasure*. As Roland Barthes explains, Brillat-Savarin observed that pleasure was "*over-determined*, that it must have multiple simultaneous causes." He taught the value of "composite pleasure" [*plaisir* composé] and so "composite histories" [*histoires* composées] (Barthes 1975, pp. 30, 33).

Hedonic Theory of History

Gourmandise drives the economy because, firstly, it "sustains the hopes and ambitions and performances" of fishers, hunters, horticulturists, and such. Secondly, appetites provide the "livelihood of an industrious multitude of cooks, pastry cooks, confectioners, and other preparers of food," who, thirdly, "employ still more workers of every kind." Gourmandise becomes "the common bond which unites peoples through the reciprocal trade of goods serving daily consumption." Any industry aimed at gourmands is aimed at both the "fattest fortunes" and the "commonest daily human needs." All of this causes an inestimable "flow of capital" (§55).

As an example, following Napoleon's defeat at Waterloo in 1815, the victorious nations extracted reparations. Rather than collapse, however, the French economy prospered. "What power came to our aid? What divinity worked this miracle? Gourmandise." Before long, "the queen of cities was no more than an immense refectory. These intruders ate in the restaurants, in the cookshops, in the *cabarets*, in the taverns, in the street stalls, and even in the streets." Among the food businesses, restaurateur Véry increased his fortune, *pâtissier* Achard began his, restaurateur Beauvilliers made a third lucky one, and Madame Sullot sold 12,000 of her tiny tarts a day from tiny shop in the Palais-Royal (§57).

The relatively lengthy Meditation 27 outlines a gastronomic theory of history: "all human industry has been concentrated on augmenting the duration and intensity of table pleasure." Since throats and stomachs have limits, people threw themselves into improving the accessories. So, they ornamented goblets and vases, invented the charms of music, and sprayed exquisite perfumes. Dancers, clowns, and other entertainers amused the eyes, every sense joined in a comprehensive pleasure of the table (§74). To such ancient gratifications, his recent contemporaries contributed dishes that were so delicate that people would never have to get up from table except that other business intruded (§75). Historically, the increasing sophistication of the economy culminates in restaurants (§136).

Brillat-Savarin's history of the sciences can be understood in this context, each new science pushing the limits to human powers in catering to gourmandise. He appreciated that the sciences were freed from "the danger of regression" when they were at last captured in print (§15–17), and the sciences at last made way for gastronomy.

Gastronomy

Starting with the imperious needs of the stomach, the dutiful actions of the tongue and the exceptional god-given taste abilities, the book explains how civilization evolved to cater to gourmandise through the political economy and the sciences, until a "new science has suddenly appeared that nourishes, restores, preserves, persuades, consoles and, not satisfied with strewing armfuls of flowers in the path of individuals, contributes even more powerfully to the might and prosperity of empires" (§15). This new science is gastronomy (Meditation 3).

Brillat-Savarin defined: "*La gastronomie est la connaissance raisonnée de tout ce qui a rapport à l'homme, en tant qu'il se nourrit*," which translates as the "systematic knowledge of everything that relates to human beings so much as they nourish themselves." He went on: "Its purpose is to watch over the preservation of people by means of the best nourishment possible." It rules over the entire lifespan from the cries of the newborn to the dying person's final drop, which gives pleasure while being, sadly, too late to digest. It also looks after every social class, directing the banquets of assembled monarchs and prescribing the minutes to boil an egg (§18).

Note the "everything" in his definition, and he specified that gastronomy encompasses natural history, physics, chemistry, cookery, business, and political economy (§18). According to Barthes, "B.S. understood very well that as a subject of discourse food was a sort of grid (or topos, the classical rhetorician would have said), through which one could successfully pass all the sciences that we today call social and human." In other words, food is a "total social fact around which a variety of metalanguages can be gathered: physiology, chemistry, geography, history, economics, sociology, and politics (today we would add the symbolic)" (1975, p. 32).

Rare in ancient Greece, the word gained currency following Joseph de Berchoux's poem *La Gastronomie* in 1801. The revived word, Brillat-Savarin said, was not always understood, but put a merry smile on every face (§36).

Summary

Among the many contributions of the foundational text of gastronomy, *La Physiologie du goût*, Brillat-Savarin set out a hedonic theory that makes the pleasure of the table the driving force of history and so the sciences, of which the culmination has been gastronomy. Given that the scope of gastronomy is often restricted to the promotion of particular items, styles, and regions of food, the intellectual fate of Brillat-Savarin's work remains tied to the success of the discipline in its more ambitious version.

Cross-References

▶ Epicureanism and Food
▶ Gluttony
▶ Gustatory Pleasure and Food

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Buddhism, Cooking, and Eating

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Synonyms

Ahimsa; Buddhism; Dharma; Mahayana; Theravada; Vegetarianism

Introduction

The story and teachings of Buddhism entail multiple points of focus on food and eating. In addition to advocating for what foods are eaten, Buddhist teachings illustrating how food is prepared and consumed offer important guidance of the application of Buddhist principles to daily life. One principle example of Buddhist writing focused on cooking and eating is the writing of the thirteenth-century Japanese monk, Dōgen, who described how food preparation was an important opportunity for practice for monastic cooks in the Zen tradition or *tenz*o. Perhaps the most significant point of ethical consequence related to eating, and a topic of much debate among Buddhist practitioners, is the question of adherence to a vegetarian diet. Historically, this debate has centered on its relationship to the first precept for both lay and monastic practitioners – "do not kill" – and the value for not harming animals.

