BACK TO GRASS
THE MARKET POTENTIAL FOR U.S. GRASSFED BEEF

Photo: Carman Ranch

STONE BARNS CENTER FOR FOOD & AGRICULTURE™

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ABOUT THIS REPORT

Grassfed beef in the U.S. is a fast-growing consumer phenomenon that is starting to attract the attention of more cattle producers and food companies, but there is a lack of coherent information on how the market works. While the U.S. Department of Agriculture (USDA) produces a vast body of data on the conventional beef sector, its data collection and reporting efforts on grassfed beef are spotty. Pockets of information are held by different private sector organizations, but they have rarely been brought together.

This report addresses that gap by providing a comprehensive overview of the U.S. grassfed beef sector, with a focus on market and economic dynamics. It brings together available data on the current state of the sector, identifies barriers to growth and highlights actions that will help propel further expansion. It analyzes consumer demand, supply chains and both domestic and imported grassfed beef production models, all the while comparing grassfed beef with conventional beef to highlight their differences.

The report tries to answer some fundamental questions about the future of the sector. How do we define "grassfed beef"? Does it matter how restrictive this definition is? Is grassfed beef destined to remain a niche, expensive product for the affluent consumer? Or can grassfed beef scale to the point where it displaces a significant portion of the conventional, grain-fed beef system in the U.S.?

This report was produced through the collaboration of Stone Barns Center for Food and Agriculture, a nonprofit sustainable agriculture organization dedicated to changing the way America eats and farms; Armonia LLC, a certified B-Corp with a mission to restore harmony through long-term investments; Bonterra Partners, an investment consulting firm specializing in sustainable agriculture and other natural capital investments; and SLM Partners, an investment management firm that focuses on ecological farming systems. The lead authors were Renee Cheung of Bonterra Partners and Paul McMahon of SLM Partners; they were assisted by Erik Norell, Rosalie Kissel and Donny Benz.

Dr. Allen Williams of Grass Fed Insights, LLC acted as a consultant to the project and provided invaluable input. We would also like to thank the many other individuals and organizations who contributed expertise to this report, especially: Dr. Urvashi Rangan, The James Ranch, Fleishers Craft Butchery, Panorama Meats, Brown's Ranch, Grassfed Exchange, American Grassfed Association, SPINS and Nielsen. This report was generously supported by The Belay Fund, a donor-advised fund of The Denver Foundation, at the request of Rob Gary.

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Published: April 2017

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This report analyzes the economics of the U.S. grassfed beef sector. It presents the reasons people choose to eat grassfed beef and explores the market dynamics that shape production and consumption and the supply chain in between. It assesses whether grassfed beef is destined to remain a niche product for affluent consumers, or whether it can become a mainstream food.

THE CASE FOR GRASSFED BEEF

Cattle production in the U.S. typically includes three phases: cow-calf, stocker and finishing. Almost all cattle spend the first two phases on pasture, eating mostly grass. In the conventional finishing phase, cattle are brought to feedlots (also known as animal feeding operations, or AFOs) at 9-15 months of age and fed a diet primarily composed of corn and other grains. After gaining weight quickly, these grain-fed cattle are slaughtered at 16-20 months. An estimated 97% of the cattle slaughtered for meat are fed grains.

There is a certain amount of "default" grassfed beef produced in the conventional system, as animals slaughtered at the cow-calf or stocker phase (for example, cull cows or bulls) may have spent their entire lives on pasture, eating mostly grass. Since these animals do not go through a proper finishing phase, their meat is usually lower-quality and is used to make ground beef or cheap beef cuts. It is usually sold through conventional channels without a grassfed label.

The clearest distinction between grassfed and conventional beef occurs at the finishing stage. Grassfed cattle remain on pastures and are finished on a diet of predominantly grass or other forages. They grow more slowly and are typically slaughtered at 20-28 months of age. Meat from these animals is usually sold with a grassfed label approved by the United States Department of Agriculture (USDA) and sold into niche grassfed beef markets for a premium.

However, the USDA's allowance of partial grassfed claims (e.g., "50% grassfed") and the absence of a requirement for on-farm inspection for grassfed claims mean that not all beef sold with a grassfed label necessarily follows these production standards. Some cattle are kept on pasture through the finishing phase, but their diet is supplemented with grains; these animals are "pasture-raised" but not 100% grassfed. A striking development in recent years has been the emergence of "grass feedlots," where cattle are fed grass (often in the form of grass pellets) in confinement. Without mandatory inspection, there is concern that grain byproducts could also be used in these production methods to produce beef labeled as grassfed. There are also other production claims that may or may not overlap with a grassfed approach, such as "natural," "vegetarian fed," "no artificial hormones," "antibiotic-free" and "USDA Organic." This has created a confusing landscape for consumers.

The differences matter. There is a growing body of scientific research pointing to the benefits of grassfed beef over conventional beef. These benefits are most evident in "purer" grassfed systems, especially those using regenerative grazing methods. The benefits include:

- Human health: Grassfed beef is more healthful for people because of its significantly better omega-6 to omega-3 fatty acid ratio, higher concentration of conjugated linoleic acids (CLAs), higher levels of antioxidants and lower risk of E. coli infection and antibiotic-resistant bacteria.
- Animal welfare: Cattle are healthier and require little drug treatment when they are not confined, have constant access to pasture and eat a predominantly grass diet.
- Environmental protection: The concentration of manure in and around feedlots can pollute air and water, whereas well-managed grazing systems can regenerate grassland, build soil and protect watersheds.
- Climate change mitigation: Intensive grain farming and feedlot cattle production are major sources of greenhouse gases, whereas grasslands managed with regenerative grazing can sequester carbon and act as net carbon sinks, offsetting methane emitted by cattle.
- Better taste and flavor: Grassfed cattle of the right breed, produced to high standards, result in beef that is tender, well-marbled and, in the opinion of many connoisseurs, better-tasting than grain-fed beef.

THE U.S. GRASSFED BEEF MARKET

The U.S. grassfed beef market is estimated to be $4.0 billion in retail and food services sales, representing 4% of the total U.S. beef market. Labeled grassfed beef — i.e., beef with a grassfed marketing claim that is kept segregated from conventional beef throughout the supply chain (which includes beef produced from "grass feedlots") — comprises around $1.0 billion of the market. Unlabeled grassfed beef, which is sold as conventional beef, accounts for an estimated $3.0 billion. Many consumers are already eating the latter unknowingly, as unlabeled grassfed meat is often mixed with fattier conventional beef trim to make ground beef and hamburgers.

EXECUTIVE SUMMARY

The labeled grassfed beef market is growing at an extraordinary pace. According to Nielsen data, retail sales of labeled fresh grassfed beef grew from $17 million in 2012 to $272 million in 2016, doubling every year. Demand is strongest for expensive middle cuts (i.e., loin and rib) and cheaper ground beef, which makes whole-carcass utilization a challenge. Although the market continues to grow strongly, there are barriers holding back the U.S. grassfed industry, including inconsistent and sometimes low quality of meat, the challenges of producing grassfed beef year-round, market confusion over the definition of grassfed and the large price premium that grassfed beef commands over conventional beef (more than 70% at the retail level), which makes grassfed beef unaffordable for many consumers.

THE U.S. BEEF SUPPLY CHAIN

One reason grassfed beef is so much more expensive is an inefficient supply chain. Over the years, the U.S. conventional beef industry has accumulated massive economies of scale through vertical integration and consolidation. The meatpacking industry is dominated by four conglomerates — Tyson, JBS, Cargill and National — that buy more than 80% of the cattle in the U.S. Their streamlined operations can process and package grain-fed beef at a very low cost, surviving on high volumes and low margins. They can process animals for as little as $100-120 per head for their customers, and even less for themselves. Distributors, which are often the packers themselves, charge a 7-10% markup for selling the meat.

In contrast, the grassfed beef industry is made up of many small players. An estimated 19% of grassfed cattle are sold by small-scale producers through direct marketing to customers, which requires extra time and resources. The remaining 81% are sold through branded grassfed programs. These brands can achieve *some* economy of scale through aggregation, but are small compared to conventional operators.

Processing and distribution remain big challenges for the grassfed beef supply chain. Most grassfed beef producers and branded programs are too small to access the large, hyper-efficient processing plants. Instead, they must use smaller regional plants that charge $150-300 per head for larger branded programs and as much as $400-800 per head for small-scale producers. The beef sold through branded programs is then handled by specialty meat distributors that charge a hefty 12-25% (or higher) markup for marketing the product to retailers and restaurants.

Although the consumer may be paying a 70% price premium over conventional beef, the grassfed cattle producer only receives a 25-30% premium for his or her animals when selling to branded programs. The spread is caused by a fragmented and inefficient supply chain in which processors, branded programs, distributors and retailers must apply a margin to cover their costs. The result is that the consumer has to pay a high premium for grassfed beef.

U.S. GRASSFED BEEF PRODUCTION

Cattle production ranks first in U.S. agricultural commodity cash receipts and is one of the most important industries in the nation, accounting for $78.2 billion of revenue in 2015. There were 92 million head of cattle and calves in the U.S. at the end of 2015 and close to 30 million head slaughtered that year.

There are an estimated 3,900 producers finishing grassfed cattle in the U.S. today, up from around 100 in 1998. They currently finish an estimated 232,000 head of grassfed cattle for slaughter each year, a tiny proportion of the 30 million cattle slaughtered annually in the U.S. Results from a survey we distributed to grassfed beef producers in late 2016 depict the current state of the sector: Producers are well-distributed throughout the country; 70% run integrated cow-calf/stocker/finishing operations; there are a large number producing less than 50 head each year (mostly selling direct-to-consumer); and there are a small number finishing more than 1,000 cattle (mostly selling through branded programs). Those selling direct-to-consumer earned a median live weight price premium for their cattle of 50% over conventional, while those selling through branded programs earned a lower median premium of 25%.

One of the major challenges facing U.S. producers is cheap imports of grassfed beef. These imports account for an estimated 75-80% of total U.S. grassfed beef sales by value. American consumers are often not aware that they are buying imported beef: As long as the imported beef passes through a USDA-inspected plant (which, for food safety reasons, is a requirement for all imported beef), it can be labeled as a "Product of the USA."

U.S. grassfed beef producers, therefore, face competition on two fronts: domestic conventional feedlots with efficient supply chains that produce grain-fed beef at low cost (often relying on financial hedges to prevent huge losses and indirectly benefiting from government subsidies for grain production); and Southern Hemisphere countries such as Australia that take advantage of year-round grazing and scale to produce large quantities of grassfed beef for export.

We analyzed the economics of grass-finishing operations in the U.S. in relation to this competition. There are two main ways to maintain a profitable grassfed operation in the U.S.: selling direct-to-consumer at a very high premium, or achieving lower production costs by operating grass finishing on a larger scale and selling through branded programs. The production costs of well-run grassfed operations are less volatile than those of conventional operations, which are coupled to fluctuating grain prices, but even the larger grassfed operations have costs of production that are substantially higher than those of conventional feedlots, especially when grain prices are low.

We also considered an aspirational model that finishes 10,000 animals per year, which uses best-practice grazing management and greater scale to bring down the production cost. No such operation exists, but a handful of operators are developing such strategies, and the projections are based on reasonable assumptions. If combined with a more efficient supply chain, this model could bring down the cost of U.S. grassfed beef production to a point that would enable a 20-30% price premium at the retail level, while remaining profitable for producers. This is the sort of premium that could unlock mass consumer demand and potentially displace a significant portion of the conventional beef system. Availability of land is not a constraint; there is enough extra grassland in the U.S. to finish all the cattle that are currently going through feedlots.

CONCLUSION

Grassfed beef, when produced using regenerative grazing practices, can have many benefits for human health, animal welfare and the environment. The grassfed beef market is growing rapidly, and we believe the U.S. grassfed beef industry can grow much further. But this will require a number of actions:

1. **The grassfed industry needs to focus on producing high-quality, well-finished grassfed beef year-round.** The best grassfed beef finishers in the U.S. are able to utilize the right forage quality, animal genetics and management skills to produce consistent, high-quality beef 12 months of the year, but management training and technical assistance are required for other producers in the country to rise to this level. Aggregation of seasonal finishing production across different regions in the U.S. can also help address the year-round availability challenge. In addition to non-profit efforts on management training and technical assistance, for-profit investments in grassfed beef production can help spur technical advancements in cattle and land management.
2. **Stronger standards for the grassfed label accompanied by national "brand-building" campaigns are required to educate consumers about U.S. grassfed beef.** Multiple grassfed certification programs are coming together to agree on a common set of principles for grassfed beef. This initiative, accompanied by concerted national "brand-building" and awareness campaigns, would educate American consumers on the reasons for consuming U.S. grassfed beef and supporting U.S. grassfed ranchers. It would also help consumers discern meaningful grassfed claims from less meaningful ones and allow "pure" grassfed beef producers to differentiate themselves. Funding of marketing efforts and awareness campaigns may need to come from the grassfed industry and outside investors and may call for the development of a U.S. grassfed trade association.
3. **Scale and aggregation are required to unlock supply chain efficiencies.** Our view is that the solution to the existing inefficiencies in the grassfed supply chain is not to construct a new, parallel supply chain but to utilize the infrastructure that has been created for conventional beef. But to do this, scale and aggregation at the grassfed finisher and branded program levels are necessary, as is greater coordination across the value chain. This can be achieved through the growth of individual operating entities or through cooperative production and marketing arrangements.
4. **Establish well-managed, scaled-up finishing systems to produce grassfed beef at low cost.** Our analysis indicates that for U.S. grassfed production to achieve production costs closer to conventional feedlot operations, the industry should establish well-managed grass-finishing operations that are scaled up further and apply best-practice cattle and grazing management that builds soil health. Although overseas grassfed production costs would still be cheaper, future growth of grassfed beef consumption should not be filled completely by imports because of the crucial ecological and social benefits that well-managed grassfed operations bring to the U.S.

These actions would help U.S. grassfed beef grow from a niche to a mainstream product. They will require cooperation both among producers and between producers and other actors along the supply chain — processors, marketers, food manufacturers, chefs, retailers and investors. This type of cooperation can be hard to achieve, but the prize is great. Going back to grass can regenerate farmland, improve animal welfare and deliver a bounty of healthy, nutritious, delicious food that everyone can enjoy.

CHAPTER 1 THE CASE FOR GRASSFED BEEF

The U.S. grassfed beef market is growing strongly and attracting plenty of attention. Supermarkets and restaurants throughout the country are carrying more and more labels proudly referring to the grassfed provenance of their meat. But what exactly is grassfed beef? How is it different from beef produced in the conventional system? How does it relate to other health and sustainability labels such as organic or "pasture-raised"? Most importantly, does it matter? This chapter tries to demystify grassfed beef and tease out the differences between marketing claims that can confuse consumers. It also presents the evidence for why grassfed beef, when produced using regenerative grazing methods, can be superior to conventional beef on human health, animal welfare and environmental grounds.

CONVENTIONAL BEEF CATTLE PRODUCTION

To understand grassfed beef, we must start by understanding the conventional beef production system in the U.S. Cattle production in the U.S. typically includes three phases: cow-calf, stocker and finishing (see diagram to the right). The stocker phase is sometimes replaced by backgrounding, which involves feeding cattle a mixed ration of grass and grains in backgrounding yards. In the cow-calf phase, breeding cows give birth to calves, which are typically weaned at 6-8 months of age. The animals then enter the next phase as "stockers" (often on another farm), which generally lasts another 3-7 months and brings them to a weight of 800 pounds and an age of 9-15 months.[1] The first two phases of production are nearly always pasture-based, meaning that livestock spend the majority of their time on grass and consume mostly forage (unless the animal is backgrounded). A summary of cattle production and market terminology is included in this report's glossary.

After the stocker phase, the cattle are referred to as "feeders" and enter the third and final stage of beef cattle production. Since the 1950s, the finishing phase for conventional cattle has largely moved off pastures and into feedlots. Feedlots, also known as animal feeding operations (AFOs), are defined as facilities where cattle are confined and fed for a total of 45 days or more in any 12-month period and where crops, vegetation, forage growth or post-harvest residues are not sustained in the normal growing season over any portion of the premise.[2] Animals in feedlots are fed a diet of about 85% starch (in the form of corn or other grains) and 10-15% forage (such as hay or silage). The ration also includes protein sources such as soybean or cottonseed meal, sometimes in conjunction with urea. They are also fed other food manufacturing byproducts (e.g., cookie crumbs, sugar beet tops, orange pulp, candy, potato byproducts and potato waste) to reduce feed costs.[3] More recently, ethanol co-products such as distiller's dried grains with solubles (DDGS) and corn gluten feed can constitute 20-50% of the ration.

