

Cattle feeding

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Different **cattle feeding** production systems have separate advantages and disadvantages. Most cattle have a diet that is composed of at least some forage (grass, legumes, or silage). In fact, most beef cattle are raised on pasture from birth in the spring until autumn (7 to 9 months).^[1] Then for pasture-fed animals, grass is the forage that composes all or at least the great majority of their diet. Cattle fattened in feedlots are fed small amounts of hay supplemented with grain, soy and other ingredients in order to increase the energy density of the diet. The debate is whether cattle should be raised on diets primarily composed of pasture (grass) or a concentrated diet of grain, soy, corn and other supplements. The issue is often complicated by the political interests and confusion between labels such as "free range", "organic", or "natural". Cattle raised on a primarily forage diet are termed *grass-fed* or *pasture-raised*; for example meat or milk may be called *grass-fed beef* or *pasture-raised dairy*. However, the term "pasture-raised" can lead to confusion with the term "free range", which does not describe exactly what the animals eat.

Contents

- 1 Types
 - 1.1 Grazing
 - 1.2 Integrated livestock-crop farming
 - 1.3 Industrial production
- 2 Grass-fed
- 3 Corn-fed
- 4 Country-specific
 - 4.1 Canada
 - 4.1.1 Alberta beef
 - 4.2 United States
 - 4.2.1 USDA label
 - 4.3 Trade
- 5 Use of growth stimulants
 - 5.1 Use of hormones
 - 5.1.1 Safety
 - 5.1.2 Artificial hormone debate
- 6 Health and nutrition
 - 6.1 Fats
 - 6.2 Antibiotics
 - 6.2.1 Safety
 - 6.2.2 Antibiotic resistance
- 7 Diseases
 - 7.1 *E. coli*
 - 7.2 Mad Cow Disease
 - 7.3 Campylobacter
 - 7.4 Bovine leukemia virus
- 8 Environmental concerns
- 9 Taste
- 10 See also
- 11 References

Types

Grazing

Animals grazing in rangelands, pastures, and grasslands and with little or no integration of crops involved. About 60% of the world's pasture land is covered by grazing systems. Grazing systems supply approximately 9 percent of the world's production of beef, according to Food and Agriculture Organization statistics.^[2]



A Hereford cow eating grass

Integrated livestock-crop farming

Animal productions are integrated with crop productions. Moreover, livestock such as cattle are primarily fed on pastures, crop residues, and fallows. An integrated farming system aims to achieve acceptable profits and high and sustained production levels. Mixed farming systems are the largest category of livestock system in the world.^[3]

Industrial production

Animals are fed in landless environments such as in stalls, pens, and feedlots in very high stocking densities. Intensive or industrial factory farming of animals originated in the United States in the late 1930s. This has resulted in an integrated model of production, where large corporations control most aspects of animal husbandry in the food industry, processing of animals into food products, and sales to the consumer market.

Industrial productions systems differ from grazing systems and integrated livestock-crop farming systems by their inclusions of various substances such as veterinary drugs, growth hormones, feed additives, or nutraceuticals to improve livestock production effectiveness.^[4]

Grass-fed

Grass and other forage compose most or the majority of a grass-fed diet. There is debate as to whether cattle should be raised on diets primarily composed of pasture (grass) or a concentrated diet of grain, soy, and other supplements.^[5] The issue is often complicated by the political interests and confusion between labels such as "free range," "organic", and "natural." Cattle raised on a primarily forage diet are termed *grass-fed* or *pasture-raised*; meat or milk may be called *grass-fed beef* or *pasture-raised dairy*. However, the term "pasture-raised" can lead to confusion with the term "free range" which does not describe exactly what the animals eat. Thus, cattle can be labelled free range but not necessarily grass-fed.^[6] Another term is "grass-finished", for which cattle are generally held to a higher standard in terms of tenderness and marbling. However, the label generally has no strict regulations.^[7]



Cut fodder being transported to feed cattle in Tanzania

Corn-fed

Cattle called "corn-fed," "grain-fed", or "corn-finished" are typically fattened on maize, soy, and other types of feed for several months before slaughter. As a high-starch, high-energy food, corn decreases the time to fatten cattle and increases carcass yield. Some corn-fed cattle are fattened in concentrated animal feeding operations known as feed lots.

In the United States, most grass-fed cattle are raised for beef production. Dairy cattle may be supplemented with grain to increase the efficiency of production and reduce the area needed to support the energy requirements of the herd.