Elaboration of Key Principles in Buddhism

Story of the Buddha

Siddhartha Gautama was born into the noble Sakya clan near the city of Benares in northern India in around 560 BC. His early life is described as one of very good fortune, luxury, and opulence (Burtt 1982). Yet, the young Siddhartha was unsettled with his position, and he questioned whether worldly pleasures of wealth, power, and luxury were truly the foundations of happiness. Having been purposefully sheltered from the vexations of life (old age, illness, suffering, death) by his father, Siddhartha knew nothing of these things until he managed to escape from the palace on several occasions. Each time, he observed a different form of suffering (an old man, a sick man, and a putrefying human corpse). Having perceived the impermanence of bodily pleasures and the inevitability of death and decay, he made a final escape from the palace to go into the world and seek the path to the true happiness of enlightenment.

The story of Siddhartha's spiritual journey involves his experimentation with several types of accepted practices of the day, particularly asceticism and yoga (Conze 2003). His practice culminated with austere eating to the point of living on, depending on the version of the story, a single bean, a single sesame seed, or a single grain of rice per day, until he fainted while crossing a river, nearly drowning had it not been for the presence of his spiritual companions. There is lack of consensus as to who cared for him after he fainted (Burtt 1982), but the story of The Golden Bowl describes how a young woman named Sujata fed the starving man a pudding of milk and rice that she had made and he soon regained his strength. It was this intake of food that he credited with the rejuvenation of his stamina, allowing him to sit under the Bodhi tree until his enlightenment (Conze 2003; Buddha Dharma Education Association 2012).

In the story of his life, food illustrates Siddhartha's rejection of the excesses of decadence and self-indulgence, as well as his denial of deprivation or austerity, as viable means to enlightenment. This represents one aspect of the foundational principle of "The Middle Way," which Siddhartha Gautama ("The Buddha") described in his first post-enlightenment sermon (Burtt 1982). In this way, eating only what the body needs – neither excess or indulgence nor denying the body adequate sustenance – becomes an opportunity for Buddhist practice.

Just as the story of Sujata marks the beginning of Siddhartha's time as the awakened one – "The Buddha" – food also plays a role in the end of his life. According to the *Mahāyāna Mahaparinirvana Sutra* of the Pali Canon, at approximately the age of 80 years old, the Buddha ate his last meal, which was an offering made to him by a metalworker named Cunda (Yamamoto and Page 2007). There is discrepancy in earlier scriptures and later translations as to whether the Buddha consumed tainted pork or poisoned mushrooms (Burtt 1982). The sutra describes the Buddha as being afflicted by "dysentery, and he suffered sharp and deadly pains" (*Mahaparinirvana Sutra*, verse.21, Yamamoto and Page 2007). Shortly after that meal the Buddha died, but before dying he asked his companion Ananda to deliver the following message to Cunda, lest he feel negatively responsible for the Buddha's death.

> It is a gain to you, friend Cunda, a blessing that the Tathagata took his last alms meal from you, and then came to his end. For, friend, face to face with the Blessed One I have heard and learned: 'There are two offerings of food which are of equal fruition, of equal outcome, exceeding in grandeur the fruition and result of any other offerings of food. Which two? The one partaken of by the [Buddha] before becoming fully enlightened in unsurpassed, supreme Enlightenment; and the one partaken of by the [Buddha] before passing into the state of Nibbana in which no element of clinging remains. By his deed the worthy Cunda has accumulated merit which makes for long life, beauty, well being, glory, heavenly rebirth, and sovereignty.' (*Mahaparinirvana Sutra*, verse.56, Yamamoto and Page 2007)

Buddhist Practice

After the Buddha's death, a series of splits occurred in the community (Pāli – *Sangha*) for reasons of differing philosophy and geography; the result being that today, there are many sectarian divisions of Buddhism practiced around the world (Lopez 2001). Scholars of Buddhism distinguish three schools, also referred to as the "Three Vehicles" of practice into which all practices fall. All schools are believed to have their origins in India. Theravāda ("The Ancient Teaching") is the oldest and, comparatively, the most conservative school. It is also known as *Hīnayāna* or "Small Vehicle" practice as, on the surface, it is concerned mostly with self-enlightenment. This is the style most predominantly practiced throughout South East Asia and Sri Lanka. However, as with all styles of Buddhism, practitioners can be found around the world. Mahāyāna Buddhism ("Great Vehicle") is the largest of the divisions with variant styles found in many parts of the world – Zen in Japan, Pure Land and Nichiren in China, and Tibetan lineages. In Mahāyāna, practice emphasizes universal enlightenment and altruism, as illustrated through the *bodhisattva* principle of striving to attain enlightenment to benefit all beings (Lopez 2001; Gyatso 2007). The third school, Vajrayana ("the Diamond Vehicle"), also known as *Tantric*, is associated with Mahāyāna practice and stresses ritual and a comparatively rapid path to enlightenment (Ray 2000). It also has its origins in India and Tibet, where the highest concentration of today's practitioners are found.