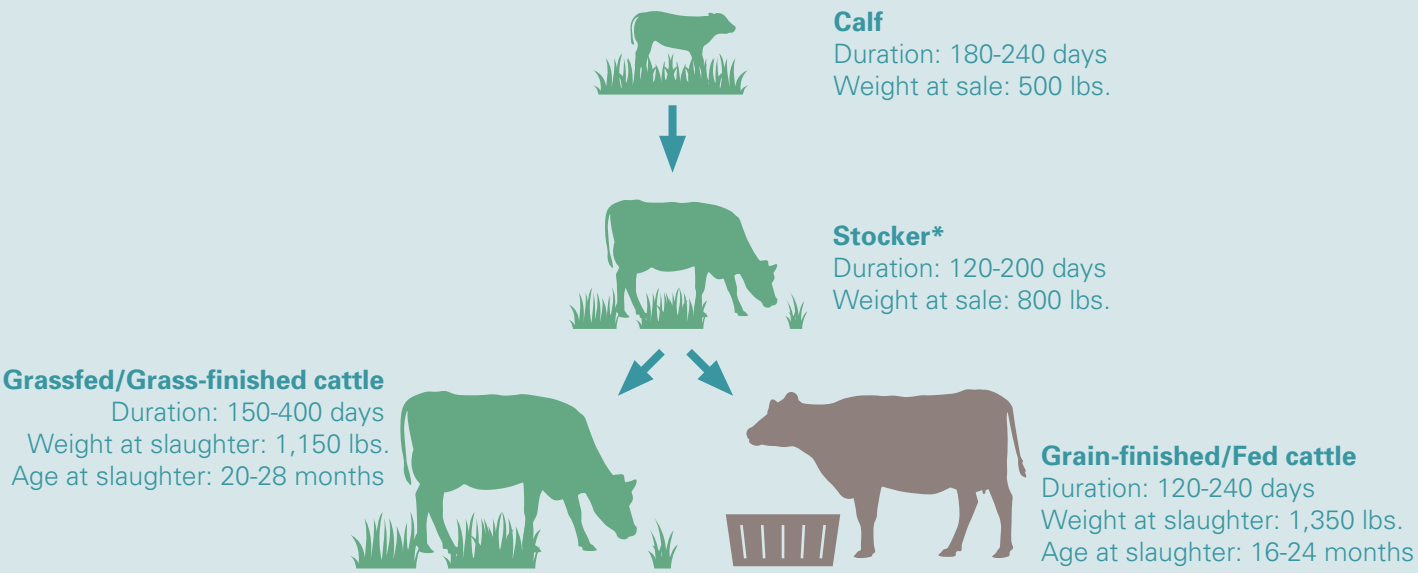
The highly engineered diet allows feeders to achieve rapid weight gain, reaching average daily weight gain of 2.5-4.0 lbs/day.[4] Beef produced from these animals can be well-marbled with fat.

In feedlots, the finishing phase will increase the feeder's weight to a minimum of 1,200 pounds in a period of 120-240 days, although animals may be fed longer and grown to over 1,400 pounds when grain prices are low. The 10-year average weight of grain-finished cattle to 2015 was 1,350 pounds.[5] Grain-finished animals, called "fed cattle," are usually 16-20 months old[6] but can be 24 months or older. An estimated 97% of the cattle slaughtered for meat are fed grains.[7] Most of them are finished in concentrated AFOs, or CAFOs,[8] which are feedlots that discharge manure or wastewater into a natural or man-made ditch, stream or other waterway and are hence regulated by the U.S. Environmental Protection Agency (EPA).[9] CAFOs have accumulated huge economies of scale, with the largest ones having the capacity to feed 50,000 head of cattle or more at one time.[10]

GRASSFED BEEF PRODUCTION

There is a certain amount of grassfed beef produced by default in the U.S. conventional system because most cattle during the cow-calf and stocker phases spend their lives on pastures eating mostly grass. Some of these animals have been fed only forage and are slaughtered and processed for meat without going through a conventional feedlot for proper finishing. These animals include some cull cows and bulls (defined as those that have reached the end of their reproductive lives) and underperforming calves and stockers that do not "qualify" for the feedlot system. They also include a small number of cattle raised in grassfed dairy operations. This unfinished "default" grassfed beef is of lower quality than finished beef. It is typically used to make ground beef (for hamburgers), cheap beef cuts or even pet food. Most of it is sold through the conventional beef supply chain without a "grassfed" label, where it may be blended with meat from grain-fed animals.

FIGURE 1.1 Conventional vs. grassfed cattle production



Note: figures reflect approximate industry average; operations can outperform on finished weight and age depending on management practices

*In conventional beef production, the stocker phase is sometimes replaced by "backgrounding," which involves feeding cattle a mixed ration of grass and grains in backgrounding yards.

Source: SLM/Bonterra

The clearest distinction between grassfed and conventional beef production occurs at the finishing stage. Rather than being sent to feedlots, grassfed cattle are kept on pasture and finished on a diet that is predominantly made up of grasses or other forages. These cattle tend to grow more slowly than grain-fed animals. Their average daily weight gain is typically 1.5-2 lbs/day, or roughly half that of feedlot animals. A finished grassfed animal is usually slaughtered later (at 24-28 months of age) and at a lower weight (around 1,000-1,200 pounds) than a grain-fed animal, though successful grassfed beef producers can finish cattle at significantly higher average daily weight gain (up to 3 lbs/day) and weight (1,240-1,350 pounds) by 20-22 months of age.[11] Meat from these animals is usually sold with a grassfed label approved by the United States Department of Agriculture (USDA) and sold into niche grassfed beef markets for a premium. If you buy a grassfed steak, this is typically what you are getting.

DEFINING GRASSFED BEEF

However, even when applied to finished animals, the label "grassfed" is ill-defined and open to abuse. Most consumers assume that a grassfed claim means the meat is derived from cattle that have continuous access to pasture and consume grass and other forage exclusively throughout their lives. This is not always the case. Production systems using the grassfed label vary according to two factors: the extent to which animals have access to pasture for grazing, rather than being confined; and the extent to which animals receive their diet in the form of grasses and forage, rather than having it supplemented with grains or other concentrated feeds.

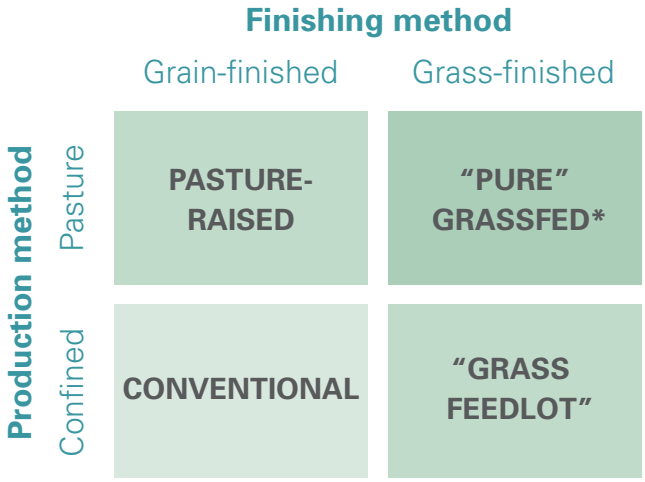
For example, a striking development in recent years has been the emergence of "grass feedlots," where animals are kept in confinement and fed grass pellets. These feedlots replicate the CAFO economies of scale and achieve animal weight gain at a rate faster than traditional grassfed finishers, but even though their beef is labeled as grassfed, it is not what consumers expect when they buy grassfed beef.

Other producers raise their cattle entirely on pasture but with a mixed ration of grass and grains. This type of beef is usually labeled as "pasture-raised" rather than grassfed. This is different from conventional beef, but it does not imply that the cattle are 100% grassfed and finished on grass.

Perhaps the most meaningless claim is "grassfed, grain-finished," used by some brands to advertise their beef. This could apply to almost all beef that passes through the conventional system, as all cattle are fed grass until a certain point. It says nothing about whether animals are confined or allowed access to pasture during the finishing phase, and confirms that their diet is mostly grain.

In this report, we use the term "pure" grassfed beef to describe meat from cattle raised on pastures and fed a 100% forage diet with limited, incidental non-grain supplementation not exceeding 1% for the total lifetime consumption of dry-matter intake.[12] It is distinct from beef with a grassfed label that comes from animals that are confined in "grass feedlots."

FIGURE 1.2 Beef types by production and finishing method



*"Pure" grassfed beef comes from animals that are raised on pasture and fed a 100% forage diet, with incidental supplementation not exceeding 1% for the total lifetime consumption of dry-matter intake, in contrast to "grass feedlot" beef that is from animals raised in confinement.

"Pure" grassfed definition derived from joint letter submitted to the USDA by four leading grassfed certification programs in the U.S., available at https://www.regulations.gov/document?D=FSIS-2016-0021-4629.

Source: SLM/Bonterra

In addition to differences over whether cattle have access to pasture or eat grass or other forages, production systems vary in their incorporation of hormones, antibiotics, pesticides, synthetic fertilizers and certain animal welfare practices. A number of production claims can be found on beef packages, for example, "natural," "vegetarian fed," "no artificial hormones," "antibiotic-free," and "USDA Organic." None of these indicate that cattle are fed and finished only on grass. All grassfed beef producers meet the requirements of "vegetarian fed," and almost all of their beef would qualify as "natural."[13] Most do not use artificial hormones and daily antibiotics, and drug use is restricted to healing sick animals. Not all grassfed beef producers are certified organic because they may use synthetic fertilizers and chemicals on their pastures, or simply may not choose to go through the organic certification process. Most organic livestock producers are not 100% grassfed, instead relying mostly on grains for feed.

It is a confusing landscape of labels for consumers. Does it matter? Does grassfed beef have any genuine benefits compared to conventional beef, or is it just clever marketing to convince consumers to pay more? And does the "purity" of the grassfed system make any difference? The following sections will explore the case for grassfed beef in terms of human health, animal welfare and environmental impact. There is an emerging body of scientific research pointing to the harm associated with conventional beef production and the potential benefits of grass-based production, especially when applying regenerative grazing practices.

HEALTH BENEFITS OF GRASSFED BEEF

Although the role of red meat in a healthy diet is still controversial, many studies suggest that pasture-raised, grassfed beef is healthier than conventional grain-fed beef. Grassfed beef can have comparable saturated fat to grain-finished meat, especially when grassfed cattle have access to healthy, ample and diverse pasture. Regardless of fat levels, the nutrient and fatty acid profiles are healthier in grassfed meat.[14]

Grass finishing increases the concentration of conjugated linoleic acids (CLAs) by a factor of between two and three compared to grain finishing.[15] CLAs are a group of fatty acids that include linoleic acid (LA), an omega-6 fatty acid, and α-linolenic acid (ALA), an omega-3 fatty acid. Both are essential fatty acids (EFAs) because they cannot be synthesized by humans and are only available from certain foods.[16] Several animal and human studies suggest that CLAs are associated with many benefits, including reduced cancer risk, reduced cardiovascular disease risk and better cholesterol levels.[17,18] Although the exact physiologic mechanisms behind these benefits are not completely understood, grassfed beef (and dairy) can provide a steady

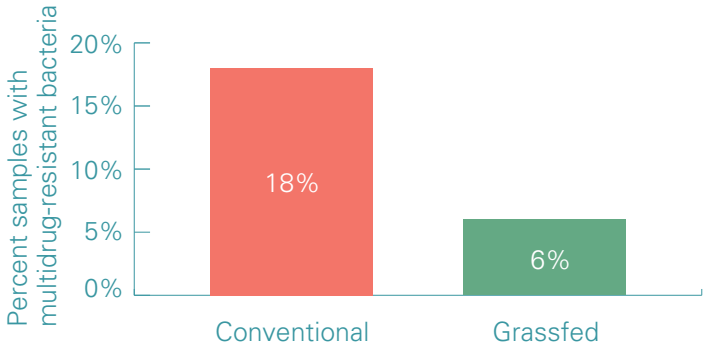
dietary source of CLAs.[19,20] The optimal ratio of dietary omega-6 to omega-3 fatty acids is believed to be between 1-to-1 and 4-to-1.[21] Seven studies that compared the overall fat content of different beef types found that grassfed beef had an average ratio of 1.53, while grain-fed beef had a less healthy average ratio of 7.65.[22]

Grassfed meat also contains higher levels of antioxidants, including vitamins E and A, as well as superoxide dismutase and catalase, enzymes that scavenge free radicals that cause oxidation and spoilage. Higher antioxidants are better for meat quality (retarding spoilage from lipid peroxidation) and beneficial to the consumer.[23]

From a food safety perspective, grain feeds create a more acidic environment in a ruminant animal's gut and digestive tract, making it more conducive to E. coli formation.[24,25,26] In addition, over 73% of large CAFOs now report using subtherapeutic doses of antibiotics in their cattle feed as a "health or production management tool."[27] The Food and Drug Administration considers 61% of the antimicrobials (primarily antibiotics) administered to livestock each year to be "medically important" for humans.[28] Overconsumption of antibiotics enables the development of antibiotic-resistant strains of bacteria that can spread from the intestinal systems of livestock to humans through soil and water, rendering antibiotics used to treat human bacterial infections ineffective.[29]

In contrast, cattle raised on pasture do not need to consume subtherapeutic doses of antibiotics to remain healthy. In a study that sampled over three hundred packages of ground beef, grassfed beef was found to be three times less likely than conventional beef to contain multidrug-resistant bacteria.[30]

CHART 1.1 Percentage of conventional and grassfed ground beef samples containing multidrug-resistant bacteria



Statistically significant difference found between the two groups
Source: *Beef Report*, Consumer Reports, 2015

ANIMAL WELFARE IN GRASSFED SYSTEMS

Humane animal treatment is typically defined as actions that ensure the following five freedoms: freedom from hunger and thirst; freedom from discomfort; freedom from pain, injury and disease; freedom from fear and distress; and freedom to express normal behavior.[31] In many ways, the feedlot model is antithetical to all but the first of these conditions of animal welfare. Standing on dirt (or sometimes concrete) flooring, often covered with thick layers of mud and manure, can produce health issues such as foot rot (causing swelling and lameness) and digital dermatitis, a bacterial infection that can also lead to lameness and intense discomfort.[32] In feedlots, antibiotics are used to prevent outbreaks of diseases, which spread easily from animal to animal when livestock are confined in the same area over a long period of time. Antibiotics are also used in feedlots to prevent acidosis (a spectrum of conditions that arise when the microbes in the rumen ferment the starches in grain feed), which can produce harmful effects ranging from stomach bloat to sudden death.[33] In contrast, grassfed beef producers rarely need to use antibiotics because cattle that are raised in their natural habitat are healthier. Grass diets do not acidify the natural pH of the animal's gut, thus reducing the risk of acidosis. Cattle are ruminants, meaning that they possess bacteria in their stomachs that allow them to digest grasses and other forms of roughage, so feeding cattle large amounts of grain is arguably a violation of their natural physiology and behavior.

ENVIRONMENTAL IMPACTS OF GRASSFED BEEF

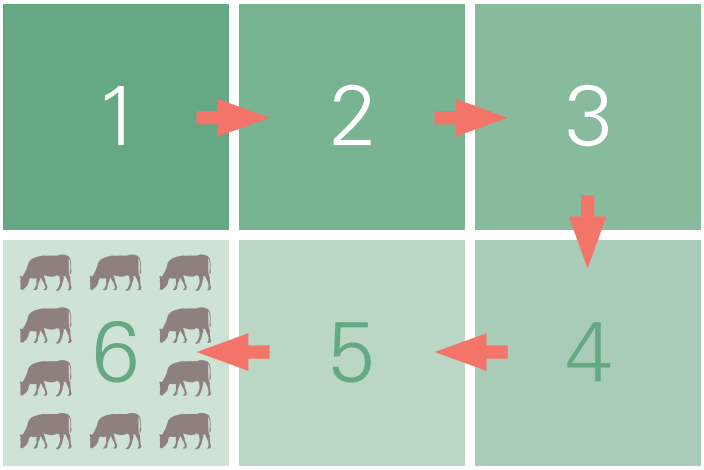
Livestock manure has, throughout the history of settled human societies, been an important source of agricultural nutrients, especially nitrogen and phosphorus. When applied in proper quantities, cattle manure can be beneficial for plant production and grassland ecosystem health. In feedlots, however, large quantities of manure are concentrated in small areas, becoming an environmental hazard. (The same applies to "grass feedlots.") When manure application exceeds the land's capacity to assimilate it, ammonia (NH_3) is rapidly volatilized and returned to the atmosphere.[34,35] Ammonia can directly affect human health: Even moderate concentrations (between 50 and 150 ppm) in the air can irritate human skin, eyes and respiratory tracts.[36]

The concentration of manure around feedlots also causes water pollution. Nutrients that leach into aquatic ecosystems can produce severe ecological damage in the form of eutrophication. In the presence of excess nutrients (i.e., under eutrophic conditions), certain algae species tend to reproduce more quickly, leading to algal blooms. Algal blooms in turn can produce hypoxic (i.e., oxygen-deprived) conditions and large-scale die-off of aquatic species.[37]

When understanding the environmental impacts of conventional beef production, it is also important to look beyond the feedlot to the cropping systems that produce the feed. The grains used in feedlots are usually grown in chemical-intensive annual cropping systems, which can cause chemical runoff, soil degradation and biodiversity loss on agricultural land.

It is true that poorly managed grazing can also degrade land. For example, set stocking or continuous grazing of cattle on pastures can lead to simplification of plant communities, soil compaction and biodiversity loss. However, well-managed grazing can rebuild and enhance soil function and land health.[38] It mimics wild ruminants roaming in nature by creating smaller paddocks with more fencing, grouping animals in a herd and grazing paddocks for short periods before moving the herd to the next paddock. A key component is allowing pasture enough recovery time, i.e., periods without any animals present. These approaches also stress the need for adaptive and holistic planning and decision-making that take into account changes in weather, forage conditions, markets and management objectives. There are a number of variations on this type of grazing system: intensive rotational grazing, adaptive multi-paddock (AMP) grazing or holistic planned grazing, to name a few. We use the term "regenerative grazing" to refer to these types of rotational grazing approaches. The case study below shows how the James Ranch applies these principles to run a successful and sustainable grassfed beef operation.

FIGURE 1.3 REGENERATIVE GRAZING PRINCIPLES



High stocking density, rotation and allowing pasture to rest are key means of ensuring a diverse, resilient and productive pasture. Individual paddocks are generally grazed for no more than a few days.
Source: Stone Barns Center for Food and Agriculture

Regenerative grazing has been shown to increase forage productivity while increasing soil organic matter, soil fertility and water-holding capacity.[39] Rancher profitability can also increase due to improved forage quality and quantity, allowing more animals to be raised on the same acreage.[40] Estimates suggest that every 1% increase in soil organic matter allows soils to hold between 20,000 and 25,000 more gallons of water per acre.[41] In these systems, grasses act as natural barriers to erosion and manure is evenly distributed by animal movement. The risk of exceeding the land's assimilative capacity is largely avoided, reducing the likelihood of ammonia volatilization and manure runoff.