Grass-fed cattle at a Walcha, NSW sale.

A growing number of health and environmental proponents in the United States such as the Union of Concerned Scientists advocate raising cattle on pasture and other forage. Complete adoption of farming practices like grass-fed beef production systems would increase the amount of forage land needed to raise cattle but reduce cropland used to feed them.^[8]



Stud Murray Grey cows receiving supplementary feeding during a drought.

Country-specific

Canada

The majority of beef cattle in Ontario are finished on a corn (maize)-based diet, whereas Western Canadian beef is finished on a barley-based diet. This rule is not absolute, however, as producers in both regions will alter the mix of feed grains according to changes in feed prices. Research by the Ontario government claims that, while Alberta beef producers have organized a successful marketing campaign promoting Alberta's barley-fed beef, corn-fed and barley-fed beef have a similar cost, quality, and taste.^[9]

Regulations on veterinary drug use in food animals and drug-residue testing programs ensure that the product in the grocery store is free of residue from antibiotics or synthetic hormones used in livestock.

The Animal Nutrition Association of Canada has developed a comprehensive Hazard Analysis Critical Control Points (HACCP) system for animal feed production called FeedAssure. This mandatory HACCP-based program includes a requirement for independent audits of feed mills including production processes and record keeping. The Canadian Cattlemen's Association has also developed a HACCP based on-farm food safety program.

A complete HACCP system is mandatory for all federally inspected establishments. These systems include prerequisite programs, which are general procedures or good manufacturing practices that enhance food safety for all meat production processes. HACCP plans build on this foundation and are designed to control potential hazards for specific production processes.^[10]

Alberta beef

The Canadian province of Alberta has a very large land area (similar to Texas)^[11] and has more than 210,000 km² (81,000 sq mi) of agricultural land, or about four times as much as Ontario.^[12] Because much of the land is better suited for cattle grazing than crop growing, it raises 40 percent of the cattle in Canada - about five million head.^[13] The other three western provinces are also well endowed with grazing land, so nearly 90 percent of Canadian beef cattle are raised in Alberta and the other western provinces.^[14] Alberta is outside the corn belt because the climate is generally too cool and too dry to grow corn for grain. The adjacent western provinces and northern US states are similar, so the use of corn as cattle feed has been limited at these northern latitudes. As a result, few cattle are raised on corn as a feed. The majority are raised on grass and finished on cold tolerant grains such as barley.^[15] This has become a marketing feature of the beef.

Alberta is the centre of the western Canadian beef industry and has 70% of the feedlot capacity and 70% of the beef processing capacity in Canada. Under World Trade Organization rules, all of the beef processed in Alberta is considered to be Alberta Beef, even though it includes many cattle raised in nearby provinces and US states. These cattle are all of a similar quality, so Alberta Beef has become a consumer branded product which is distinctly different from the typically corn-fed beef produced in most of the US and Ontario. However, it is really a product brand rather than an indication of origin, since much of the beef may have been raised in other provinces or US states.^[16]

United States

According to the United States Department of Agriculture (USDA) there are 25–33 million head of feed cattle moving through custom and commercial cattle feedyards annually. The monthly USDA "Cattle on Feed Report" is available for public viewing.^[17]

The feed cattle enterprise is an industry where millions of dollars move through these custom and private cattle feeding facilities every year. The business of feeding cattle is based on a commodity market mechanism. Both corn and cattle are bought and sold via commodity market prices. This makes for huge variations within the final outcome of profit and loss within the enterprise. However, the Chicago Mercantile Exchange provides producers with options or hedges for smoothing price volatility and risk. Additionally, forward contracts and pre-paying for feedstuffs counteracts the variation in both commodities.

There are many segments of the USA cattle business:

- *Seed stock*, where producers breed for improved genetics
- *Cow/calf*, where ranchers and farmers raise cows and calves for commercial production
- *Stocker/grower*, where producers place light weight calves on pasture, wheat or corn stocks
- *Grow yards/back grounding* facilities, where high forage diets are fed to light weight feeder calves weighing 350 to 500 pounds (160 to 230 kg) to be fed to the weight of 750 to 900 pounds (340 to 410 kg)
- *Custom/Commercial Finishing* yards, where cattle are fed to harvest at the weight of 1,000 to 1,500 pounds (450 to 680 kg). Once the fed cattle are sold for harvest they are shipped for processing and distribution to the consumer.