The original teachings of the Buddha (Pāli – *Sutras*) are compiled into one triplex cannon known as the Pali Canon (first century BCE) or *Tripitaka* ("Three Baskets"), which are central to all styles of practice and form the single text of the Theravādan school. Mahāyāna doctrine also includes more recent scriptures (Chinese Canon [983 CE] and Tibetan Canons [1411 CE) as well as other later translations of the Buddha's original teachings (Pali Text Society 2012).

The three parts of the Pali Canon are the *Vinaya Pitaka* ("Discipline Basket"), which addresses rules for monks and nuns; the *Sutta Pitaka* ("Discourses Basket") contains the discourses of the Buddha and some of his disciples, and the *Abhidhamma Pitaka* ("Higher Teachings Basket") describes concepts and states pertaining to metaphysics and psychology.

Many of the points of debate pertaining to dietary restrictions in Buddhism arise from inconsistencies and variant interpretations between earlier Pali Canon discourses (Theravadan) and later Mahāyāna scriptures (Chinese and Tibetan Canons, in addition to other Mahāyāna literature) (Gunasekara 2012; Kapleau 1981; Kahila 2012).

Basic Tenets of Buddhism

To understand how Buddhism approaches food and eating, it is important to be familiar with the most basic Buddhist teachings, which are The Four Noble Truths, the Eightfold Noble Path, and its related Precepts for practitioners.

After his enlightenment, the Buddha gave his first teaching or discourse on the nature of suffering (Pāli – *Dukkha*) in his famous "Sermon at Benares" (Burtt 1982). In this teaching, the Buddha outlined the foundational tenets of Buddhism called the "Four Noble Truths," which are the following: (1) Living involves unavoidable cycles of suffering (birth, old age, sickness, and death) (Sanskrit – *Samsāra*). (2) Suffering and remaining trapped in cycles of *Samsāra* (via reincarnation) are rooted in selfish craving, attachment, and comfort seeking (the "Three Poisons" [Pāli – *akusala-mūla*] of greed, hatred, and ignorance). (3) The only way to avoid suffering is to relinquish selfish craving and greed. (4) The way to do this is to follow the Eightfold Noble Path. This is the means to abolish suffering and free oneself from endless cycles of *Samsāra* (Khema 1987).

The Eightfold Path provides summary guidelines for psychological and moral orientations, as well as meditation practice. Couched within the Noble Eightfold path are the five (monastics follow many more) precepts, guidelines, or commitments for practice (Pāli – *pañca-sīlāni)* that are foundational to both Theravāda and Mahāyāna practice (Gyatso 2007). The Precepts are guidelines that facilitate practice, rather than rules that prompt rewards or sanctions.

It is the first of these precepts – the vow to abstain from taking life ("do not kill") that has played the most significant role in Buddhist discourse about food, namely, the issue of vegetarianism. Unlike the Abrahamic religions (Judaism and Islam), the Buddha established few dietary laws (Wijayaratna 1990). According to the *Vinaya Pitaka* of the Pali Canon, this is limited to the explicit prohibition for monastics from consuming horses, elephants, snakes, lions, and dog, which implies that other meats were allowed. Monks were also forbidden from requesting favorite foods in alms, an indication of self-indulgence:

> If a monk, who is not unwell, requests and eats delicacies such as curd, fresh butter, sesame oil, honey and molasses, fish, meat, and milk, he commits a Pacittiya offense. (Vinaya Pitaka, IV 88, Wijayaratna 1990)

However, how a practitioner engages with food is one component of the application of Buddhist principles, such as nonviolence (Sanskrit – *Ahimsa*) and the relinquishment of greed and ego gratification via the Eightfold Noble Path. In this way, the Buddha provided recommendations not only for what to eat but also how a practitioner should use food to facilitate practice of the "Middle Way" and skillful means (Sanskrit – *Upaya*).

Sōtō Zen: Dōgen and Instructions for the Zen Cook

Perhaps the most extensive discourse on the use of food for Buddhist practice comes from the Mahayana tradition and the thirteenth-century monk and founder of the Sōtō Zen school of Buddhism, Dōgen. He wrote detailed instructions for food preparation and consumption for monastics in his *Tenzo Kyokun (*Instructions for the Zen Cook), which was translated and commented upon by Kosho Uchiyama Roshi as the *Jinsei Ryori no Hon* (How to Cook Your Life) in 1970 (Dōgen and Uchiyama 1983). Together these works illustrate the principles of Buddhist spiritual training; maintaining equanimity, an unbiased mind, and *Upaya* through the daily tasks and processes of food preparation carried out by monastery cooks:

> A dish is not necessarily superior because you have prepared it with choice ingredients, nor is a soup inferior because you have made it with ordinary greens. When handling and selecting greens, do so wholeheartedly, with a pure mind, and without

> trying to evaluate their quality, in the same way in which you would prepare a splendid feast. The many rivers which flow into the ocean become the one taste of the ocean; when they flow into the pure ocean of the dharma there are no such distinctions as delicacies or plain food, there is just one taste, and it is the buddhadharma, the world itself as it is. (p. 13)

Dōgen describes the role of the *tenzo* as being "the incomparable practice of the Buddhas" (p. 12) and an important opportunity for Zen practice. He states, "Though a person might be fortunate enough to be appointed to the office of *tenzo*, if he lacks the aspiration to walk the Way, he will return empty-handed from the mountain of goodness and the ocean of virtue" (p. 15). Dōgen describes the role of *tenzo* as being an experience that all potential monastic leaders should first undertake.