Photo: Carman Ranch

RANCH PROFILE:
THE JAMES RANCH

Owned by Dave James, the James Ranch is 10 miles north of Durango, Colorado, in the beautiful Animas River Valley. The ranch has 400 acres of high-altitude, irrigated pastures for its 100% grassfed beef and dairy cattle operations, as well as a spruce tree nursery and an organic vegetable and flower garden. It seeks to develop financially viable agricultural and related enterprises that sustain a profitable livelihood for the families directly involved, while improving the land and encouraging the use of all natural and human resources to their highest potential. Their land management practices can be summarized as follows:

- Decisions are made holistically, taking into account how they affect the land, ecosystems, animals (wild and domestic), families, communities, customers and future generations.
- The land is under conservation easement and contributes to open space and pastoral beauty.
- The ranch does not feed cattle and dairy cows any grain and does not use artificial fertilizers, pesticides or insecticides.
- The ranch uses a "quick rotational grazing" system where animals are kept together and rotated every 1-3 days onto a fresh mix of nutritious grass and clover. As they move quickly from one pasture to another, the cattle invigorate the plant root systems and fertilize pastures with manure, simulating the grazing patterns of ancient herds that maintain natural balance in grasslands.

The ranch runs 150 head of grassfed beef cattle on 340 acres of irrigated pastures (the rest are set aside for dairy). The cattle gain 2-3 lbs/day and are finished at 25-28 months of age, normally in July, weighing around 1,150 pounds.

The James Ranch only sells frozen beef. "Frozen beef is just as delicious, and maybe better, because it holds all of the flavor in the meat," Dave explains. The ranch has established trust with the local community and sells most of its products at its farm stand. Some are also sold through a local restaurant owned by Dave's son-in-law. With customers paying a high premium over conventional beef and buying directly, the James Ranch is a small but profitable business.

BEEF PRODUCTION AND GREENHOUSE GASES

Beef cattle have been identified as a large source of greenhouse gases (GHGs), especially methane, and therefore a major contributor to anthropogenic climate change. Reducing the GHG emissions associated with beef is therefore an imperative. Researchers have sometimes concluded that grain-finished cattle produce less methane than grassfed animals since they are slaughtered younger, so grain feeding is often considered more efficient in terms of GHG output per pound of beef.[42] However, most cattle life cycle analyses (LCAs) performed to date have not taken into account the positive or negative externalities that grazing and cropping systems have on soil carbon. When this broader life cycle analysis is applied, a different picture emerges.

There is evidence that grasslands managed with regenerative grazing techniques can sequester carbon in soils.[43] According to one study of cattle-raising practices in the U.S. Northern Great Plains, converting cropland to pasture and applying intensive grazing management increased soil carbon sequestration by 151.7 grams of CO_2e/m^2/year, which reduced the lifetime GHG impact of grassfed beef by 24%.[44,45] Another study found that intensive rotational grazing was able to sequester 106 grams of carbon per square meter, while other pasture management approaches released at least 171 grams per square meter.[46] This particular study focused only on carbon (not all GHGs); however, it demonstrates that good grazing management can encourage carbon sequestration.

A more recent analysis suggests that grassfed beef produced through intensive rotational grazing has a lower GHG impact than grain-fed beef once soil carbon is taken into consideration. This analysis looked at soil carbon sequestration on pastures under well-managed grazing as well as typical soil carbon losses on croplands that grow grains for conventional feedlots. Moreover, this study found that soil carbon sequestration more than offset methane and other GHG emissions from grassfed cattle. This would make grassfed cattle production a potential net carbon sink. The implication is that well-managed grazing, rather than contributing to climate change, can help mitigate it.[47]

Our understanding of the methane cycle is also limited. Before cattle, large numbers of wild ruminants roamed across North America. They would have released a significant amount of methane into the atmosphere, but some scientists believe this was offset by soils acting as a methane sink. This is due to the presence of methanotrophic bacteria, which utilize methane as their only source of energy. Research has shown that one hectare of pastureland can oxidize as much methane as emitted by 162 head of cattle per year.[48] The methane-mitigating bacteria can only be found in abundance in well-managed grass-based livestock systems with aerobic soils, not in feedlot environments.

TASTE AND FLAVOR

No matter how worthy a type of beef is on health or environmental grounds, most consumers will not buy it if it does not taste good. There is a common misconception among some American consumers that grassfed beef is lean, easily overcooked and not tasty.

Grassfed beef does not have to be lean. Part of the problem is that grassfed animals are not always finished to a high enough standard. They may not graze high-quality forages and achieve the high daily weight gain during the finishing phase that is necessary to produce well-marbled meat. But high-quality marbling can be achieved on a consistent basis with good grazing management and the right animal genetics. It requires healthy animals, nutritious grasses and, ultimately, healthy soil, which is the goal of regenerative grazing. Healthy soils lead to enhanced forage diversity and quality (e.g., higher plant brix, or the plant's sugar or carbohydrate content), resulting in improvement in average daily gain. Productive soils also increase year-round forage biomass production, enabling producers to finish grassfed cattle throughout the year.[49]

There is a growing consensus among chefs and gastronomical experts that high-quality grassfed beef not only rivals but is in fact better-tasting than grain-fed beef. It has a "beefier" and more complex taste. As award-winning food and travel writer Mark Schatzker attests in his book *Steak: One Man's Search for the World's Tastiest Piece of Beef*, after traveling around the world in search of the best beef tasting experience, he was pleasantly surprised to find it in a piece of grassfed steak produced in the U.S. Having participated in many beef taste tests, Schatzker comments that, "when grain-fed steak lovers are given a piece of good grassfed beef, they always love it. No learning curve is required there."[50]

Leading chefs in the U.S. are already serving domestic grassfed beef. In the following, Dan Barber, author of *The Third Plate* and renowned chef and co-owner of Blue Hill at Stone Barns (recently named the Best Restaurant in America by food publication *Eater*[51]), shares his perspective on grassfed beef.

Q&A WITH DAN BARBER

CHEF AND CO-OWNER OF BLUE HILL AT STONE BARNS
AND AUTHOR OF *THE THIRD PLATE*

Photo: Richard Boll

Q: How does the taste of grassfed beef compare to conventional beef?

DB: With conventional beef, what you're tasting is fat: nutty and greasy. There's an oily quality that coats your mouth. One thing that's missing is real beefiness. The flavor comes from the fat, rather than the animal itself. Grassfed beef has a taste that's clean and rich, and undeniably beefy.

Q: How do your customers compare their grassfed beef experiences at Blue Hill with their past experiences of eating grain-fed beef?

DB: People come in with the same misconception about grassfed beef: that it's chewy or dry. Hopefully they come away with that myth debunked. A dry grassfed steak is usually the fault of the chef.

Q: What's the best steak you've ever had?

DB: It came from an eight-year-old dairy cow (by conventional standards, dog food) retired from Blue Hill Farm, our family's farm in the Berkshires. The flavor was complex and persistent, like a great wine.

Q: What are your favorite grassfed beef cuts to cook with?

DB: I'm more excited to use some of the uncoveted cuts, like beef cheeks or neck.

Q: What is meant by the idea of "grassfed terroir"?

DB: Grain-fed beef is stripped of any sense of place. Of course, there's still variation — based on the breed, the aging process — but for the most part, a grain-fed steak tastes the same whether it's raised in New York or New Mexico. Grassfed beef tastes different based on the pasture the cattle were eating — which means it varies by farm and even time of year.

THE GRASSFED ADVANTAGE

Conventional feedlots have not been held fully accountable for externalities associated with their operations, the costs of which have instead been borne by taxpayers and the rest of society. Although it is difficult to account for all the social and environmental benefits lost due to feedlot operations, the externalized environmental and public health costs of beef (and other) CAFOs have been estimated to be on the order of billions of dollars.[52] Meanwhile, there is a growing body of scientific research pointing to the advantages of grassfed beef production over conventional feedlots. Grassfed beef production that uses regenerative grazing methods also seeks to minimize externalities and restore the environment while providing healthy food.

But how we define "grassfed" matters. Meat from animals finished on diets that are only partially grass-based will not have the same fatty acid and antioxidant profiles as meat from 100% grassfed animals — its profiles will be closer to those of conventional beef. "Grass feedlots" that keep animals in confinement will have many of the same problems with manure concentration, nutrient runoff and animal welfare as a conventional feedlot. All cattle production systems have to grapple with the challenge of potentially large greenhouse gas emissions, especially methane. The only way to counteract this is through regenerative grazing methods that build soil health and put carbon in the ground. Fortunately, this can also be the answer to the challenge of producing consistent, high-quality finished beef on pasture. Healthy, biologically active soils beget nutritious, high-carbohydrate plants, which is what cattle need to gain weight and finish well.

Consumers seem to intuitively "get" this. When they buy grassfed meat, they picture cattle grazing on pastures. They believe that grassfed beef means health, sustainability and high animal welfare. The next chapter will explore consumer demand for grassfed beef. It will analyze how much they buy, what they buy and how much they pay. It will look at the recent growth in the U.S. grassfed beef market and identify obstacles that may prevent this niche food from going mainstream.

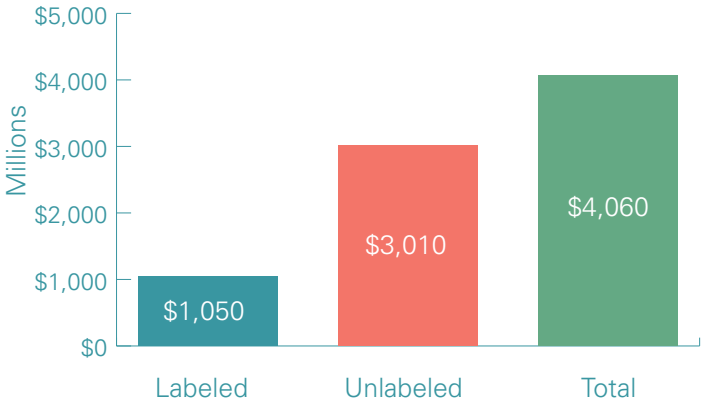
CHAPTER 2 THE U.S. GRASSFED BEEF MARKET

Although grassfed beef is still a small niche within the total U.S. beef industry, more consumers in America are eating grassfed beef, and the market is expanding quickly. This chapter examines the consumption patterns that underpin the grassfed beef market and looks at the factors that are both propelling and inhibiting demand.

MARKET SIZE

The grassfed beef industry generated an estimated $4.0 billion in retail and food services sales in 2015, accounting for nearly 4% of the $105 billion total beef market in the U.S.[53] This includes both domestic and imported grassfed beef. Labeled grassfed beef — i.e., beef with a grassfed marketing claim that is kept segregated from conventional beef throughout the supply chain (which includes beef produced from "grass feedlots") — comprises around $1.0 billion of sales. Unlabeled grassfed beef, which is sold as conventional beef, accounts for a large share, generating an estimated $3.0 billion. The methodology used in this analysis is explained in Appendix 1. Given the conservative assumptions used to derive our estimate, the actual grassfed beef market size is probably larger than what is presented here.

CHART 2.1 Estimated 2015 grassfed beef market size in the U.S.



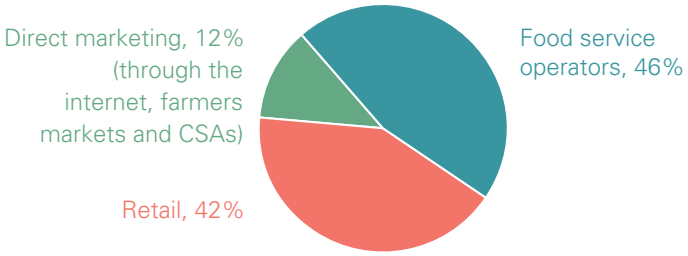
Source: SLM/Bonterra

Data about unlabeled grassfed beef is hard to obtain, precisely because it is sold as conventional beef without the grassfed label. In many cases, it is blended with meat from conventional animals to produce ground beef and hamburgers, so it is impossible to identify by the time it reaches the consumer. This category also covers the "default" grassfed beef that is produced in the conventional system from culled cows, bulls and young animals that do not go through feedlots. Our discussion in this chapter pertains mostly to the labeled segment. This includes most of the finished grassfed beef produced in the U.S. It is also the type of beef that consumers encounter when they see "grassfed" on menus or butcher counter labels.

SALES BY CHANNEL

So where are consumers buying (labeled) grassfed beef? It is primarily sold through three channels: retail (e.g., grocery stores, warehouse clubs, butcher shops), food service (e.g., restaurants, cafeterias) and direct marketing whereby ranchers sell directly to consumers through farmer's markets, CSAs and the internet. An estimated breakdown of labeled grassfed beef sales in 2015 by sales channel is presented below.

CHART 2.2 Estimated 2015 labeled grassfed beef sales volume by sales channel



Source: Nielsen, SPINS, Beefretail.org, Technomic, Grass Fed Insights, LLC

Within the food service operator segment, 45% of all beef is consumed through limited service restaurants (e.g., McDonalds and other fast food chains), followed by full service restaurants (22%), with the remaining 33% comprised of educational and healthcare facilities and hospitality and catering services.[54] Grassfed beef consumption patterns in the U.S. are likely to be similar, since a majority of it is consumed as hamburgers and an increasing number of burger joints are offering grassfed beef. In the future, usage of grassfed beef may rise in other sub-segments that promote healthy eating, such as schools, universities and healthcare facilities.

WHERE DOES ALL THE UNLABELED GRASSFED BEEF GO?

Many American consumers are already eating grassfed beef without their knowledge. With a retail value of $3 billion, an estimated 1.1 billion pounds of grassfed beef in the U.S. are sold without a grassfed label. This represents 6% of all beef consumed nationally, by retail meat weight.[55]

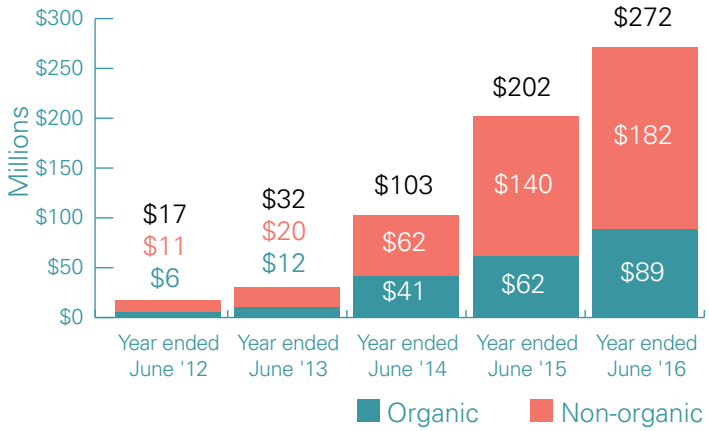
Most unlabeled grassfed beef is lean with little marbling. It fills a large void that is created by Americans' insatiable appetite for hamburgers. The U.S. grain-fed beef industry produces a huge amount of trim, but its high fat content needs to be mixed with leaner trim (such as that of grassfed beef) to "dilute" the overall fat content to the maximum 30% allowed in hamburgers.[56] Besides hamburgers and ground beef, unlabeled grassfed beef is also utilized as cheap beef cuts, sausages and pet food. It is usually sold as conventional beef, but could also be marketed through any of the "natural," organic or antibiotic-free segments and fetch a premium price if it meets these specific qualifications.

Grassfed beef is not a fad, as nearly all major retailers have added it to their shelves in recent years. Examples include natural/organic grocery chains such as Whole Foods and Sprouts as well as mainstream retailers such as Kroger, Walmart, Target and Albertsons/Safeway. Mainstream restaurants such as Chipotle use grassfed beef, and others have also begun offering grassfed beef burgers, led by Carl's Jr./Hardee's in 2014, followed by Outback Steakhouse and Chili's. In the National Restaurant Association's "What's Hot" 2016 Culinary Forecast, grassfed beef was ranked sixth out of 32 items in the Main Dish/Center of Plate category by the nearly 1,600 professional chefs surveyed.[57]

The trend of adding grassfed beef to the menu extends across the value chain. Food service distributors now offer grassfed beef to some customers. Examples include Sysco, US Foods and Aramark, which started serving grassfed beef in some of its sports stadium concessions.[58] Well-known traditional meat purveyors like Omaha Steaks and Allen Brothers have added grassfed beef to their selection. Existing "natural" beef branded programs such as Strauss, Meyer Natural Foods, Maverick Ranch, Creekstone and Nolan Ryan's now sell grassfed beef to retailers and food service providers. Furthermore, the two largest beef meatpackers in the U.S. also carry grassfed beef: JBS acquired U.S. grassfed producer Grass Run Farms in 2015 and also imports from overseas; Cargill imports from Australia through its joint venture with one of the largest Australian beef processors, Teys Australia.

MARKET GROWTH IN RETAIL

CHART 2.3 Retail fresh grassfed beef sales



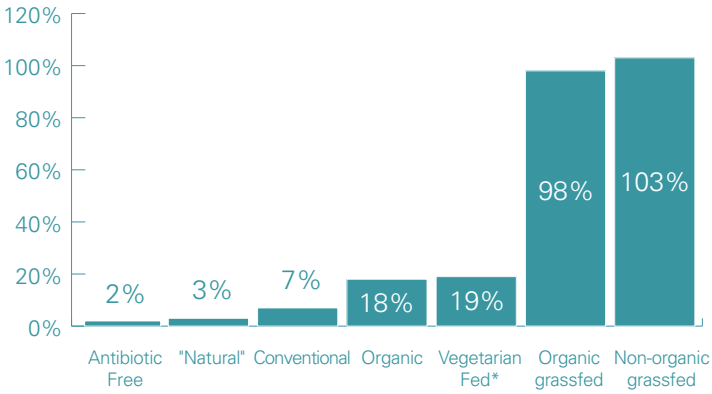
Note: Sales reflect price discounts

Fresh meat refers to fresh/refrigerated and frozen meat including patty and burger

Source: Nielsen

Despite accounting for just a small share of the U.S. beef industry, labeled grassfed beef has seen tremendous growth in the retail sector. According to marketing research firm Nielsen, retail sales of fresh grassfed beef grew 15 times in the four years since June 2012, reaching $272 million by June 2016.[59] (Actual sales were higher since not all retailers share sales data with third parties.) Organic and non-organic grassfed beef have both enjoyed compounded annualized growth rates (CAGR) of approximately 100% during this time (i.e., doubling in size every year), significantly outpacing other beef segments such as antibiotic-free, organic and natural.