USDA label

The USDA's Agricultural Marketing Service (AMS) released a revised proposal for a grass fed meat label claim for its process-verified labeling program in May 2006.^[18] The Union of Concerned Scientists, which in general supports the labeling proposal, claims that the current revision, which contains the clause "consumption of ... grain in the immature stage is acceptable", allows for "feed harvesting or stockpiling methods that might include significant amounts of grain" because the term "immature" is not clearly defined.^[19]

On October 15, 2007 the USDA established a standard definition for the "grass fed" claim which requires continuous access to pasture and prevents animals from being fed grain or grain-based products.^[20]

Trade

Beef production tends to be concentrated, with the top six producers—the U.S., the European Union, Brazil, Australia, Argentina, and Russia—accounting for about 60% of global production. Significant shifts among producers have occurred over time. Cattle production worldwide is differentiated by animal genetics and feeding methods, resulting in differing quality types. Cattle are basically residual claimants to crop or land resources. Those countries with excess or low-value land tend to grass-feed their cattle herds, while those countries with excess feed grains, such as the U.S. and Canada, finish cattle with a grain ration. Grain-fed cattle have more internal fat (i.e., marbling) which results in a more tender meat than forage-fed cattle of a similar age. In some Asian countries such as Japan, which is not a grain surplus country, tastes and preferences have encouraged feeding grain to cattle, but at a high cost since the grain must be imported.^[21]

Until 2015, the US had mandatory Country of Origin Labeling (COOL) rules requiring that foreign beef be labelled as such under a complicated set of rules, but in May 2015 the World Trade Organization ruled that the US law was a violation of international trade law, so the US government repealed the law.^[22] The Alberta Beef label found on some beef might be considered an indication of origin, but although it indicates that the beef was processed in Alberta, under WTO labeling rules many of the cattle may have been raised in other western provinces or in the northwestern United States. In reality it is a consumer label of product type rather than a definitive indication of cattle origin.^[23]

Use of growth stimulants

Antibiotics are routinely added to grain feed as a growth stimulant. Livestock consume 70% of the antibiotics in the United States.^[24] This practice contributes to the rise of antibiotic-resistant bacteria, including MRSA.^[25] The most common form of antibiotics are called ionophores. Ionophores were originally developed as coccidiostats for poultry and prevent coccidiosis in cattle as well. Ionophores work by improving both feed efficiency and growth rate and lower methane production as one result. Ionophores have not been shown to create antibiotic-resistant MRSA.^[26]

Use of hormones

The use of supplemental growth hormones is controversial. The benefits of using growth hormones includes improved feed efficiency, carcass quality, and rate of muscle development. The cattle industry takes the position that the use of growth hormones allows plentiful meats to be sold for affordable prices. Conversely, there exists customer concern about growth hormone use being linked to a number of human health problems. However, there have been insufficient studies to prove or disprove these concerns.^[27] Growth hormones are synthetically created but testing cannot distinguish between artificial hormones and those naturally produced by the animal itself. Using hormones in beef cattle costs \$1.50 and adds between 40 and 50 lb (18 and 23 kg) to the weight of a steer at slaughter, for a return of at least \$25.^[28]

American regulators permit hormone use on the grounds that no risk to human health has been proven. In contrast, most European Union nations have banned them based on the grounds that they have yet to be proven safe. The organic food industry takes the position that the studies that suggest possible concerns should be more closely examined by governmental regulators.^[29]

Safety

In Canada, all veterinary drugs used in food production processes are required to pass stringent tests and regulations set by the Veterinary Drugs Directorate (VDD) and are enforced by the Food and Drug Act of Health Canada. The Canadian Food Inspection Agency (CFIA) monitors all food products in Canada by sampling and testing by veterinarians and inspectors working on behalf of the provincial and federal governments. They monitor the food supply to condemn and destroy any product that is unacceptable. In the rare case where the CFIA have found a residue, it has been substantially below the Maximum Residue Limit (MRL) to make acceptable for safe consumption. The MRL is the maximum amount of a drug residue that may remain in a food product at the time of human consumption. MRLs are safety measures based on Accepted Daily Intakes (ADIs).^[30] The ADI level is determined from toxicology studies to be the highest amount of a substance that can be consumed daily throughout a lifespan without causing adverse effects.^[31] Beef hormone residues are MRLs that have been established by the Joint Expert Committee on Food Additives of the United Nations.^[30] Although there is growing concern that hormone residues in meat and milk might be harmful to human and animal health, the quantities of hormones found in a serving of meat are far below the level considered to be a risk to the development of cancer. Besides, the World Health Organization stated that the hormone levels are indistinguishable between the implanted and nonimplanted animals.^[31]