Dōgen also influenced how food is consumed in Zen practice, as he is also credited with bringing the practice of Ōryōki from Chinese monasteries to Japan, thereby introducing it to Zen practice. The practice of Ōryōki emphasizes mindful attentiveness to the act of eating through a ritualized series of movements and a specific process of eating and completing the meal that acknowledge gratitude and attention toward the food (Loori 1999). Throughout the process, practitioners are called upon to focus attentiveness to the precision of each movement, as well as noticing distractions or wandering thoughts. In this way, mindfulness and self-awareness are fostered. The name Ōryōki translates to "just enough" in reference to the practice of not using more food or dishes that are left as waste or to clean for others, thus reiterating the principle of moderation and the "Middle Way." The use of Ōryōki as a meditation technique has been adopted by other styles of Buddhist practice (Shambala 2012).

Buddhism and Food: What to Eat

Vegetarianism

The most prominent dietary practice, and question of ethical debate, pertaining to Buddhism has to do with vegetarianism. According to the *Tripitaka*, the Buddha was not a vegetarian. Nor did he explicitly advocate for a vegetarian diet (Gunasekara 2012; Kapleau 1981). However, the first of the precepts forbids killing and in the *Jivaka Sutra* of the *Majjhima Nikaya* (*Sutta Pitaka*) the Buddha prohibits his monks from consuming flesh from any animal that was "seen, heard, or believed" (referred to as the "Three-Fold Rule") by the monk to have been killed specifically for his benefit (Nanamoli and Bodhi 1995; Gunasekara 2012; Wijayaratna 1990). The Buddha's non-compulsory stance on food restrictions is illustrated in the *Khandhaka* or second book of the *Vinaya Pitaka*, via Theravādan portrayal of the story of Devadatta who was a clansman and fellow practitioner of the Buddha (Batchelor 2010; Wijayaratna 1990). The story describes how Devadatta challenged the Buddha's leadership, including attempts at murdering him, and creating a schism among the Buddha's followers. Devadatta insisted that the Buddha impose rules or "the Five Austerities" (Sanskrit – *Tápasya*)" for the monks' practice. Among these austerities were the requirements that monks should only live on collected alms and never accept invitations to dine with lay people. Devadatta also insisted that monks should abstain completely from eating any flesh or fish and practice complete vegetarianism. The Buddha chose to allow the monastics to practice these austerities if they wished, but he did not impose them as mandatory (Nanamoli and Bodhi 1995; Gunasekara 2012).

The Buddha also cautioned his monks to accept alms without discrimination for a few reasons (Kahila 2012; Gunasekara 2012). First, if a monk refused alms based on dietary restrictions, lay practitioners would be prevented from gaining merit through their acts of charity. Additionally, as an application of the Buddha's prescribed "Middle Path," monks were counseled to eat all foods that they received as a practice of gratitude, humility, and given the Buddha's resistance to asceticism, to maintain a healthy body to support their practice (Gyatso 2007).

Most of the emphasis on vegetarianism stems from later Mahāyāna scriptures, such as the *Lankvatara Sutra, Brahma Net Sutra*, or the *Shurangama Sutra* in the Chinese Canons that take a stronger position on dietary practices than those originally attributed to the Buddha in the *Tripitaka*. For example, the *Brahma Net Sutra* states as one of the 48 Secondary Precepts:

> 3. On Eating Meat
> A disciple of the Buddha must not deliberately eat meat. He should not eat the flesh of any sentient being. The meat-eater forfeits the seed of Great Compassion, severs the seed of the Buddha Nature and causes [animals and transcendental] beings to avoid him. Those who do so are guilty of countless offenses. Therefore, Bodhisattvas should not eat the flesh of any sentient beings whatsoever. If instead, he deliberately eats meat, he commits a secondary offense. (Brahma Net Sutra: Moral Code of the Bodhisattvas 2000)

Hence, Mahāyāna practitioners are more likely than Theravadan, to practice vegetarianism, though there are many exceptions, particularly of Theravadan practitioners following vegetarian diets (Kieschnick 2005).

In the Mahāyāna view, vegetarianism reflects the value of *Ahimsa* (nonviolence), which possibly also reveals an influence of Hinduism. The belief in reincarnation, which is foundational to Buddhism and Hinduism, might also play a role in the decision not to eat meat, given that, in this view, animals and humans exchange incarnations throughout the cycles of *Samsāra* (Balsys 2004).

Given the above points, it is possible that, since followers of the living Buddha were mendicants who relied on alms begging and invitations to dine in lay practitioner's homes, the debate over vegetarianism probably did not arise until monks settled in monastic dwellings, whereby, if meat was provided to them by lay practitioners, it was most likely specifically killed for the monks' consumption (Kahila 2012).