CHART 2.4 Retail fresh beef 4-year compounded annualized growth by dollar value June 2012 - June 2016



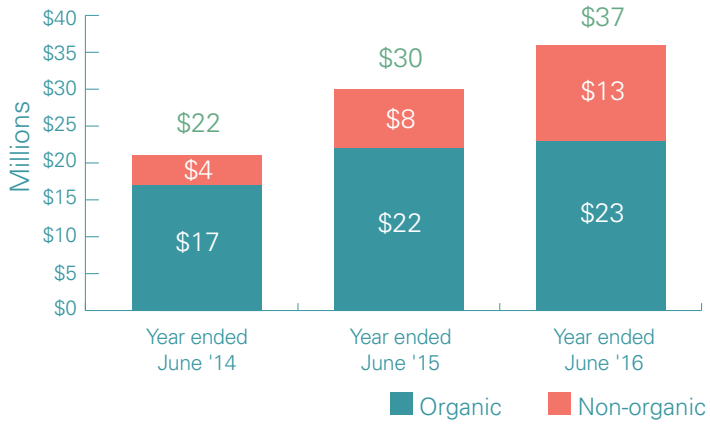
Note: Dollar value reflect discounts

Fresh meat refers to fresh/refrigerated and frozen meat including patty and burger

*Not fed animal byproducts

Source: Nielsen

CHART 2.5 Retail processed grassfed beef sales



Note: Sales reflect price discounts. UPC items only.

Processed meat includes refrigerated and frozen hot dogs, sausages, deli meat and shelf-stable snacks (e.g., jerky)

Source: SPINS

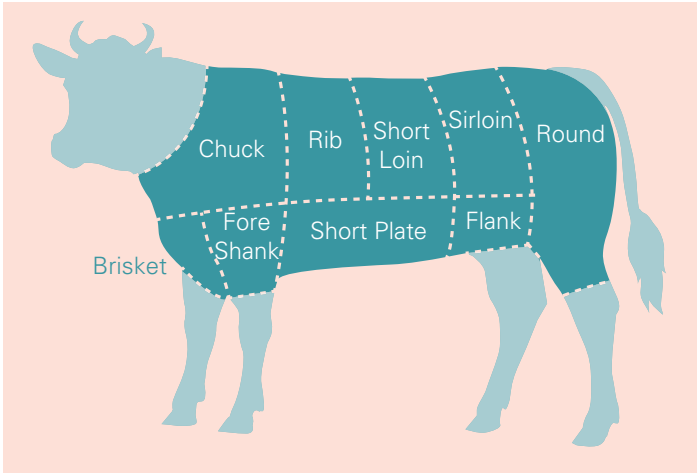
Similarly, based on data from market research provider SPINS, sales of grassfed processed beef products, such as hot dogs, deli meat and jerky snacks, have grown 68% in the two years ending June 2016.[60] (Actual sales were higher since not all retailers share sales data with third parties.)

The growth of grassfed beef is particularly impressive considering the country's decline in overall beef and meat consumption. National beef consumption volume fell at 2.3% per year on a consumption per capita basis from 2006 to 2015.[61] Red meat (i.e., beef and pork) consumption per capita by volume decreased at nearly 1% annually from 1976 to 2015 as consumers have shifted to chicken, seafood and plant-based proteins.[62] Grassfed beef is one of the bright spots in a challenging market. Americans are reducing their overall consumption of red meat but demanding healthier, sustainable options — quality over quantity. For example, premium burger joints that offer natural organic or antibiotic-free meat dishes are seeing strong growth, while growth of traditional fast food chains is stagnant.[63] In this context, grassfed beef consumption is likely to keep growing in the near- to medium-term.

RETAIL BEEF CONSUMPTION PATTERNS

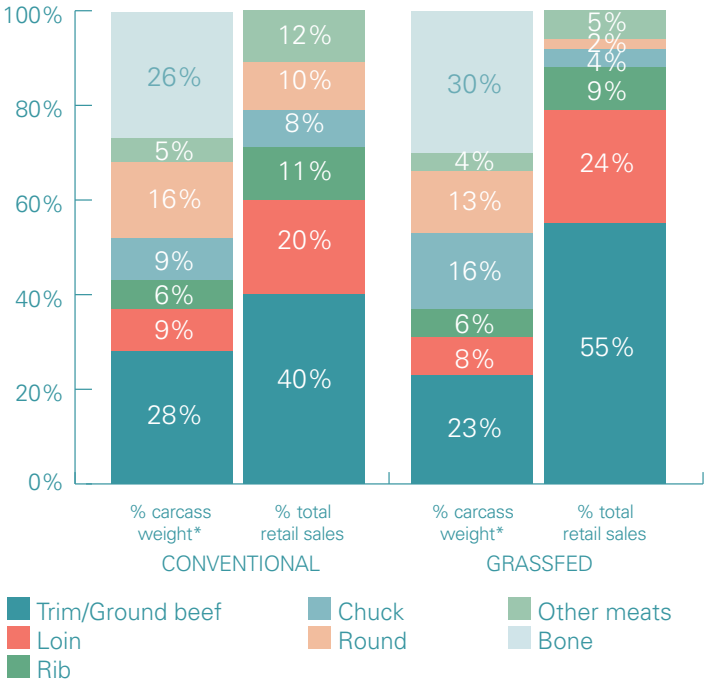
One challenge of producing beef is that the parts of the animal that are not meat, such as the head, hooves and bones, make up a significant portion of the animal's weight, but generally sell for little value. Meat comprises only around 46% of a 1,300-pound conventional animal's live weight and approximately 40% of a 1,100-pound grassfed animal.[64] Consumers also prefer certain beef cuts over others. Most often, they go for the expensive "middle meats," which consist of the loin and rib or for cheaper ground beef (which can come from any part of the animal). Other cuts, such as chuck and round that are mainly used in slow-cooking to make stews, are much harder to sell, since consumers have not been educated on how to cook them. Together with most of the cuts from the bottom half of the animal, these less popular cuts are often turned into trim and sold as ground beef. Some of the trim is also processed to make grassfed beef sausages, which is a small but fast-growing category.

FIGURE 2.1 BEEF CATTLE CARCASS PRIMAL CUTS



The issue of selling and making money from the whole carcass (which includes the hide, offal and other matter not incorporated in the official carcass weight), also known as whole-carcass utilization, particularly affects the grassfed beef industry. The chuck and round, together comprising 30% of a grassfed animal's carcass weight, only generated 6% of total retail grassfed beef sales in the last five years ending June 2016 (see graph below). Overall, ground beef generated 55% of total grassfed sales, meaning that many of the animals' higher-value cuts are sold at large discounts or ultimately sold as cheap ground beef. This makes selling the whole grassfed animal at a profit through retail a big challenge. (Food service operators may better utilize the less popular cuts to make different dishes.)

CHART 2.6 Beef carcass usage vs. retail fresh meat sales by cut - conventional vs. grassfed



Note: Fresh meat refers to fresh/refrigerated and frozen meat including patty and burger. Retail sales represent 5-year average of 2012-2016 data for last 12 months ending June.

Sales reflect price discounts.

* Carcass weight % represents how the carcass is typically fabricated; cuts not sold may be turned into trim. Assuming boneless retail meat yield of 74% and 70% for conventional and grassfed beef, repectively.
Source: National Cattlemen's Beef Association "Beef Cuts - Primal & Subprimal Weights and Yields" 2014; Beefretail.org; Nielsen; interviews with grassfed beef experts

DEMAND DRIVERS

What is driving the demand for grassfed beef? Multiple studies, and almost all of the industry experts we interviewed, concur that consumers eat grassfed beef because of its health benefits relative to conventional beef, followed by their concern for animal welfare and the environment. Health is by far the most important driver of grassfed beef consumption.[65] A Mintel survey suggests that purchasing grassfed meat is important to parents of children under 18 and consumers aged 35-54 years old with income of at least $50,000.[66] Another piece of focus group research concluded that baby boomers and others who care about health and fitness are also likely buyers of grassfed beef.[67]

BARRIERS TO ACCELERATING DEMAND

Although grassfed beef demand has grown strongly, several barriers hamper its transition to a mainstream product.

QUALITY & TASTE

There is a common misconception that grassfed beef is lean, tough and not delicious. The grassfed beef industry overall has not always been able to produce high-quality beef on a consistent basis. Some animals are not finished to a high standard, which can lower meat quality. The United States Department of Agriculture (USDA) operates a voluntary grading system that grades beef based on indicators of marbling and age, which is comprised of the grades, from high to low: Prime, Choice, Select and Standard.[68] A lot of the grassfed beef consumed in the U.S. is graded Select or lower or is not submitted for grading. The quality of beef is also inconsistent: The same producer may supply marbled beef one week and lean meat the next, frustrating consumers and chefs.

However, there are skilled operators in the U.S. who are consistently growing well-finished grassfed beef by having the right animal genetics, high-quality forage and high-quality processing. A small handful of branded grassfed programs consistently achieve USDA Choice or higher for an average of 80% of their beef every week. A few other finishers now also achieve 50% Choice and better on a consistent basis.[69]

Another challenge is consumer perception of frozen meat. Most grassfed beef sold through direct marketing is frozen. Consumers and meat buyers often have the impression that frozen beef is less tasty than fresh. But multiple beef producers and marketers we interviewed disagree; they believe that freezing meat, akin to the process of meat aging, actually further enhances the beef flavor and quality.

YEAR-ROUND AVAILABILITY

Despite the growing movement of eating local, in-season foods, the American public is accustomed to eating fresh beef year-round, since grain-fed cattle are finished throughout the year. One seasoned retail meat buyer expressed that "consumers are very unforgiving if a retailer only sells beef seasonally." Finishing cattle on grass year-round can be done in every region of the country, and some producers are doing it successfully and profitably. However, adoption is currently limited and primarily done in temperate geographies where limited stored forage (hay) supplementation is necessary. If the grassfed beef industry wants to target more mainstream consumers, year-round availability is a requirement.

PRODUCTION CLAIMS

Most consumers are rightfully confused by the multiple sustainability and production claims found in the beef marketplace. Beef labeled "grassfed" may come from animals that have been fed grain byproducts or confined in feedlot environments. There is pasture-raised beef and organic beef, but this may come from cattle fed and finished on grains.

Part of the problem is that the USDA, the authority that approves food products to carry the grassfed label, does not have strict rules on what is considered grassfed or require audits to verify grassfed claims. It intends for their "grassfed" and "100% grassfed" claims to be applied only to meat derived from cattle that are fed 100% forage, which can consist of grass, forbs, browse and cereal grain crops in the vegetative/pre-grain state, but it also allows partial grassfed claims (e.g., 50% grassfed), which carry little to no value over or difference from conventional systems.[70] Entities seeking approval are allowed to define their own claim (e.g., 50% or 100% grassfed) and show their operations are compliant with their own definition through a set of written protocols and an affidavit. Without audits, however, the concern is that marketers could be approved for a "100% grassfed" label without necessarily following the practices described in their submitted documentation. For example, grain byproducts could be used as feed but not reported.

The myriad labels and marketing claims make it difficult for consumers to discern meaningful grassfed claims from less meaningful ones. There are, however, several certified grassfed labels that aim to deliver on consumers'

TABLE 2.1 Examples of leading certified grassfed labels in the U.S. and how they compare to the USDA grassfed label

LABEL	VERIFICATION	FEED			PRUDENT DRUG USE		SUSTAINABLE AGRICULTURE			
● NO ● YES ● PARTIAL	Is It Verified?*	Do standards require 100% grass-based feed?	Do standards prohibit animal waste in feed?	Do standards prohibit pesticides as feed additives?	Do standards prohibit antibiotics or require that antibiotics be used only to treat individual sick animals?	Do standards prohibit artificial growth hormones and other drugs to promote growth?	Do standards prohibit synthetic fertilizers and synthetic pesticides on pasture and in feed?	Do standards prohibit GMOs in pasture and in feed?	Do standards address responsible manure management?	Do standards require responsible pasture management?
Animal Welfare Approved Grassfed	●	●	●	●	●	●	●	●	●	●
PCO Certified 100% Grassfed	●	●	●	●	●	●	●	●	●	●
Food Alliance Grassfed	●	●	●	●	●	●	●	●	●	●
American Grassfed Association	●	●	●	●	●	●	●	●	●	●
USDA Grassfed/ 100% Grassfed	●	●	●	●	●	●	●	●	●	●

Source: *Beef Report*, Consumer Reports, August 2015 and 2017 update

expectation of what grassfed beef means. These include Animal Welfare Approved Grassfed, Pennsylvania Certified Organic (PCO) 100% Grassfed, Food Alliance Grassfed and American Grassfed Association. While their requirements on animal treatment vary, these standards have a similar philosophy on what is allowed and prohibited in terms of feed, drug use and pasture and manure management.[71]

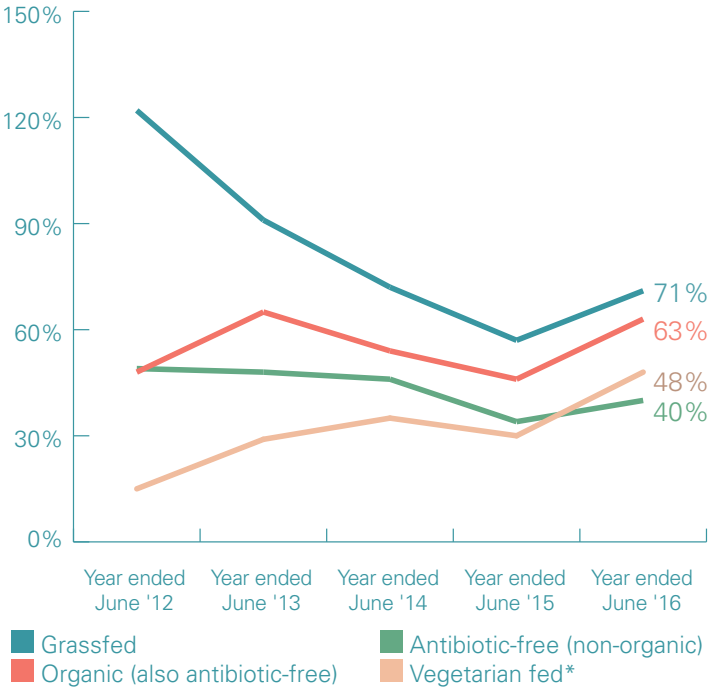
Because these labels are found in only a fraction of the market, they are not widely known or understood by consumers. The minimum floor for what the USDA requires grassfed to mean needs to be higher. Consumers and the market also need to be educated on what to look for if they wish to buy "pure" grassfed beef.

The following case study on Fleishers Craft Butchery illustrates how a customer-focused butcher company specializing in local, high-quality meat strives to overcome some of these market barriers when selling grassfed beef.

PRICE

Perhaps the biggest challenge constraining the growth of the grassfed beef market is price. According to Nielsen, fresh grassfed beef commanded a 71% premium over conventional beef (net of discounts) at the retail level in the 12 months ending June 2016. The grassfed premium was also higher than for other beef production claims, such as antibiotic-free, vegetarian fed or organic, although it has fallen and is quickly converging with the (non-grassfed) organic premium. This level of premium is not affordable for many people. There may be consumers who are willing to pay the premium and eat less beef, but this represents a minority. Unless the price gap between grassfed and conventional beef narrows, expanding grassfed consumption on any significant scale will be a challenge.

CHART 2.7 Fresh meat retail price premium to conventional beef by production claim



Note: Prices reflect discounts

Fresh meat refers to fresh/refrigerated and frozen meat including patty and burger

*Not fed animal byproducts

Source: Nielsen

The next two chapters will explore the reasons for the high grassfed beef premiums by looking at the supply chains that link farms to consumers as well as the grassfed production systems used on U.S. farms.

Photo: Carman Ranch

Est. 2004
FLEISHERS
CRAFT BUTCHERY

RETAILER PROFILE: **FLEISHERS CRAFT BUTCHERY**

Fleishers Craft Butchery operates four retail stores in New York and Connecticut, specializing in locally sourced, high-quality meats and value-added product sales. Fleishers sells beef as well as pork, chicken, lamb, turkey and prepared foods. The company's mission is to create industry-wide change in the way that Americans raise and consume meat. Approximately 15% of their beef sales are grassfed, and the other 85% are generated from animals that are pasture-raised, humanely treated and never given hormones or antibiotics. Fleishers sources grassfed cattle from local farms throughout the Northeast.

Fleishers' Founder and Chairman, Ryan Fibiger, is passionate about the eventual move to a fully grassfed beef system, but as Fleishers aims to increase grassfed sales to 50% of overall beef sales in the next two years, it faces several challenges. These include consumer education, high costs of small-scale production and processing and balancing price premiums across different cuts. Fibiger notes that the demand for beef is less elastic than for other meats. If cattle or production costs increase, he can charge more for Fleishers' beef; however, customers are generally unwilling to pay more than a 25% premium for its grassfed products over its pasture-raised products, which are priced significantly above feedlot commodity beef.