There are three natural hormones (estradiol, progesterone, and testosterone) and their synthetic alternatives (zeranol, melengestrol acetate, and trenbolone acetate) have been approved by the VDD for use in Canadian beef production.^[30]

Estrogen, progesterone, and testosterone are naturally present in beef cattle. These hormones are also present in humans. Industry studies state that the contribution of estrogen, progesterone and testosterone from beef consumption is minuscule compared to the quantities produced naturally in the human body. By comparison, an adult male will produce 136,000 ng of estrogen on a given day; whereas the estrogen levels present in a 6-ounce serving of beef from a treated animal is only approximately 3.8 ng.^[30] In another word, a human being will produce almost 36,000 times the amount of estrogen in one day that would be present in a piece of beef produced with the growth hormones treated.^[30] Thus, current scientific evidence is insufficient to support the hypothesis that pubescent maturation is caused by the hormonal substance use in animals.^[31] However, the differences between levels in treated and non-treated animals were deemed significant enough for the EU to ban imports of U.S. beef.^[32]

Artificial hormone debate

To date there is insufficient evidence to either support or debunk concerns about the impact on human health of ingested hormones from animals treated with growth hormones,^[33]

Bovine somatotropin, or bovine growth hormone, is a naturally produced protein in cattle. Recombinant bovine somatotropin (rBST) or recombinant bovine growth hormone (rBGH) is an artificial growth hormone produced using microbes with modified (recombinant) DNA. It is approved in the United States since 1993; however, its use has been controversial since farmers have started using it.

Health and nutrition

Fats

Most grass-fed cattle are leaner than feedlot beef, lacking marbling, which lowers the fat content and caloric level of the meat. Meat from grass-fed cattle also has higher levels of conjugated linoleic acid (CLA) and the omega-3 fatty acids ALA, EPA, and DHA.^[34]

Flax (or linseed) is one of the most biologically available botanical sources of omega-3 fatty acid which is high in protein and ALA (alpha-linolenic acid). Recently, research has been conducted involving the use of ground flax seeds as a fat supplement in cattle rations. Being high in protein and fats, it can easily replace other energy dense foods such as corn. It is believed that the inclusion of omega-3 fatty acids in the diets of beef producing cattle will bring an increase in health to the animals and to the quality of carcass upon slaughter.^[35] Some studies have found that feeding flax seeds may increase the omega-3 content and improve marbling in the carcass of the animal at slaughter while others have found no differences. Flax seeds suppress inflammatory effects from bovine respiratory disease (BRD) often affecting stressed cattle due to production practices such as transport and processing. BRD can lead to lung tissue damage and impair the performance of the cattle leading to a low final body mass at slaughter or premature death. Another effect of feeding flax in cattle ration is an observed increase in the daily dry matter intake.^[36] This was observed in feeding a total dietary content of omega-3 fatty acids of under 10% of total feed.

Although the direct beneficial effects of feeding omega-3 fatty acids remain uncertain, the preventative effect from feeding omega-3s to stressed cattle have shown great promise. Although flax feeds are greatly more expensive compared to other feeds, the economical benefits from having a generally healthier herd of cattle outweighs the cost

Research shows that tissue lipids of North American and African ruminants were similar to pasture-fed cattle, but dissimilar to grain-fed cattle. The lipid composition of wild ruminant tissues may serve as a model for dietary lipid recommendations in treating and preventing chronic disease.^[37]

Antibiotics

Antibiotics are commonly used in the food production system as a way to control the growth of potentially harmful bacteria. Potential benefits from the use of antibiotics include the prevention of diseases, increase in food and water uptake, and increase the digestive effectiveness of the animal. There are concerns however about residues of the antibiotics getting into the milk or meat of cattle. In Canada, The Canadian Food Inspection Agency (CFIA) enforces standards which protects consumers by ensuring that foods produced will not contain antibiotics at a level which will cause harm to consumers.^[31] In the United States, the government requires a withdraw period for any animal treated with antibiotics before it can be slaughtered, to allow residue to exit the animal.^[38]



A scene of sorghum transportation

However, less intense population density is sometimes cited^[39] as a reason for decreased antibiotic usage in grass-fed animals. However, bovine respiratory disease, the most common cause for antibiotic therapy has risk factors common in both forms of production (feedlot and pasture finished).^[40]

In dairy herds, grazed cattle typically have a reduced need for antibiotics relative to grain-fed cattle, simply because the grazed herds are less productive.^[39] A high energy feedlot diet greatly increases milk output, measured in pounds or kilograms of milk per head per day, but it also increases animal physiological stress,^[39] which in turn causes a higher incidence of mastitis and other infectious disease, more frequently requiring antibiotic therapy.