The point of debate lies in the relationship of meat consumption to indirect or proxy participation in the killing of an animal; a violation of the first precept, and this is where the debate lies to this day (Kapleau 1981). The Australian monk, Venerable Shravasti Dhammika, points out that the principles of Ahimsa, not killing, and not contributing directly to the suffering of other sentient beings (e.g., animals) are a fairly straightforward argument though perhaps overly simplistic (Dhamikka 2009). He illustrates the complexity of the debate by summarizing the following arguments on the side of meat-eating:

> (1) If the Buddha had felt that a meatless diet was in accordance with the Precepts, he would have said so and in the Pali Tipitaka as least, he did not. (2) Unless one actually kills an animal oneself (which seldom happens today) by eating meat one is not directly responsible for the animal's death and in this sense, the non-vegetarian is no different than the vegetarian. The latter can only eat his vegetables because the farmer has ploughed the fields (thus killing many creatures) and sprayed the crop (again killing many creatures). (3) While the vegetarian will not eat meat he does use numerous other products that lead to animals being killed (soap, leather, serum, silk, etc.). Why abstain from one while using the others? (4) Good qualities like understanding, patience, generosity and honesty and bad qualities like ignorance, pride, hypocrisy, jealousy and indifference do not depend on what one eats and therefore, diet is not a significant factor in spiritual development. (2)

The Five Pungent Spices

According to Mahāyāna texts, such as the *Shurangama Sutra*, another precept – the Third Precept – calls on the practitioner to exercise "sexual responsibility" (Khema 1987), which has significance for dietary practice, namely, in the avoidance of the "Five Pungent Spices," which include leek, onion, garlic, and asafetida. Again, included in the 48 Secondary Precepts:

> Beings who seek samadhi should refrain from eating [the] five pungent plants of this world. If these five are eaten cooked, they increase one's sexual desire; if they are eaten raw, they increase one's anger. (Shurangama Sutra, BTTS, 2002)

Avoidance of these spices is not, by and large, a practice of Theravadan Buddhists, as this dietary proscription is not recorded in the Pali Canon.

Summary

Many aspects of Buddhist practice reference food: from the start and end of Siddhartha Gautama's spiritual enlightenment to guidelines crafted centuries later by monks to the debate over vegetarian eating. The Pali Canon is the text that contains the original teachings of the Buddha. There are few dietary proscriptions in this text, though many recommendations pertaining to eating have been added in later Mahayana writings. The Buddha's advisement to his disciple Ananda that "decay is inherent in all compound things. Work out your own salvation with diligence" (Burtt 1982, p. 22) illustrates a foundational orientation toward proscriptions in practice (including those pertaining to food) that the decision to adhere or not adhere has no other worldly ramifications, but only limits one's own advancement toward liberation.

Cross-References

- ▶ Buddhist Perspectives on Food and Agricultural Ethics
- ▶ Christian Ethics and Vegetarianism
- ▶ Christianity and Food
- ▶ Hinduism and Food
- ▶ Islam and Food
- ▶ Jainism and Food
- ▶ Meat: Ethical Considerations

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Buddhist Perspectives on Food and Agricultural Ethics

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Synonyms

Buddhism and GM food; Buddhism and vegetarianism; Food and dukkha or "suffering"

Introduction

The variety of Buddhist traditions makes it difficult to generalize about its food and agricultural ethics. Buddhism as a missionary religion has tended to adapt to local dietary customs, rather than import food restrictions. Another factor encouraging this variety is that Buddhist traditions have often been less concerned about what we eat than how we eat it, since the *dukkha* (suffering or "dis-ease") that it addresses is rooted in our craving – and food is the second most popular example of human craving. One persistent factor, however, has been a concern to reduce the suffering of animals, which contributed to the development of vegetarianism in East Asia. In general, Buddhism does not emphasize "being natural," but its emphasis on intentions raises questions about the economic motivations for genetically modifying food.

Traditional Buddhist Perspectives

There are some important distinctions within Buddhism that have had important implications for food practices, especially the difference between monastics and laypeople, and the difference between Theravada (South Asian) and Mahayana (mostly East Asian) Buddhism. Monastics, following the personal example of the Buddha, are expected to live a simple life largely unconcerned about mundane matters such as food. In Theravada Buddhist societies, they eat only before noon (and usually only once). According to the *Patimokkha* rules that regulate their daily lives, "There are many fine foods such as these: ghee, butter, oil, honey, molasses, fish, meat, milk, and curds. If any *bhikkhu* who is not sick should ask for them and consume them, it is an offense entailing expiation" (*Vinaya Pitaka* IV. 88, in Oldenberg, 167). The careful wording implies that the problem is not with these foods themselves, but that desiring them and indulging in them is a distraction from what monastics should be concentrating on. There is no suggestion that lay followers should also avoid them, and the qualification – "any *bhikkhu* who is not sick" – exemplifies the pragmatic Buddhist approach: there may be times when even monastics would benefit from consuming them.

The main food issue for Buddhists has been, and continues to be, whether one should be vegetarian – somewhat complicated by the (contested) fact that, according to the earliest accounts we have, the *Mahaparinibbana Sutta*, Shakyamuni Buddha died of a stomach ailment caused or aggravated by eating pork. Buddhist vegetarians have sometimes considered this fact scandalous and denied it, but it is consistent with what is known about the early Buddhist community.

According to the *Vinaya* rules established and followed by the Buddha himself, Theravada monastics are mendicants. They do not grow or normally cook their own food; they beg for it. Being dependent on what is donated to them each morning, they are not required to be vegetarian, with two important restrictions. First, ten kinds of meat are prohibited, usually translated as bear, lion, hyena, tiger, panther, elephant, horse, serpent, dog, and human flesh – but not including beef, pork, or fowl, the types of meat most commonly eaten (*Vinaya Pitaka* VI. 23, in Oldenberg, 193). Significantly, the prohibition seems to involve more concern for the social or physical consequences for the monks themselves than for the animals eaten (Kieschnick, in Sterckx 2005).