Fibiger also identifies the premature mainstreaming of grassfed beef via imported meat as a potential concern, noting that "it is great consumers can now buy grassfed beef in Walmart," but if they buy a low-quality imported grassfed steak, "they will never buy grassfed again!"

Each Fleishers retail outlet features a butcher counter, where highly trained butchers provide information on where the animals come from and how they were raised. Through its commitment to high standards across the value chain and knowledgeable meat staff, Fleishers has forged strong relationships and trust with a loyal cohort of customers who rely on Fleishers' ability to source meat of the highest standard from a quality and social and environmental sustainability standpoint. As the company seeks to expand to new markets and add more stores, Fibiger hopes that high-quality grassfed beef producers will multiply, too, such that grassfed cuts are increasingly consistent, marbled and tender year-round. The next step will be the evolution of distinct flavors associated with different regions and production practices — in other words, grassfed terroir may be right around the corner.

Photo: Carman Ranch

CHAPTER 3 THE U.S. BEEF SUPPLY CHAIN

The wide price gap between conventional and grassfed beef in the U.S. is partly caused by the nature of the supply chain. In this chapter, we explore the steps in the supply chains that move conventional and grassfed beef from the farm to the consumer. We then explain how the dynamics of these supply chains result in grassfed beef being much more expensive than grain-finished beef by the time it reaches the consumer.

CONVENTIONAL BEEF SUPPLY CHAIN

Within the conventional beef system, the first two phases of cattle production on pasture are typically handled by two different groups: cow-calf and stocker operators (sometimes the backgrounder, who feeds a mixed ration of grass and grains to cattle, replaces the latter). The animal is then transported to a feedlot, which finishes the animal on a ration of grains to the desired slaughter weight. The animal is then passed to a meat processor, also known as a meatpacker, who is responsible for slaughter and fabrication (i.e., cutting the carcass into primals and subprimals). In addition to fed cattle, cull beef cattle from cow-calf and stocker operators and dairy cattle are also processed by meatpackers at the end of their useful lives (some are fed at feedlots beforehand). Imported beef, either in the form of live cattle or meat, also enters this supply chain at different points.

The packers produce white and private label beef for branded programs and retailers. These are then marketed and distributed to retailers and food service operators, usually by food service distributors, but sometimes also directly by packers and branded programs.

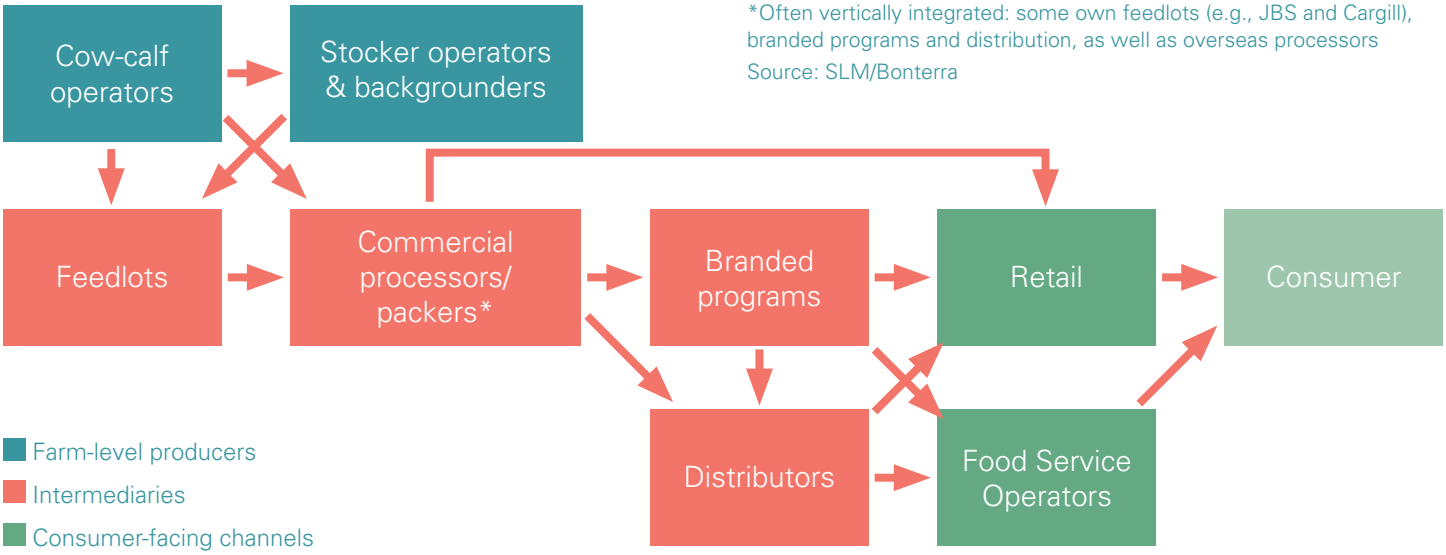
INDUSTRY CONCENTRATION

The conventional supply chain has been streamlined over time. The quest for efficiency has led to consolidation in terms of geography and company market share, resulting in the number of players shrinking.

Although cow-calf operations remain fragmented and spread out throughout the U.S. (see Figure 3.2 on the next page), a majority of the calves in the conventional system are transferred to stocker operators (or backgrounders) that are mostly found in the Great Plains and Corn Belt.[72]

Feedlots are also concentrated in the Great Plains, with four states, Colorado, Kansas, Nebraska and Texas, together accounting for 71% of all fed cattle sold in 2012. Most conventional cattle are finished in a small number of feedlots: in 2012, the largest 66 CAFOs (concentrated animal feeding operations), each with capacity for over 50,000 head of cattle, accounted for 33% of all fed cattle marketed, even though they represented only 0.1% of all feedlots in the U.S. Contrastingly, finishing operations with less than 1,000 head (97% of feedlots) handled only 11% of fed cattle sales.[73]

FIGURE 3.1 Conventional beef supply chain



*Often vertically integrated: some own feedlots (e.g., JBS and Cargill), branded programs and distribution, as well as overseas processors

Source: SLM/Bonterra

The meatpacking industry is even more heavily concentrated. The four largest companies in the U.S., namely Tyson, JBS, Cargill and National, together buy over 80% of the cattle in the U.S.[74] They control some of the largest slaughter plants in the country, strategically located near big feedlots to reduce transportation cost. According to the USDA, the 13 largest slaughter facilities accounted for 16.2 million head or 57% of the total cattle slaughtered in 2015, yet they comprise only 2% of the 808 federally inspected facilities in the country.[75] These facilities are equipped with state-of-the-art processing and fabrication machinery, quickly turning carcasses into primals or subprimals and packaging them for shipment. Figure 3.3 shows the county overlap between the slaughter facilities owned by the "Big Four" and feedlots with at least 500 head of capacity in 2012. The map's color scheme represents the density of the number of cattle on feed in each county that year.

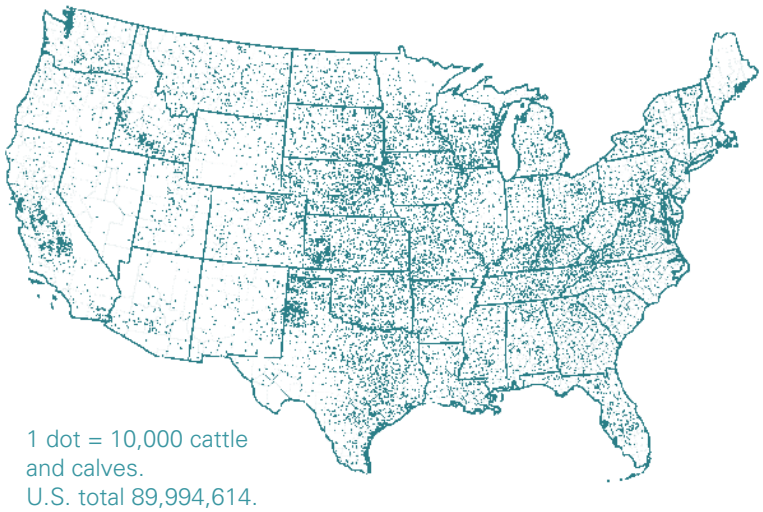
The large packers are continuing to consolidate to remain competitive in the commodity market and are becoming more vertically integrated. They acquire and own slaughter and further processing facilities and often have their own distribution operations. Packers such as JBS and Cargill own feedlots, hence owning a portion of their cattle supply. The quest for vertical integration and scale is, in a way, a response to the strong bargaining power of the highly consolidated retail and food service sectors, which have built scale over time to keep prices low for consumers. This market dynamic, however, forces the highly fragmented cow-calf and stocker producer base to be price takers in the system.

GRASSFED BEEF SUPPLY CHAIN

(The description in this section pertains to beef that is labeled grassfed. Unlabeled grassfed products are sold through the conventional supply chain.)

Cow-calf producers in the grassfed and conventional markets operate similarly, since all cattle begin their lives on pasture. These operators are distributed throughout the U.S. In contrast to the conventional system, however, grassfed stocker operators and finishers are also dispersed throughout the U.S. And there are more integrated operations, where the cow-calf, stocker and finishing phases take place on the same property. A majority of grassfed beef producers are small-scale.

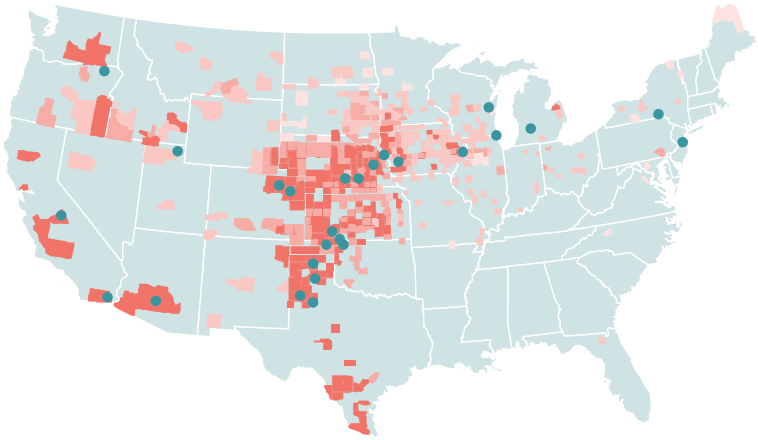
FIGURE 3.2 Distribution of cattle and calves in the U.S., 2012



1 dot = 10,000 cattle and calves.
U.S. total 89,994,614.

Source: USDA 2012 Census Ag Atlas Maps

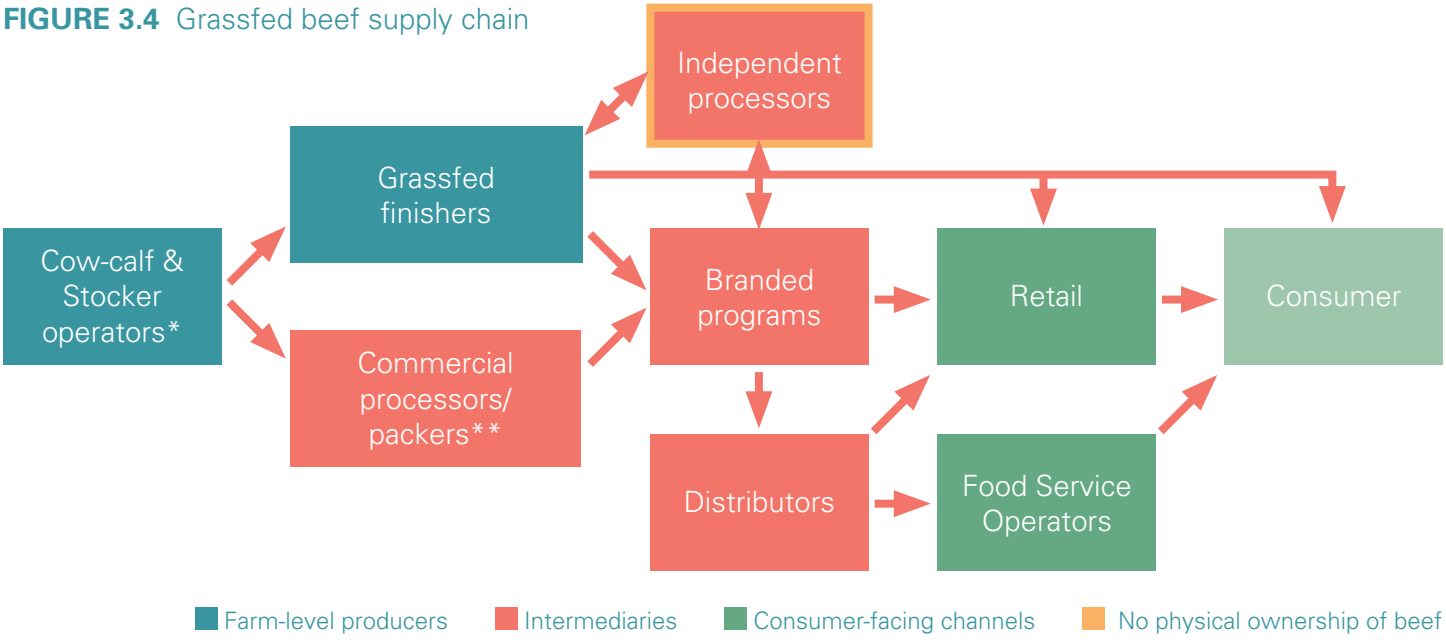
FIGURE 3.3 Conventional feedlot and packer concentration in the U.S., 2012



Source: Food and Water Watch

Note: Analysis only includes feedlots with at least 500 head of capacity. Processing plant analysis only includes county location of the plants owned by the "Big Four"; it does not indicate the exact location.

FIGURE 3.4 Grassfed beef supply chain



*Many small cow-calf operators and stockers are also grassfed finishers; they also send cull animals to packers
**Often vertically integrated: some own branded programs and distribution
Source: SLM/Bonterra

The process by which domestic grassfed animals are transferred from the grassfed finisher to the ultimate consumer is also different from the conventional market.

Branded programs buy an estimated 81% of the domestic, finished grassfed animals by volume, while the remaining 19% are mostly sold by producers through direct marketing.[76] Both branded programs and individual producers tend to use smaller, independent processing facilities. These facilities typically charge a fee for their services on a contract basis and do not buy or own the animals.

Branded programs aggregate and market grassfed beef on behalf of producers, who otherwise would not have the scale and resources to supply retailers and food service providers with adequate and consistent volume. Most branded grassfed programs are still small and are active at the local or regional level only. A list of the top branded programs selling domestically produced fresh grassfed beef, based on estimated sales volume, is illustrated on the right.

Some branded programs may own a herd in addition to buying animals from other producers, but very few have their own processing and distribution capability. While the commodity beef industry is becoming more consolidated and vertically integrated, few grassfed beef players own more than one or two segments of the whole supply chain. The following case study on Panorama Meats describes one of the larger branded grassfed programs in the U.S.

TABLE 3.1. Top branded programs selling U.S. fresh grassfed beef (in alphabetical order)

1. Bartels
2. Crystal River
3. Dakota Beef
4. Grassland Livestock Alliance
5. JBS/Grass Run
6. Jones Creek
7. Joyce Farms
8. Panorama Meats
9. Pasture One/Creekstone
10. Strauss
11. Thousand Hills
12. U.S. Wellness Meats
13. White Oak Pastures

Source: Grass Fed Insights LLC

PANORAMA™
Organic Grass-Fed Meats

BRANDED PROGRAM PROFILE: **PANORAMA MEATS**

Panorama Meats is one of the leading USDA-certified organic, 100% grassfed beef branded programs in the U.S. The company behind this brand, Western Grasslands, Inc., was founded by Darrell Wood and Ernest Phinney in 2002. The brand partners with 40 long-time family ranchers spanning ten states in the Western U.S. and Nebraska. It also markets non-organic grassfed beef under the Western Grassfed Beef label online and to restaurants and retailers.

Panorama's organic grassfed beef is sold year-round at more than 120 Whole Foods Market stores in Northern California, the Northwest, Texas, Arkansas, Louisiana, Oklahoma and Florida, and also at Brookshire Brothers stores in Texas. In addition, Panorama works with a growing number of distributors that sell to other retailers and distributors in the Western U.S.

Wood decided to switch to grassfed production, which ultimately led to the founding of Western Grasslands Inc., after his ranch suffered consecutive years of financial losses while selling into the conventional grain-finished system. He also realized that grassfed production would leave the land in better condition for his children and serve as a model for other ranches. Panorama's participating ranchers employ pasture rotation and land management practices that promote animal health and protect delicate rangeland ecosystems.[77] "The worst that can happen to the land" Wood explains, "is that you leave it alone and not graze it." Panorama's certified organic cattle are 100% grassfed, raised on organic pastures their entire lives (supplemented with hay during the winter if necessary) and Born and Raised in the USA®. They cannot be implanted with hormones, fed animal byproducts or treated or fed with antibiotics.[78] All of Panorama's affiliated ranches are rated at least a Step 4/Pasture-centered under the Global Animal Partnership (GAP) 5-Step Animal Welfare Rating Program.[79]

Darrell Wood, Co-Founder & President

By aggregating volume, Panorama achieves scale that its individual ranchers otherwise would not have. As a majority rancher-owned company, its goal is to ensure a fair price for its producers. It pays on average a 30% premium over the price of commodity beef by carcass weight. So how does Panorama balance that with selling at a reasonable price to customers? Wood believes it comes down to trust and commitment. Many of the ranchers have been working with Panorama for over 10 years. During the peak of high beef prices in 2014/15, their ranchers had the option of selling feeders to the commodity market for a quick profit, but almost all of them continued to finish animals for Panorama.

Looking ahead, the company aims to recruit more ranchers to join its network, which is extending eastward to the Midwest and Eastern regions. It will also increase its value-added product offerings, such as pre-packaged retail-ready cuts of steaks, selected offal items, bone broth and beef sticks. As the younger generation of shoppers look for quick, convenient ways to eat healthy protein and more consumers begin to understand whole-animal usage, these new products will allow Panorama to cater towards consumers' evolving tastes and preferences.