There are two distinctions between the clinical and nonclinical use of antibiotics in cattle. Clinical use of antibiotics refers to the treatment of cattle due to sickness. However, corn-fed cattle draw attention to the nonclinical use of antibiotics. Antibiotics are used to promote growth and treat sick cattle. Some critics conjecture that the cattle would not get sick if they were not fed a corn-based diet that subjects them to diseases caused by the malfunctioning of their rumen.^[39]

Safety

In Canada, the veterinary drug regulation, consisting of two federal government agencies, namely Health Canada (HC) and the CFIA, are responsible for implementing the Food and Drugs Act, and enforcing those standards and policies, respectively.^[31]

Testing for Drug Residues samples include three(3) proper methods: monitoring, surveillance, and compliance. These procedures are given to Swab Test On Premises (STOP) to detect antibiotic residues in kidney tissues.^[31]

Antibiotic resistance

Antibiotics are used in the cattle industry for therapeutic purposes where they are used in the treatment of infections, prophylactically for disease prevention, and as growth promoters. The latter means that there is an increased efficiency of feed use, where growth is stimulated with less feed. Ultimately, this results in reduced costs for cattle producers, and for consumers.^[31]

Antibiotic resistance is a naturally occurring phenomenon throughout the entire world due to the overuse and/or inappropriate use of the substance. However, its usage is supported primarily because of its effectiveness in the treatment and prevention of diseases, as well as its role as growth promoters. Antibiotic is also present in antibacterial cleaning products, and in disinfection products used in farm and veterinary practices.^[31]

Diseases

E. coli

Escherichia coli, although considered to be part of the normal gut flora for many mammals (including humans), has many strains. Strain *E. coli* 0157:H7 is associated with human illness (and sometimes death) as a foodborne illness. A study by Cornell University^[41] has determined that grass-fed animals have as much as eighty percent less of this strain of *E. coli* in their guts than their grain-fed counterparts, though this reduction can be achieved by switching an animal to grass only a few days prior to slaughter. Also, the amount of *E. coli* they do have is much less likely to survive our first-line defense against infection: stomach acid. This is because feeding grain to cattle makes their normally pH-neutral digestive tract abnormally acidic; over time, the pathogenic *E. coli* becomes acid resistant.^[42] If humans ingest this acid-resistant *E. coli* via grain-feed beef, a large number of them may survive past the stomach, causing an infection.^[43] A study by the USDA Meat and Animal Research Center in Lincoln Nebraska (2000) has confirmed the Cornell research.^[44]

Mad Cow Disease

Meat and bone meal can be a risk factor for bovine spongiform encephalopathy (BSE), when healthy animals consume tainted tissues from infected animals. People concerned about Creutzfeldt–Jakob disease (CJD), which is also a spongiform encephalopathy, may favor grass-fed cattle for this reason. In the United States, this risk is relatively low as feeding of protein sources from any ruminant to another ruminant has been banned since 1997.^[45] The problem becomes more complicated as other feedstuffs containing animal by-products are still allowed to be fed to other non-ruminants (chickens, cats, dogs, horses, pigs, etc.). Therefore, at a feed mill mixing feed for pigs, for instance, there is still the possibility of cross-contamination of feed going to cattle. Since only a tiny amount of the contaminating prion begins the cascading brain disease, any amount of mixed feed could cause many animals to become infected. This was the only traceable link among the cattle with BSE in Canada that led to the recent US embargo of Canadian beef. No cases of BSE have been reported so far in Australia. This is largely due to Australia's strict quarantine and bio-security rules that prohibit beef imports from countries known to be infected with BSE.