The other restriction is often followed by Buddhist laypeople as well as *bhikkhu*: not to eat meat (or fish) if you know or have reason to suspect that it was killed *for you*. "If a bhikkhu sees, hears or suspects that it has been killed for his sake, he may not eat it" (*Mahavagga*, *Vinaya Pitaka*, in Oldenberg, 220).

This would seem to be a compassionate policy, given Buddhist emphasis on not harming living beings. However, the issue of animal suffering is cited in Buddhist texts less often than the consequences for one's own suffering: it is bad karma to cause the death of any sentient being. Even when those texts mention the importance of compassion, the main concern is often the negative effects of meat-ending on one's own capacity to cultivate compassion (Kieschnick 2005).

Recently there has been a movement among expatriate Tibetan Buddhists (most of whom now live in the more tropical climate of India) to become more vegetarian, led by the Dalai Lama (who nevertheless sometimes eats meat for health reasons). This development is more consistent with a general Mahayana emphasis on vegetarianism, a concern especially strong in China and doctrinally supported by later Mahayana scriptures such as the *Lankavatara Sutra*, *the Surangama Sutra*, and the *Brahma's Net Sutra*. The main points these texts make (e.g., Suzuki 1932) in favor of vegetarianism are that eating meat:

- Was prohibited by the Buddha (according to the *Lankavatara*)
- Is inconsistent with the first Buddhist precept, which prohibits taking the life of any sentient being
- Produces bad breath and foul smells that inspire fear in other beings
- Inhibits compassion and causes suffering to animals
- Prevents progress in Buddhist practice and causes bad karma (e.g., you might be reborn as a lower animal)
- May be eating a former relative

In the sixth century Chinese Buddhism (unlike South Asian Theravadin Buddhism) began to emphasize vegetarianism. Chinese, Korean, and Vietnamese monastics today continue to abstain from meat and fish (often milk products and fertilized eggs too), and many devout Chinese laypeople are also vegetarian. The laity played a leading role in this transformation: under the influence of Mahayana scriptures such as the ones mentioned above, as well as popular stories about karmic retribution, laypeople came to expect monastics to uphold higher standards of purity and renunciation. By the tenth century vegetarianism had become a minimum standard to be followed by all monks and nuns in China. As in South Asia, monastics are dependent upon lay support, so the concerns of an increasing number of lay vegetarians could not be ignored (Kieschnick 2005).

The only other important and common dietary prohibition is to avoid the five "pungent odors," usually translated as garlic, onions, scallions, shallots, and leeks (sometimes chillies and other spices are added to this list). In addition to the often-objectionable smells associated with them – a big concern in a crowded monastic situation – the *Surangama Sutra* claims that they are stimulants to anger if eaten raw and stimulate sexual desire when cooked.

Two points should be kept in mind regarding the above dietary restrictions. First, although monastics in principle have no choice, laypeople choosing to follow them make a personal decision, in the sense that such practices are not required in order to be a Buddhist or follow the Buddhist path. Not observing them may create bad karma and make one's spiritual path more difficult to follow, but that is one's own decision. Second, as mentioned earlier, the key to Buddhist self-cultivation is less the "outer practice" of what one does than the "inner path" of how one does it. This is especially emphasized in Mahayana, which has a more relaxed attitude toward such observances. *Upaya* "skillful means" may sometimes prompt us to break precepts in some situations, because Buddhist rules, like other teachings, are pragmatic rather than absolute. A moral mistake is not an offense against God but an unskillful act that causes more trouble for ourselves. Precepts are vows I make to oneself, that I will try to live in a certain way, with the understanding that when I fall short then I will bear the karmic consequences. This encourages a flexible attitude toward food practices.

Genetically Modified Food

Some contemporary Buddhists and Buddhist organizations have become concerned about food with genetically modified ingredients. For example, according to a December 1996 press release of the Dharma Realm Buddhist Association (based in Burlingame, California), "Genetic engineering of food is not in accord with the teachings of Buddhism. Genetic engineering of food is unwarranted tampering with the natural patterns of our world at the most basic and dangerous level."

There is, however, virtually no support for the view that "unnatural is bad" in any important traditional Buddhist text, because Buddhism has not valorized nature or "being natural" in the way that the West has often done (although an exception is addressed below). For example, Asian Buddhist attitudes toward stem cell research are usually quite positive, according to "No Buddhist Hard Line on Stem Cells," an article in *Science & Theology News*:

While many Buddhists in the Western countries view any destruction of embryonic life as wrong regardless of the possibility that a cure for severe diseases like Alzheimer's or critical spinal cord injuries might be found in a distant future, a considerable amount of Asian Buddhists come to a more permissive conclusion. First of all, *Buddhists are not inclined to see a man-made creation as something competing with a "good" nature*. There is a very positive attitude toward changing nature's course if it enhances the welfare of all living beings, and more so if it allows medical advancements.

Second, *Buddhist ethics are not principles to be followed as law*. They are not designed as expressions of indisputable human rights or as a consequence of dignity inherent in every human being. Ethics are much more a matter of personal choice; principles like the one of "non-harming" should be followed as guidelines, and in extraordinary circumstances need not be applied in the strictest sense (Schlieter 2004).