CHALLENGES IN THE GRASSFED BEEF SUPPLY CHAIN

Two key areas of the supply chain are particularly impacted by the fragmentation and lack of scale of the U.S. grassfed beef industry: processing and distribution. This has resulted in grassfed beef being more costly than conventional beef by the time it is moved from the farm to the consumer.

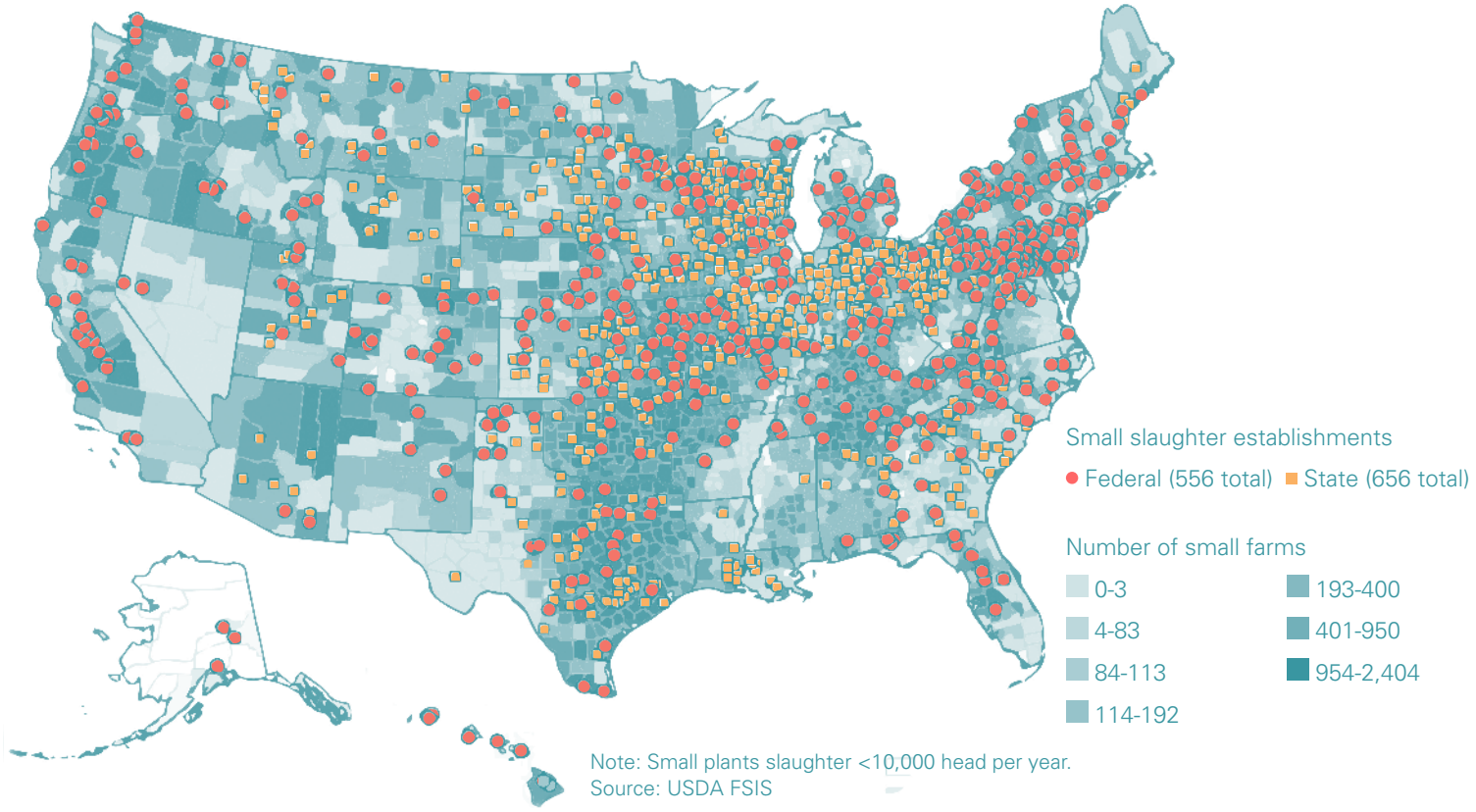
PROCESSING

In a 2013 survey of 384 U.S. grassfed beef producers, shortage of processors was cited as their single biggest challenge.[80] While this may be true for small-scale growers in remote regions, there is in reality no shortage of processing facilities in the U.S. (as seen in the map below). What grassfed beef producers lack is convenient and cheap access, particularly to federally inspected plants that allow meat to be sold outside of their own states.[81] For example, producers that utilize very small plants often have to schedule six months in advance in order to process their cattle during busy seasons, even though they may not know when they will finish the animals. There is also no USDA-inspected plant in the state of Wyoming.

In the conventional system, processing plants are very large: the 13 largest facilities can process 5,000 head per day.[82] Their large scale allows the meatpackers to bring down costs for themselves and their customers. According to industry experts, large processors can charge as little as $10/head for slaughter and $100-120/head for processing (i.e., slaughtering plus fabrication). Sometimes they even pay customers to slaughter animals since they can make big profits from selling large amounts of "drop," i.e., byproducts such as the hide, offal and tallow, to specialized domestic and overseas markets.

Contrastingly, nearly all grassfed finishers and branded programs work with local and regional processors since they do not have the volume to interest the large facilities. Mid-sized, regional facilities have the capacity to slaughter 200-1,000 head of cattle per day,[83] and the smallest facilities can only process 300 cattle or fewer per year.[84] Due to the lower volume, these plants charge much more compared to the large processors. The smallest processors may also have to give away or pay to have their "drop" taken, instead of making money from it. The cost for processing can be $150-300/head (net of "drop" credit) for larger branded programs and as much as $400-800/head for small-scale producers.[85] The minimum volume required to have the "Big Four" or other large plants process the animals is estimated to be 500

FIGURE 3.5 Distribution of small cattle slaughter plants in the U.S., 2010



Note: Small plants slaughter <10,000 head per year.
Source: USDA FSIS

head of cattle per week or 26,000 head per year. Most independent grassfed finishers sell fewer than 50 animals a year, and no branded grassfed programs are at this scale yet either.

Another challenge is cattle transportation costs. The cost of trucking animals to and from a processing facility is usually charged by the load (approximately 40 animals per load). Many small-scale producers only sell a few head at a time, so they have to deliver animals themselves or pay a much higher cost per head to send them to the processor.[86]

DISTRIBUTION

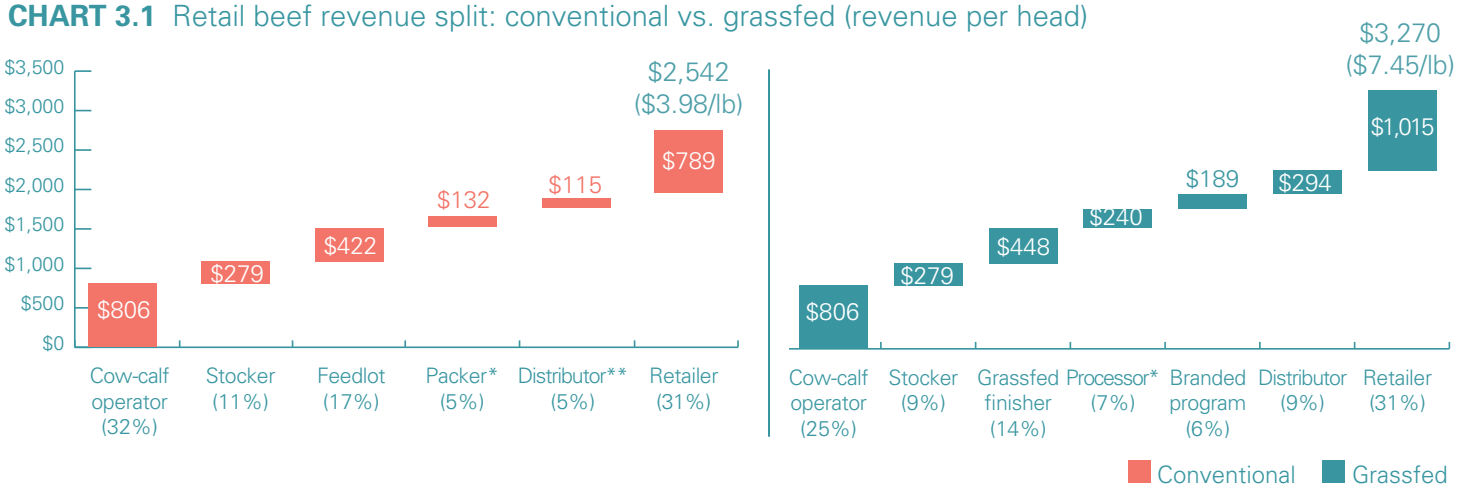
In the conventional beef system, large distributors are in place to move beef to the retail and food service operators. As a commodity business, the distributors profit by charging a thin markup of just 7-10% across large volumes.[87] The role of distribution is also increasingly played by the meatpackers themselves, further streamlining the process.

Grassfed branded programs and producers do not have their own distribution network and have to work with third-party specialty meat distributors. These distributors charge a 12-25% (or higher) markup on the product, as they are dealing with niche buyers and low volumes. While some mainstream distributors are selling small volumes of grassfed beef, they will only carry it at scale if more customers, who are very price-sensitive, express interest in buying.

CONVENTIONAL VS. GRASSFED SUPPLY CHAIN ECONOMICS

The analysis below compares the revenue earned at each segment of the supply chain for conventional and grassfed beef produced in the U.S. Our assumption is that the conventional beef is sold via a meatpacker, while the grassfed beef is sold through a branded grassfed program, to a retailer. The cost of production at the cow-calf and stocker phase is identical for the two beef categories, but grassfed beef becomes more expensive at every step of the chain, starting with the finishing phase. After passing through the supply chain, a conventional grain-finished animal would effectively be sold at a price of $2,542/head at the retail level based on 2006-2015 average cattle prices. A domestically produced grassfed animal, on the other hand, would amount to a price of $3,270/head. While grassfed cattle prices change depending on prices of conventional cattle, the implied 29% premium becomes magnified on a retail price per pound basis since a typical grassfed animal yields less meat. On a retail price per pound of meat basis, the conventional meat would sell for $3.98/lb compared to $7.45/lb for grassfed, reflecting an 87% premium (assuming no retail discount).[88] There are, however, grassfed beef producers who have heavier cattle and higher carcass and retail meat yield than the numbers assumed in this analysis, so their premium would be less on a per pound basis. Appendix 2 contains an explanation of the assumptions used in this analysis.

CHART 3.1 Retail beef revenue split: conventional vs. grassfed (revenue per head)



Note: % in horizontal labels indicates % of revenue received by each segment.

Percentage of revenue split shown for each segment may not add to 100% due to rounding.

No backgrounding stage is assumed in the conventional supply chain.

*Excludes "drop" revenue from selling byproducts such as offal and hide. In the grassfed beef value chain, the processor typically only provides contracted processing services and does not buy the animal.

**Packer is often also the distributor in the conventional supply chain. Some may also own feedlots. Some packers have their own beef branded programs.

See Appendix 2 for assumptions and methodology.

Source: SLM/Bonterra

Photo: Savory Institute, at TomKat Ranch

Since the grassfed supply chain is longer and less efficient, only a small portion of the grassfed premium gets passed back to the producers. The revenue percentage split indicated in the graphs above shows that the cow-calf operator, stocker operator and finisher on the grassfed side all receive a smaller portion of the revenue dollar compared to their conventional counterparts. Since the conventional supply chain is more streamlined and efficient, the intermediaries (namely the packer and distributor) take a smaller cut of the revenue so that a higher proportion is distributed back to producers.

Despite the markups, no segment is currently making a huge profit in either grassfed or conventional beef. Every segment's profit is thin and can easily turn into a loss. For example, for retailers, beef is often a loss leader used to attract customers to the store. The commodity beef business is even more cutthroat than grassfed: Each segment is often making money at the expense of another; it is hardly ever the case that they are all making a profit at any one time.[89]

The current inefficiency in the grassfed beef supply chain has created opportunities for entrepreneurs and innovators to find new, alternative ways of marketing beef more directly to consumers, as discussed in the "Alternative marketing strategies" section below. But even if the supply chain becomes cheaper and more efficient, the cost of finishing for most grassfed beef producers is still high compared to grain finishing and compared to grass-based production overseas. In the next chapter, we discuss why that is the case and explore what can be done to lower the cost of grassfed beef production.

ALTERNATIVE GRASSFED BEEF MARKETING STRATEGIES

Can grassfed beef producers market their beef differently so that less revenue is lost to the intermediaries? As we shall see, direct marketing is no longer limited to farmer's markets, community-supported agriculture (CSA) and individual farm websites. Various innovative distribution and marketing strategies that do other forms of direct marketing have emerged over the years. Their common objective is to bring transparency to consumers and allow more revenue to flow back to the producers. The following are several examples of such business models.

Massachusetts-based Walden Local Meat Co. buys local grassfed cattle and other pasture-raised livestock and direct markets the meat through a monthly, customized, e-commerce-enabled share program to customers. Selling portions comprised of different cuts, Walden uses a proprietary algorithm to balance customer preferences and the movement of whole carcasses across wholesale and retail channels. Other brands have established a vertically-integrated marketing strategy: Producers such as US Wellness Meats and Prather Ranch have their own meat shops, where they also sell sustainable meat on behalf of other vetted producers. Other producers such as Belcampo, Adena Ranch and White Oak Pastures own processing facilities and deliver a farm-to-fork experience to consumers through their own restaurants. By establishing trust and loyalty among consumers, these alternative marketing models have the potential to scale from a local to regional level.

Photo: Carman Ranch

CHAPTER 4 U.S. GRASSFED BEEF PRODUCTION

In this chapter, we turn our attention to grassfed beef producers in the U.S. We explore their current operating models and compare their production costs with other beef systems. We assess whether grassfed beef can be produced at lower cost, as this could be the key to allowing U.S. producers to compete with domestic conventional beef and grassfed imports. A final question is whether there is enough land available in the U.S. to support a scaled-up grassfed production system.

OVERVIEW OF GRASSFED BEEF PRODUCERS

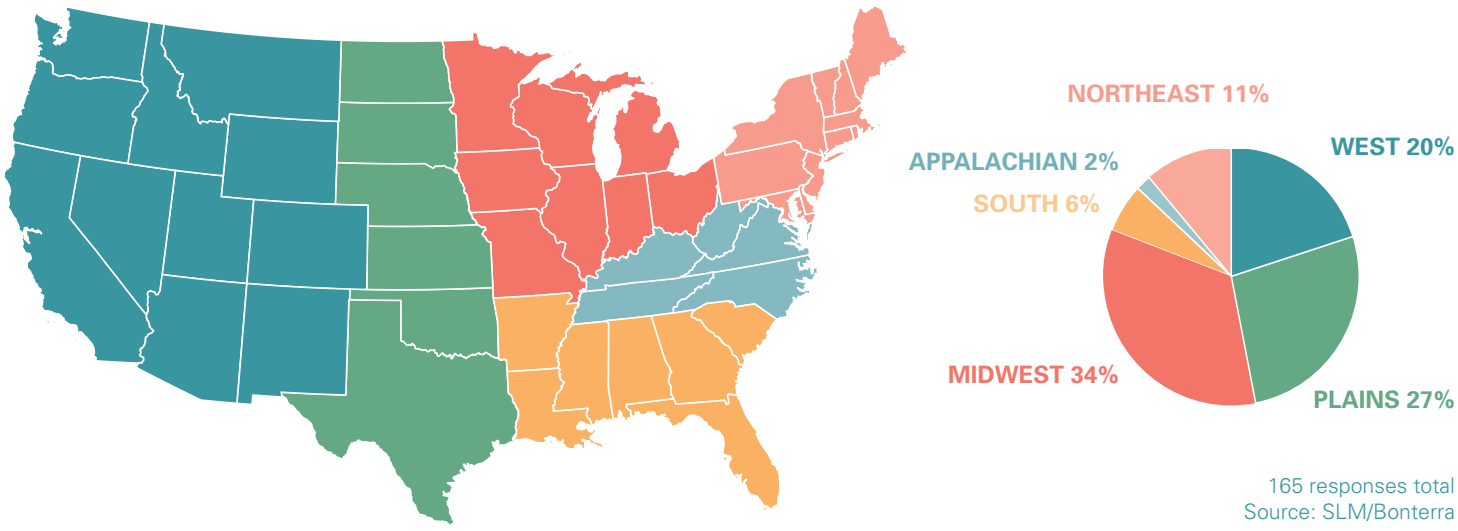
Cattle production[90] ranks first in U.S. agricultural commodity cash receipts and is one of the most important industries in the nation, accounting for $78.2 billion of revenue in 2015. There were 92 million head of cattle and calves in the U.S. at the end of 2015 and close to 30 million head slaughtered that year.[91] More than 600,000 farms and ranches specialize in cattle production.[92]

Grassfed beef production is a tiny piece of this large industry. With just over 100 serious grassfed beef finishers in 1998, the industry has grown to more than 3,900 producers at the end of 2016. They currently produce an estimated 232,000 head of grass-finished cattle for slaughter each year.[93] They utilize a mix of irrigated and non-irrigated pastures. Most supplement native grasses with purchased winter hay or planted cover crops such as rye, oats and hairy vetch. Those who emphasize regenerative grazing feed their cattle a diverse mix of forage.

In late 2016, we distributed a survey to grassfed beef producers and received 165 responses.[94] The total number of grass-finished cattle marketed by the respondents represents roughly 8% of the total sold by the U.S. grassfed beef industry. The results from this survey provide a sense of the current structure of the U.S. grassfed beef industry. The data is consistent with the other sources analyzed for this report.