However, according to a report filed in the Australian, on February 25, 2010, those rules were suddenly relaxed and the process to submit beef products from known BSE-infected countries was allowed (pending an application process).^[46] But less than a week later, Tony Burke, the Australian Minister For Agriculture, Fisheries and Forestry swiftly overturned the decision and placed a 'two year stop' on all fresh and chilled beef products destined for Australia from BSE known countries of origin, thereby relaxing fears held by Australians that contaminated US beef would find its way onto Australian supermarket shelves after a long absence.^{[47][48]}

Soybean meal is cheap and plentiful in the United States. As a result, the use of animal byproduct feeds was never common, as it was in Europe. However, U.S. regulations only partially prohibit the use of animal byproducts in feed. In 1997, regulations prohibited the feeding of mammalian byproducts to ruminants such as cattle and goats. However, the byproducts of ruminants can still be legally fed to pets or other livestock such as pigs and poultry such as chickens. In addition, it is legal for ruminants to be fed byproducts from some of these animals.^[49] A proposal to end the use of cow blood, restaurant scraps, and poultry litter (fecal matter, feathers) in January 2004 has yet to be implemented,^[50] despite the efforts of some advocates of such a policy, who cite the fact that cattle are herbivores, and that blood and fecal matter could potentially carry BSE.

In February 2001, the USGAO reported that the FDA, which is responsible for regulating feed, had not adequately policed the various bans.^[51] Compliance with the regulations was shown to be extremely poor before the discovery of the Washington cow, but industry representatives report that compliance is now 100%. Even so, critics call the partial prohibitions insufficient. Indeed, US meat producer Creekstone Farms alleges that the USDA is preventing BSE testing from being conducted.^[52]

Campylobacter

Campylobacter, a bacterium that can cause another foodborne illness resulting in nausea, vomiting, fever, abdominal pain, headache and muscle pain was found by Australian researchers to be carried by 58% of cattle raised in feed lots versus only 2% of pasture raised and finished cattle.^[53]

Bovine leukemia virus

Bovine leukemia virus (BLV) is insect-borne and found in 20% of US cattle, and 60% of US herds. Studies in Sweden and the Soviet Union have linked BLV outbreaks and increases in human leukemia. BLV and HTLV-1 share a common gene, HTLV-1 is the first human retrovirus ever shown to cause cancer.

Environmental concerns

In arid climates such as the Southwestern United States, livestock grazing has severely degraded riparian areas, the wetland environment adjacent to rivers or streams. The Environmental Protection Agency states that agriculture has a greater impact on stream and river contamination than any other nonpoint source. Improper grazing of riparian areas can contribute to nonpoint source pollution of riparian areas.^[54]

Scientists refer to riparian zones as hot spots of biodiversity, a characterization that is particularly apparent in arid and semiarid environments^[55] (like Nevada, where over 80% of the 300 represented terrestrial wildlife species are "directly dependent on riparian habitat"), where such zones may be the only tree-dominated ecosystems in the landscape. The presence of water, increased productivity, favorable microclimate, and periodic flood events combine to create a disproportionately higher biological diversity than that of the surrounding uplands.^[56]

"According to the Arizona state park department, over 90% of the original riparian zones of Arizona and New Mexico are gone". A 1988 report of the GAO was equally grim, estimating that 90% of the 5,300 miles of riparian habitat managed by the BLM in Colorado was in unsatisfactory condition, as was 80% of Idaho's riparian zones, concluding that "poorly managed livestock grazing is the major cause of degraded riparian habitat on federal rangelands."^[57]

Grass fed beef hides the controversial and heavy use of human sewage sludge by ranchers in the beef industry.^{[58][59]} Science has cited being more cautious and reevaluating the practice that was first legalized in 1992.^[60] There are new emerging toxic pollutants that could contaminate beef that ultimately end up on USA dinner plates.^[61]

Taste

The cow's diet affects the flavor of the resultant meat and milk. A 2003 Colorado State University study^[62] found that 80% of consumers in the Denver-Colorado area preferred the taste of United States corn-fed beef to Australian grass-fed beef, and negligible difference in taste preference compared to Canadian barley-fed beef, though the cattle's food was not the only difference in the beef tested, nor is Denver a representative sample of the world beef market, so the results are inconclusive.

Grass-fed beef is not standardized. Most is leaner than conventional feedlot beef, but some is equally marbled due to carefully managed grazing, excellent pastures, and improved genetics. Another technique for producing well-marbled grass-fed cattle is to keep the animals on pasture for two years or more. Most pasture-based ranchers dry-age the beef for 7–21 days, enhancing the flavor and tenderness of the meat.

Remarkably, in some circumstances, cattle are fed wine or beer. It is believed that this improves the taste of the beef. This technique has been used both in Japan and France.^[63]

See also

- Free range
- Fodder
- Hay

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