Although food is not the issue addressed in this article, its implications apply to GM food as well. Buddhism generally has had a nonnormative understanding of nature, which does not appeal to "natural law" or some similar standard that must be observed. According to Lambert Schmithausen's examination (1997) of ecological ethics in the early Buddhist tradition, the early texts emphasize the beauty of nature less than the struggle for life, the prevalence of greed and suffering, and most of all the universality of impermanence and decay. Accordingly, Asian Buddhists do not usually object to GM food as being "unnatural" – with one significant exception.

The press release of the Dharma Realm Buddhist Association (a Chinese organization) also asserts that lack of labeling "is a de facto violation of religious freedom" because it becomes difficult to avoid GM foods, a particular problem for Buddhist vegetarians who may want to avoid nonvegetarian genes in their vegetables. There is nothing in the five basic ethical precepts of Buddhism (to avoid harming living beings, stealing, lying, improper sex, and alcohol) that implies that a scientist should not take a gene from one species and transfer it to another one, especially if such genetic modification would improve the food. For most Buddhists, however, a genetically modified turkey so enlarged for breast meat that it could not walk clearly would be unacceptable, not because such a turkey is unnatural, but because such a chicken would suffer.

Some Chinese Buddhists, however, have expressed concern about transferring animal genes into plant foods. Transferring genes between plants was less objectionable – as long as the genes of garlic, onions, scallions, shallots, and leeks were not used. The simplest explanation for the difference between these concerns brings us back to the point about cultural interaction emphasized at the beginning of this article: Theravadin Buddhists in South Asia follow the earliest teachings, which do not privilege "the natural." Chinese Buddhism, in contrast, has been influenced by traditional Chinese values that emphasize harmony within society (Confucianism) and living naturally (Taoism).

Emphasis on Motivation

Buddhists often express concern about the *motivations* behind the introduction of genetic modifications into food, highlighting the importance of *cetana* "intentional action" in Buddhist teachings. This emphasis on motivation and intention points at what is distinctive about the Buddhist perspective, so the rest of this article will address that perspective and what it implies for genetically modified food. This involves expanding the evaluation criteria beyond the narrow issue of traditional dietary restrictions by considering broader issues about how consistent GM food is with Buddhism's basic worldview and understanding of human motivation.

One of the ways that Buddhism explains *dukkha* "suffering" is by tracing it back to the "three poisons" (also known as the "three unwholesome roots," *akusala-mula*) of human motivation: greed, ill will, and delusion (*Numerical Discourses*,Thera and Bodhi 1999). The Buddhist doctrine of karma can be understood in this fashion: when one's actions are motivated by greed, ill will, or delusion, there are negative consequences that increase suffering. To reduce one's *dukkha*, these need to be transformed into their positive counterparts: greed into generosity, ill will into friendliness, and the delusion of a separate self into the wisdom that acknowledges one's nonduality with the world.

In order to consider the implications of this teaching for generic modification, it is necessary to highlight the Buddhist solution to delusion, which means emphasizing the "three basic facts": in addition to *dukkha*, these include *anicca* "impermanence" and *anatta* "nonself" (Thera and Bodhi 1999).

Anicca means that nothing is eternal, everything arising and passing away according to conditions, including ourselves. Socially, this implies an openness to change, including progress – if it really is progress, i.e., an improvement of previous conditions. That technologies are new is not a problem, for the important issue is their effects on our *dukkha*. Buddhists are not nostalgic for some prelapsarian age in the past when life was good because "natural" because there never was such a golden age.

The delusion that *anatta* resolves is duality: our usual sense of self as something separate from the external world that we are "in." This is the most troublesome *dukkha* of all because the groundlessness of our constructed self is usually experienced as a sense of *lack* that we are unable to resolve: we feel the need to make ourselves more real, more substantial, but can never do so because the self is a psychological and social construct having no "substance" of its own that could become real.

In contrast, the wisdom of *anatta* is realizing that nothing has any substantiality or "self-being," not only because there is no permanence but also because everything is interdependent on everything else, without any reality of its own. Nevertheless, that we do not need to worry about disturbing genetic "essences" does not liberate us to do whatever we want technologically. The most important criterion for Buddhism remains *dukkha*: does a genetic modification tend to reduce suffering, or increase it? Emphasis on interdependence complicates such an evaluation, and, unsurprisingly, this is where there have been the most problems, due to unexpected "side effects": for example, Bt corn pollen alleged to kill monarch butterflies, allergic reactions due to the Cry9C protein in StarLink corn, cross-pollination of native Mexican maize, genes from genetically engineered plants found in the guts of honeybees, etc.

What do these Buddhist principles imply about GM food? The traditional Buddhist approach focuses on how the three unwholesome roots of motivation – greed, ill will, and delusion – function on the individual level, but an important issue in contemporary Buddhism is whether they also operate collectively and institutionally. If so, does the law of karma still imply unwholesome results – not in some magical way, but in the sense that we reap what we sow? The issue is where the motivations behind the development and introduction of GM food fit into the karmic process, as understood by Buddhism.