The survey confirms that grassfed beef production is well dispersed throughout the U.S., similar to cow-calf operations. The average age of surveyed farm/ranch operators is 54.1 years, a testament to the aging agricultural demographic (although slightly below the national average age of 58.3 for all farmers).[95] On average, respondents have been raising grassfed cattle for nearly 11 years. A majority of them are small-scale producers with a median of 40 mother cows in their herds. Unlike the specialized roles found in the conventional system, 70% of the respondents are fully integrated producers, holding cattle from birth to slaughter. They also have more diverse farm enterprises: only 58% of the surveyed producers rely on cattle and beef sales for more than half their farm revenue, compared to 85% for conventional beef cattle farms.[96]

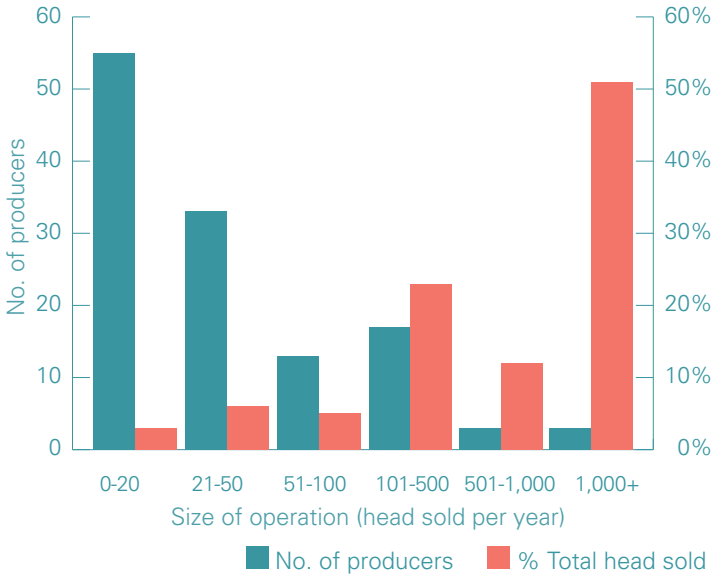
FIGURE 4.1 Grassfed production distribution by producer count based on 2016 producer survey



165 responses total
Source: SLM/Bonterra

Of the survey respondents, 77% are "finishers," meaning that grass finishing is part or all of their cattle operation. Their finished cattle are slaughtered at an average age of 25 months, consistent with the 24-28 month industry norm.[97] They sell a median of 25 grassfed cattle per year, but some of them market a much higher number. The very small-scale finishers (selling up to 20 head of grassfed cattle per year) make up 44% of the finishers in our survey, but they only account for 3% of the 17,750 cattle sold by all surveyed finishers. On the other hand, those who finish at least 1,000 head a year constitute 2% of the finishers, but account for 51% of the total head sold.

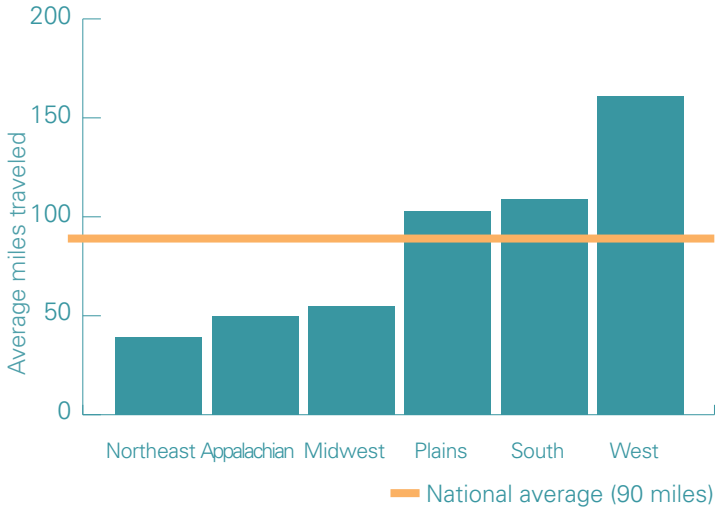
CHART 4.1 Grassfed finishers distribution by size of operation



124 responses out of 129 finishers surveyed
Source: SLM/Bonterra

The surveyed finishers' cattle are transported on average 90 miles to a processing facility. The distance varies widely by region, with those in the Northeast traveling only 39 miles, versus an average of 161 miles in the West. Ten percent of operators reported transporting their cattle 200 miles or more. Since most of the respondents are small-scale producers, transporting animals can be a costly and/or logistically challenging task.

CHART 4.2. Average miles traveled by finished cattle to processor

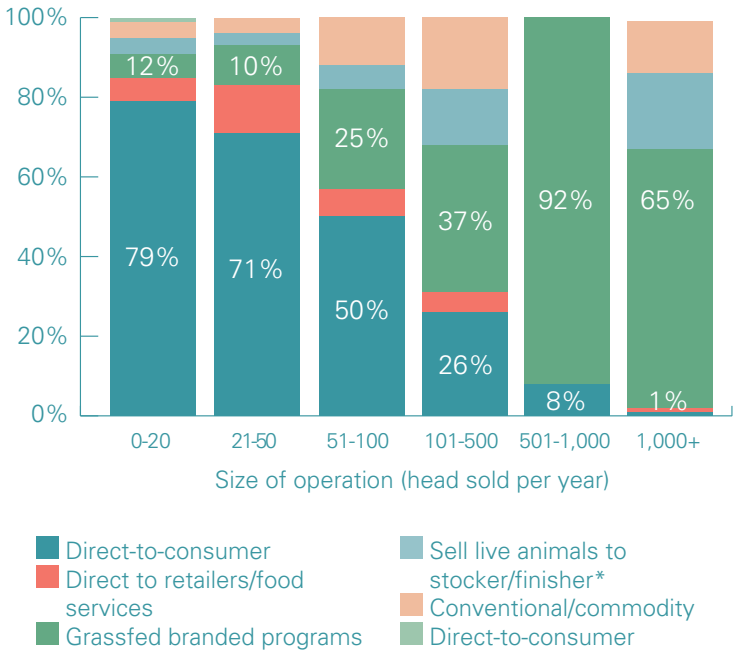


126 responses out of 129 finishers surveyed
Source: SLM/Bonterra

The channels used to sell animals vary widely according to operation size. Small producers selling less than 20 head a year generate 79% of their revenues by selling directly to consumers. Large producers selling more than 1,000 head a year earn only 1% of their revenues from the direct-to-consumer channel, and instead rely on branded grassfed programs for 65% of their revenues. This reflects the relative small size of direct markets, the resource intensiveness associated with direct marketing and also the high costs and operational challenges of sourcing from many very small producers for branded grassfed programs.

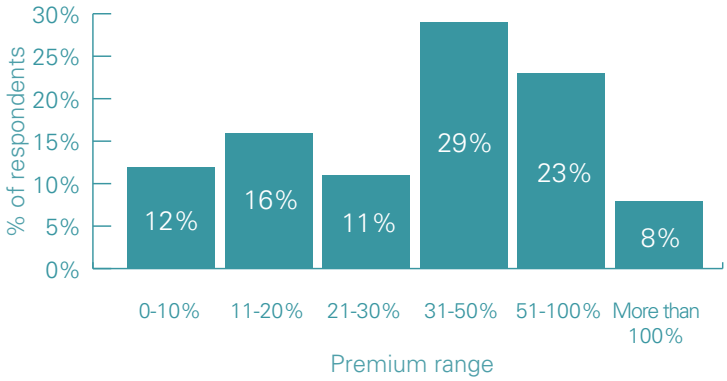
Photo: Carman Ranch

CHART 4.3 Average percent of grassfed beef revenue by sales channel



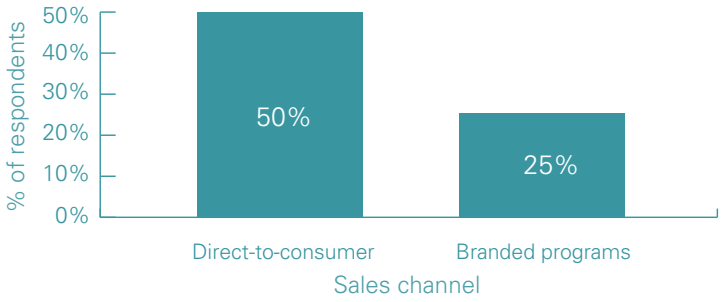
*represents those who are also cow-calf operators and stockers
128 responses out of 129 finishers surveyed
Source: SLM/Bonterra

CHART 4.4 Current grassfed live weight premium received over conventional beef



116 responses out of 129 finishers surveyed
Source: SLM/Bonterra

CHART 4.5. Current grassfed median live weight premium over conventional beef



54 and 14 respondents, respectively, with at least 90% of their total beef revenue generated from direct-to-consumer and branded programs
Source: SLM/Bonterra

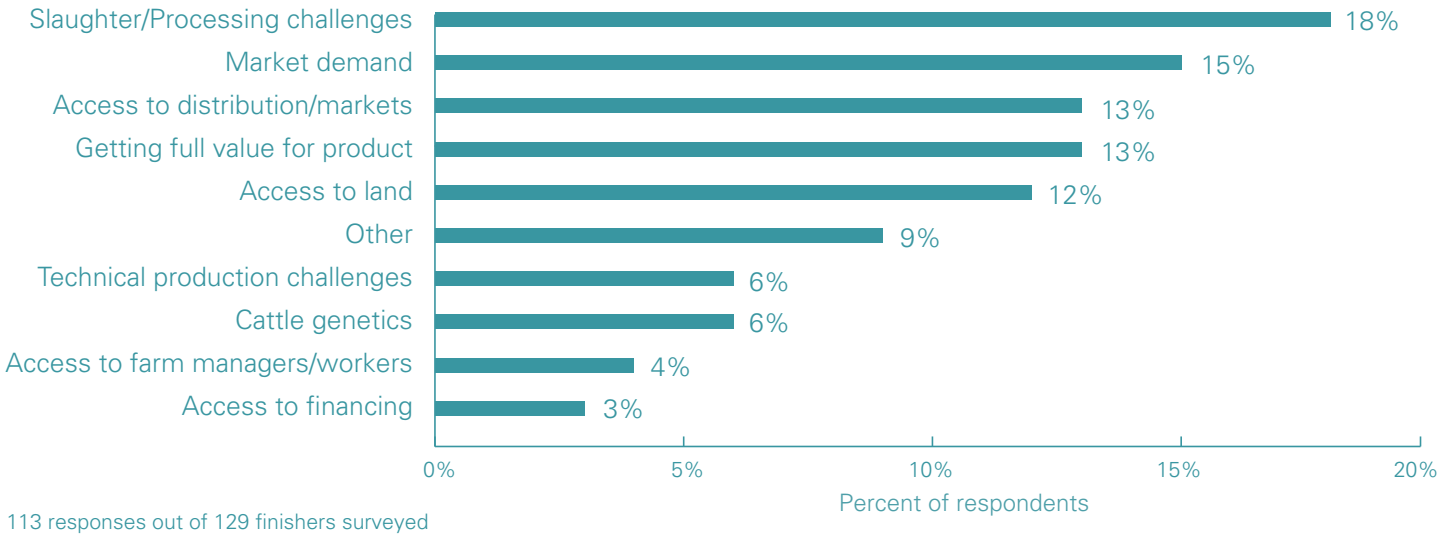
GRASSFED PREMIUM AT PRODUCER LEVEL

Of the surveyed finishers, the most common level of price premium received is 31-50% over conventional beef live weight prices. But a wide range of price premiums are indicated, with 31% of producers receiving a premium of above 50% and 28% of producers receiving less than 20%. The strongest determinant of price premiums is the choice of sales channel. Producers selling direct-to-consumer command a median price premium of 50% over conventional live weight prices (although it should be remembered that they must also incur extra marketing and processing costs), whereas those selling through branded programs receive a median premium of 25%. This is consistent with our research on typical premiums paid by branded grassfed programs.

TOP CONCERNS FOR GRASSFED FINISHERS

Despite the premiums, producing grassfed beef continues to pose challenges. Processing was the top concern for 18% of the surveyed finishers, particularly for small-scale producers. They cited the challenges of traveling long distances to processors, not being able to schedule dates they want for slaughter and the shortage of processors that are organic or inspected by the USDA that are also willing to work with small producers. Other top concerns are linked to selling beef, namely market demand, getting full value for product and access to distribution/markets. These include issues such as traveling long distances to farmer's markets, inconsistent sales from direct marketing with high marketing costs and local markets being saturated or uninterested in grassfed. These challenges pertain especially to small operations, particularly those in remote areas where the local customer base is limited.

CHART 4.6. Grassfed finishers' top concerns



113 responses out of 129 finishers surveyed
Source: SLM/Bonterra

GRASSFED BEEF PRODUCTION FROM OVERSEAS

The demand concern cited by the survey respondents is not unwarranted. There is a much bigger force shaping the U.S. grassfed beef market that is beyond the control of U.S. producers — cheap grassfed beef from overseas. Unbeknownst to many people, grassfed beef imports account for an estimated 75-80% of total U.S. labeled and unlabeled grassfed beef sales by value.[98] This is a vastly higher share than for beef in general: Imports accounted for only 9% of all U.S. beef supply volume in the five years to 2015.[99]

Top importers of grassfed beef include Australia, New Zealand and South American countries such as Brazil, Argentina and Uruguay.[100] Australia is responsible for an average 31% of all U.S. beef imports from 2011 to 2015, with grassfed beef (both labeled and unlabeled) accounting for 97% of its shipments.[101] These countries have large areas of grassland or rangeland devoted to livestock and a suitable climate for year-round grazing, hence, grassfed production is still the norm.

Overseas producers such as those in Australia can produce large volumes of grassfed beef that is cheaper than domestic grassfed beef, even after taking shipping costs into consideration. The beef is processed in overseas meatpacking plants (some of which are owned by the same top players as in the U.S.), imported with or without the grassfed label and inspected by a USDA-approved plant before being distributed to meatpackers and/or branded programs.

American consumers are often not aware that they are buying imported beef. Since the USDA's December 2015 removal of the COOL (Country of Origin Labeling) requirement, beef produced overseas that passes through or is processed in any USDA-inspected plant (which, for food safety reasons, is a requirement for all imported beef) can be labeled as a "Product of the USA."[102] Meatpackers, distributors and retailers can now withhold provenance information from consumers, which works in favor of international meatpackers, such as JBS and Cargill, that import beef from multiple countries to make lean trim. Individual U.S. states that want to make COOL mandatory must pass their own state laws; the state of Colorado is in the process of trying to pass such a bill.[103]

ECONOMICS OF GRASS FINISHING

U.S. grassfed beef producers, therefore, face competition on two fronts: domestic feedlots with efficient supply chains, and Southern Hemisphere countries producing large quantities of grassfed beef for export. How can they compete? What profitable business models are U.S. producers using now? And how can U.S. grassfed feed producers come close to the costs of production of the conventional system or grassfed imports?

For this report, we collected data on the economics of beef finishing from a range of sources. We have used this to analyze and compare the operational and financial performance of five different systems. We start by looking at a small U.S. grain-finishing feedlot selling approximately 3,500 live animals per year to conventional packers (Scenario A), based on data from Iowa State University.

U.S. GRASSFED BEEF PRODUCTION

(Although most of the fed cattle in the U.S. are finished in much larger feedlots with one-time capacity of 32,000 head or more, enterprise budgets and estimated costs for these large operations are not publicly available.) We then look at the average returns of a grassfed/grass-finishing operation in Southern Australia selling by carcass weight to export-oriented processors (Scenario B), based on data published by Meat & Livestock Australia (MLA).[104]

The next two scenarios are based on data collected for this report from U.S. grassfed finishers and industry experts. They are exemplary case studies that reflect two existing profitable business models used by some of the successful grassfed beef producers in the U.S. today. The first is a small-scale grassfed operation selling individual beef cuts direct-to-consumer at high prices from a production of 40 head each year (Scenario C). The second is a large-scale grass-finishing operation selling 4,000 head each year by carcass weight to branded programs (Scenario D). (Numbers in both scenarios have been modified slightly to respect the sensitive nature of information obtained from producers.)

Finally, we assess the economics of a very large-scale grass-finishing operation in the U.S. selling 10,000 head per year by carcass weight to branded programs (Scenario E). No such operation currently exists in the U.S. — this is an aspirational case study — but we are aware of groups that are developing this type of model, and it indicates what could be achieved with greater scale.

Each scenario assumes the purchase of a feeder animal weighing 750-800 pounds at the start of the finishing phase, looks at the cost of bringing this animal to a finished weight and calculates revenue based on price per pound. All the grassfed scenarios assume a "pure" grassfed system in which cattle are fed only forage and not a "grass feedlot" model. Key operational metrics are the average daily weight gain and the cost of gain per pound. The key financial metric is EBITDA margin per animal (i.e., earnings before interest, tax, depreciation and amortization, divided by revenue). A full explanation of the methodology and assumptions used for the analysis can be found in Appendix 3.

The results are shown in the table to the right. The following sections present the scenarios in more detail and assess the implications of the data.