For a brief period, "golden rice" genetically engineered to include beta-carotene (which our bodies convert into vitamin A) was proposed for nutritional deficiencies in some undeveloped countries, until it was realized that the amount of beta-carotene that could be added was too small to be significant. A more significant and notorious example of GM, however, was Monsanto's attempt to introduce a patented "terminator gene" into the world's main food crops. In general, genetic modifications seem designed to benefit the food industry more than the food consumer. The focus is on growing and processing food more efficiently and profitably, rather than on taste or nutrition. In a competitive industry, this may end up reducing consumer prices, yet it is not otherwise clear that GM in food has been contributing to the reduction of consumer *dukkha*.

On the other side, there is a noticeable and continuing pattern of unexpected problems, often for those who have not asked for GM food and may have little to gain from it. A few contested examples were cited earlier. Monarch butterflies feed exclusively on milkweed leaves, and in 1998 it was claimed that milkweed contamination from Bt corn pollen was killing them. Also in 1998, Arpad Pusztai, a scientist working in Britain, reported that in his experiments genetically modified potatoes were causing immune system damage to rats. In 2000 StarLink corn, with a protein indigestible to humans, was accidentally released into the human food chain, leading to 37 reports of serious allergic reactions investigated by the U.S. Food and Drug Administration. In 2001 Ignacio Chapela and David Quist, researchers from the University of California, claimed to have discovered that genes from biotech corn had contaminated native maize in the Mexican highlands (Hart 2003).

There are at least two reasons to be concern about such incidents, in addition to the specific problems they reveal. First, they support what the Buddhist emphasis on interdependence implies: that meddling with the genome of food plants and animals is an extraordinarily complicated process with many types of subtle consequences that are very difficult to anticipate and evaluate exhaustively. As a consequence, we can expect these types of accidents to recur indefinitely. Equally disturbing has been the reaction of the food industry, which has tried to deny or minimize these incidents, and – particularly in the cases of Pusztai, and Chapela and Quist – has undertaken questionable public relations campaigns to impugn their scientific competence and personal integrity.

What do these concerns reveal about institutional motivation? We are reminded that the food industry is a food *industry*. Providing nutritious and healthy food – something more complicated than producing most other consumer products – is not the ultimate goal in this system but the means within a larger economic process in which the focus is on productivity and profitability. Given the extraordinary difficulties with testing for possible adverse effects, along with corporate pressures for short-term profitability and growth, there are inevitable questions about whether the food industry can be trusted to place top priority on safeguarding the needs, not only of human consumers, but of the ecosystems that its modifications affect. Furthermore, given the strong corporate influence on governmental agencies – especially in the United States – there are also important questions about whether, for example, the Food and Drug Administration can be trusted to prioritize the needs of consumers and the biosphere.

In terms of the karmically significant motivations discussed earlier, the larger ethical problem here might be characterized, from a Buddhist perspective, as *institutionalized greed*.

Is there a correlative problem with *institutionalized delusion*? If there is a problematical duality between the institutional interests of food producers and individual interests of consumers, there is a larger one between the human species and the rest of the biosphere. Since the advent of the modern era, our escalating technological powers have been used to exploit the rest of the biosphere, with little concern for the consequences of our domination for other species. We continue to act as if the other beings with which we share the earth have no value or meaning except insofar as they serve human purposes. The underside of our own evolutionary success is an ecological crisis that is already seriously affecting the quality of our own lives. The nonduality between ourselves and the rest of the biosphere – a collective version of the wisdom that Buddhism emphasizes – means that these two consequences are inseparable. There are no "side effects," only consequences we like and consequences we do not like. Since we are part of the natural world, if we make nature sick, we become sick. From a Buddhist perspective, this is a paramount example of karma.

The genetic modification of food is only a part of this larger commodification process, but a significant part, since technological modification of other plant and animal species, without a much better understanding of their genomes and how all the genomes of living creatures affect each other, seems to be an especially dangerous example of how our ambitions can outrun our wisdom. From this perspective, the genetic engineering of food, as presently practiced, may be incompatible with basic Buddhist teachings, because it is inconsistent with the kinds of personal and collective transformation of motivations necessary if the basic problem of *dukkha* – not only human *dukkha* but that of other living beings as well – is to be addressed successfully.

This does not necessarily mean that the genetic modification of food is always something that should be avoided, which would be an "essentialist" claim inconsistent with the primary Buddhist emphasis on reducing *dukkha*. Since Buddhism does not privilege "the natural," including the natural selection that drives the evolutionary process, there is the possibility that some genetic modifications might actually serve to reduce *dukkha*. Although it would need to be very carefully tested, there is the possibility that a vitamin A-enriched rice might someday be a benefit to humankind without being a threat to the rest of the biosphere.

Summary

Historically, the most important issue regarding food has been whether or not Buddhist emphasis on compassion implies vegetarianism. Theravadin (South Asian) Buddhists generally eat meat and fish unless they know or suspect that it was killed purposely for them. Devout Mahayana Buddhists in East Asia are usually vegetarian.

Recently the issue of genetic modification has become controversial. From a Buddhist point of view, technologies are neither good nor bad in themselves. Nor are they neutral. That is because technologies cannot be separated from the larger social, economic, and ecological contexts within which they are devised and applied. The Buddhist understanding of karma as *cetana* implies that personal and institutional motivations are an essential part of that context. This means that any attempt at evaluating a technology such as the genetic modification of food needs to take the motivations behind those innovations into account.

Cross-References

► Ethical Matrix and Agriculture
► Hinduism and Food
► Vegetarianism

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