Photo: Carman Ranch

TABLE 4.1: Sample beef finishing operations by size and production system (per head basis)

SCENARIO	A: U.S. GRAIN-FINISHED FEEDLOT	B: SOUTHERN AUSTRALIA GRASSFED	C: U.S. EXEMPLARY GRASSFED, SMALL	D: U.S. EXEMPLARY GRASSFED, LARGE	E: U.S. ASPIRATIONAL GRASSFED, VERY LARGE
Marketing strategy	Sell live cattle to processor	Sell live cattle to processor	Direct marketing to consumers	Sell live cattle to branded program	Sell live cattle to branded program
Marketed products	Live cattle	Whole animal sold by carcass weight	Individual beef cuts	Whole animal sold by carcass weight	Whole animal sold by carcass weight
Time period (CY - calendar yr; FY - fiscal yr)	CY2016	FY 2012-2015 (3-year average)	CY2016	CY2016	CY2016
Average no. of head sold per year	3,450	113	40	4,000	10,000
Feeder cattle entry weight, lbs	750	794	800	800	800
Finished cattle live weight, lbs	1,250	1,279	1,150	1,240	1,240
Carcass yield	64%	55%	57%	59%	59%
Finished cattle carcass weight, lbs	800	699	656	732	732
Weight gained, lbs	500	485	350	440	440
Average daily gain (ADG), lbs/day	3.0	1.3	2.2	2.5	2.5
Time to achieve finished weight, days	167	367	159	176	176
Retail meat yield	N/A	N/A	55%	N/A	N/A
Implied volume of beef sold, lbs	800	699	361	732	732
Live cattle price, $/lb*	$1.20	$0.77	$2.79	$1.49	$1.49
Carcass or meat price, $/lb*	$1.87	$1.40	$8.90	$2.52	$2.52
Total revenue	**$1,499**	**$982**	**$3,209**	**$1,844**	**$1,844**
Cost of feeder cattle	$1,084	$577	$1,088	$1,088	$1,088
Total feed/pasture cost	$291	$27	$340	$300	$200
Other operational costs	$73	$59	$230	$142	$90
Total operational costs	**$1,447**	**$663**	**$1,658**	**$1,530**	**$1,378**
Gross margin	**$51**	**$319**	**$1,551**	**$314**	**$466**
Gross margin %	3%	32%	48%	17%	25%
Land lease	$5	$62	$120	$53	$42
Management	$16	$96	$500	$48	$27
Other overhead	$25	$42	$300	$140	$80
Total overhead	**$46**	$200	$920	$241	**$149**
Processing costs			$500		
EBITDA	**$5**	**$119**	**$131**	**$73**	**$317**
EBITDA margin	0%	12%	4%	4%	17%
Cost of feed/lb of weight gained	$0.58	$0.06	$0.97	$0.68	$0.45
Cost of gain, $/lb gain	$0.82	$0.59	$4.26	$1.55	$1.00

Note: Fiscal year for Australian beef industry ends in June

* Live cattle prices are implied only for Scenarios B-E since their revenue is on a meat (Scenario C) and carcass (Scenarios B, D and E) basis. Carcass/meat price for Scenario A is implied only since it sells on a live cattle basis.

Source: SLM/Bonterra

CONVENTIONAL U.S. GRAIN-FINISHED FEEDLOT

According to this analysis, the U.S. grain-finishing feedlot (Scenario A), which assumes the 2016 average corn price of $3.48/bushel,[105] is barely profitable and has the lowest EBITDA margin of all models. Feedlots' profitability is largely determined by the commodity price cycles for cattle and corn, resulting in wide swings in profit and loss. This explains why feedlots also sell feed, pen space and yardage (custom feeding on behalf of clients). In years with high grain prices, the cost of gain can be in the range of $1.00-1.50/lb, even for the largest feedlots in the country,[106] which would render many feedlots unprofitable were they not protected against losses through hedging and forward contracts. Sterling Marketing estimates that feedlots lost a cumulative unhedged $4.7 billion in 2015, compared to an unhedged profit of $3.9 billion in 2014 and losses of $1.1 billion in 2013.[107] Financial losses would have been even more significant if corn prices were not kept artificially low; from 1995 to 2014, $94 billion of corn subsidies were disbursed by the U.S. government.[108] Despite the feedlot industry's attempt to reduce operating costs through consolidation and alternative forms of cheap feed, the industry's long-term financial sustainability is questionable given the wide fluctuations in grain prices. Contrastingly, the U.S. grassfed industry and Australian agricultural sector operate with no government subsidy, so the actual costs of production are already embedded in the price paid by the consumer.

AUSTRALIAN GRASSFED BEEF OPERATION

The Australian grassfed property (Scenario B) has the highest EBITDA margin of any of the scenarios based on existing operations. Its cost of gain is 28% lower than the U.S. feedlot and 62% lower than the existing large-scale U.S. grassfed operation (Scenario D). In Australia, the low cost of grassfed beef production is predominantly due to the low cost of feed. This is attributed to favorable environmental conditions, which allow pastures to grow throughout the year without irrigation or substantial fertilizer or chemical inputs. This is different from many existing U.S. grass-finishing operations in which high feed costs are associated with use of chemical inputs or with producing/buying feed. Despite the low average daily gain, Australia's low production and feeder acquisition costs more than offset the lower revenue generated per head.

SMALL U.S. DIRECT MARKETING PRODUCER

Our research indicates that many U.S. grassfed beef producers struggle to be profitable, especially if land and labor costs are fully reflected at market values. These operations, like many other farm enterprises in the U.S., are implicitly subsidized by benefiting from "free" land (often inherited) or unremunerated family labor. But some producers are consistently profitable; our research indicates that they use one of two main strategies.

The first is direct marketing to consumers. This is the strategy employed by the small-scale producer profiled in Scenario C. This type of producer has the highest cost of production on a per head basis of any of the scenarios, but a robust direct marketing strategy, built on consumer trust, can lead to a profitable small-scale operation. Sales prices averaging at least $8.50/lb of meat are required to make these operations work. Producers we interviewed achieved an average price of close to $9.0/lb in 2016, approximately an 84% premium to the retail conventional beef price in July 2016 (as provided by Nielsen). It is only with this level of high premium that small-scale producers can be profitable, since apart from production costs, they also have high processing and overhead costs and low retail meat yield (i.e., less meat to sell) as they may not have access to the best-equipped processors. The majority of U.S. grassfed beef producers pursue this type of marketing strategy, although, because of their small scale, they do not account for the majority of grassfed cattle finished in the country.

LARGE-SCALE U.S. OPERATION SELLING TO BRANDED PROGRAMS

The second profitable strategy employed by U.S. grassfed beef producers is achieving sufficient scale to lower costs of production while selling animals via branded programs. Our exemplary large-scale operation in Scenario D achieves a similar EBITDA margin to the small-scale producer, but with a much lower cost of gain — $1.55/lb vs. $4.26/lb. Through good management, this producer is also able to achieve an average daily weight gain of 2.5 lbs/day and finish cattle to a heavier live weight of 1,240 pounds. Selling to branded grassfed programs allows these producers to sell at an average price of $2.52/lb of carcass weight in 2016, reflecting an approximate 24% premium compared to conventional beef on a live weight basis.[109] For many producers, this provides sufficient additional revenue to be profitable, as they keep production cost low through economy of scale. Production cost may also be more stable, as it is not impacted by fluctuating grain prices.

PRODUCER PROFILE:
GABE BROWN AND BROWN'S RANCH

There are some producers that manage to achieve the high price premiums of direct marketing while also taking advantage of low costs of production. Brown's Ranch in North Dakota is one example. It is a medium-scale cattle operation but it achieves success not merely through scale but by integrating cattle production with other farming activities in the form of a "stacked enterprise."

Gabe Brown, along with his wife, Shelly, and son, Paul, own and operate a diversified 5,200-acre farm near Bismarck, North Dakota. Gabe, a pioneer of the soil health movement, emphasizes regenerating soils as the foundation for increasing crop yields, improving livestock forage productivity and restoring ecosystem function. The farm is non-irrigated and is comprised of 2,000 acres of native pasture, 2,000 acres of cropland, 1,000 acres of former cropland that has been seeded back to perennials and 200 acres of trees and farmstead. Through a stacked enterprise model, the Browns integrate their grazing and no-till cropping system with a wide variety of cash crops and multispecies cover crops, along with poultry, swine, sheep and grassfed beef that are managed using holistic-planned grazing. The diversity and integration has regenerated the natural ecosystems on the ranch without the use of synthetic fertilizers, pesticides or fungicides. Brown's Ranch continues to grow its profit while shrinking farm acreage. "As you stack enterprises," Gabe explains, "you become more profitable and are better off running more enterprises on less land."

Brown's Ranch raises 300 cow-calf pairs and 200-600 yearlings, and finished 150 grassfed cattle in 2016. Cattle are moved once per day across a large number of paddocks established with temporary fencing. Most paddocks are grazed only once every 15 months, except during the final 60 days of the fattening phase, when finished cattle are moved between two and six times per day to nutrient-rich forage. Cattle are finished throughout the year at around 1,250 pounds and 24-30 months of age. Most of the finished beef is sold to consumers directly through their website, Nourished by Nature, though the ranch has previously sold to branded programs.

A few factors have contributed to the overall success of the cattle business: the herd has genetics that have been carefully selected to excel on grass, and by moving the calving season to the milder months of mid-May and June, input and labor costs dropped significantly due to better calf vigor. Despite generating over $1,500 of net profit per head (see below), the cattle operation is the farm's least profitable livestock enterprise per dollar invested. However, cattle add tremendous value to the ranch by combating invasive grasses and maintaining soil and ecosystem health. To Gabe, "cattle are without a doubt the tool in the Great Plains to regenerate land, as they resemble bison most closely."

Gabe (right) and Paul (left) Brown

Brown's Ranch grassfed beef production cost per head

PHASE	DAYS	COST/DAY	COST*
Nursing calf	300	$1.48	$444
Weaning calf	45	$1.30	$59
Grazing natural pasture	150	$0.70	$105
Grazing cover crop	90	$0.83	$74
Bale grazing	90	$2.20	$198
Finishing	60	$0.85	$51
Land**			$68
Cow depreciation			$300
Total	**735**	**$1.77**	**$1,299**

TOTAL NET PROFIT PER HEAD	
Gross income from retail cuts	$3,452
Beef production cost	($1,299)
Processing/marketing/transport	($596)
Total net profit per head	**$1,557**

* includes labor and machinery
** For this analysis, we have assumed a land lease rate of $17/acre for non-irrigated pastureland based on USDA 2016 data for North Dakota and assumed an average of 4 acres per cow-calf pair per interview with Brown's Ranch.
Source: Brown's Ranch

ASPIRATIONAL VERY LARGE U.S. OPERATION SELLING TO BRANDED PROGRAMS

Only a handful of U.S. grassfed operations currently finish more than 5,000 head per year. But some operators are developing models for very large-scale grass-finishing operations finishing 10,000+ head on multiple properties. They are exploring opportunities to convert highly productive pastureland into large-scale finishing, to transform degraded cropland into pasture or to use intensively managed grazing to rehabilitate grassland that has been degraded through poor management. We have developed a hypothetical case study (Scenario E) based on some of these models and our own analysis of what can be achieved with scale.

In this scenario, the proposed operation finishes 10,000 head annually and sells to branded programs. An operation of this size can benefit from meaningful economies of scale. This aspirational case assumes that the finisher receives the same revenue per head as the current U.S. exemplary large-scale operation (Scenario D). By employing best-practice regenerative grazing methods, pasture cost can be lowered to $200/head. (Some of the producers we studied are already approaching this level of feed cost.) With the benefits of scale, it is conceivable that cost of gain could be reduced significantly to approximately $1.00/lb, a level that is only 22% above the 2016 cost of U.S. feedlots (Scenario A). At this production cost, the aspirational case can generate an EBITDA margin that is higher than all other existing systems.

Establishing grass-finishing operations of this size and efficiency is one way that U.S. grassfed production can compete with the feedlot system. This scale of operation should enjoy lower processing and distribution costs, allowing the cost savings to flow along the supply chain and reduce prices for consumers. This would help reduce the retail price premium for grassfed beef to the 20-30% level indicated by meat buyers we interviewed that may unlock mass consumer demand and still be profitable for producers. It is at this point that grassfed beef might start to displace conventional feedlot beef in a significant way and move from a niche to the mainstream. Although overseas grassfed production may still be cheaper, the future growth of U.S. grassfed beef consumption should not be filled completely by imports because of the crucial ecological and social benefits well-managed grassfed operations bring to the country.

SCALABILITY OF GRASSFED BEEF PRODUCTION

Scaled-up, low-cost U.S. grassfed beef production has the potential to compete more strongly with conventional U.S. feedlots. But how feasible is this? Is there enough land in the U.S. to implement grassfed beef production on a large scale? Supporters of industrial feedlots often argue that producing the same quantity of beef on pasture would be impossible. However, a close analysis of U.S. land resources indicates that it is feasible in biophysical terms. (This section draws on research by Dr. Allen Williams of Grass Fed Insights, LLC.[110])

The U.S. currently produces approximately 30 million head of grain-finished cattle per year. Assuming 864 pounds of carcass weight for each animal,[111] this equates to annual production of 26 billion pounds of grain-fed beef. A well-finished grassfed animal has a carcass weight of at least 708 pounds,[112] so roughly 36.6 million head of grassfed cattle would be needed to produce the equivalent amount of beef.

Where is the land to finish an additional 36.6 million head of cattle on grass? The feedlot industry cannot exist without abundant sources of grain. The USDA estimates 2016 corn acreage at 94.1 million acres. Approximately 15% of this corn goes to finishing beef cattle,[113] so transitioning this acreage to grass would free up 14.1 million additional acres of pasture. Cattle feed also includes soybeans, wheat and other small grains, grown on an estimated 3.5 million acres, which could also be converted to grassland. This high-productivity former cropland could produce an average of 5.7 tons of grass and legume forage annually — enough to finish 1.88 animals per acre.[114] In other words, if the 17.6 million acres currently used to grow grain for feedlots were converted to pasture, there would be enough land to finish 33 million head of cattle, very close to the targeted 36.6 million. Indeed, if only a small portion of the row crop acreage were planted with cover crops for cattle grazing every year after the grains were harvested, grassfed beef production could already increase significantly.

There are also other types of land that could be used to finish cattle on grass. The U.S. holds about 15-20 million acres of idle grasslands. Through proper grazing and forage management (and infrastructure upgrades for fencing and stockwater), 10 million of those underutilized acres could average annual production of 3 tons of forage per acre and support at least 10 million head of grassfed cattle annually. Finally, there are approximately 20 million acres enrolled in the USDA Conservation Reserve Program

(CRP). If 30% (six million acres) were transitioned to grazing, this land could finish another four million head.[115] (Although CRP land can provide important ecosystem services, many CRP areas are overtaken by invasive species, as animals are not allowed to graze them, and could benefit from regenerative grazing practices.[116]) Combining all these sources of land could open nearly 34 million acres to roughly 47 million head of grassfed beef cattle, as summarized below.

TABLE 4.2 Land availability for finishing cattle on grass in the U.S.

Land type	Potential acres to convert (million)	Implied no.grass-finished cattle (million)
Row crop	18	33
Idle grassland	10	10
Conservation Reserve Program (CRP)	6	4
Total	**34**	**47**

Source: Dr. Allen Williams "Can We Produce Grass Fed Beef at Scale?" https://grassfedexchange.com/blog/can-we-procuce-grass-fed-beef-at-scale

The analysis above assumes that the targeted number of additional grassfed cattle is achieved by bringing more land under grassfed production systems. But there may be another way to achieve a similar goal — increasing production on existing grasslands. There are 762 million acres of grazing rangeland and pasture in the U.S. Many are not intensively managed and have low stocking density. Increasing the stocking density by 33% through intensive rotational and other regenerative grazing methods would accommodate enough grass-finished animals to replace all the grain-finished cattle in the U.S. without using more land, while also regenerating soil.[117]

Some may challenge this vision by saying that even if it can be done, it should not be done, as putting all those extra cattle on grass would have a damaging effect on the environment. But wild ruminants once roamed North America without damaging the environment and in fact played a critical role in creating fertile soils. Regenerative grazing methods of cattle and other species are important tools to restore grasslands. They have the potential to reduce greenhouse gas emissions, build soil health and improve water quality, while simultaneously increasing beef production and profitability for producers. Again, the type of grassfed beef matters.

It is unrealistic, of course, to expect grassfed beef to replace conventional feedlot beef any time soon given the amount of resources invested in the current beef system. While the above two analyses illustrate that it is theoretically feasible to significantly increase grassfed beef production in the U.S., we recognize that there are practical obstacles to doing so and only assume that some of the land will be converted in this way in the near term.

Grassfed production in the U.S. also faces a number of challenges that need to be overcome. Farmland prices have appreciated strongly over the last decade, while grain prices have come down sharply in the last three years, tipping the economic calculus further in the direction of feedlots. Cattle genetics are holding the grassfed sector back, as animals have been selected over decades to perform well in feedlots and not on pasture, and breeding may be required to improve feed conversion and carcass yield on grass. Year-round finishing can be difficult for many producers, especially during winter. Solving this requires intensive forage and grazing management.

Perhaps the biggest challenge is human resources. Because the grain-fed system has dominated the U.S. cattle industry for so long, there is a lack of skilled grassfed beef producers in the U.S., particularly for the grass-finishing phase. Respondents in our survey on average have just over 10 years of grass-finishing experience, which illustrates the relative youth of the sector (if not the ranchers themselves). Training, education and mentoring are required to develop high-caliber grassfed finishers.

Nonetheless, through a combination of bringing more land under grassfed production and increasing stocking density on existing pastureland, it is possible for the U.S. grassfed industry to expand substantially in the coming years. Indeed, domestic grassfed beef production continues to grow despite some of the production challenges discussed in this chapter. Of the producers we surveyed, 62% have increased their production of grassfed beef in the last three years and 75% expect to grow their production over the next three years.

CONCLUSION

Grassfed beef, when produced using regenerative grazing practices, can have many benefits for human health, animal welfare and the environment. Consumers are beginning to recognize this, and demand for grassfed beef is growing strongly. American cattle producers are responding by increasing their grassfed beef production. Some producers have carved out profitable businesses based on selling directly to consumers or via branded grassfed programs.

However, despite this recent growth, grassfed beef still represents only 4% of the total U.S. beef market. Labeled grassfed beef sells at such a high premium to conventional beef (70%) at retail that many consumers cannot afford it. A majority of this grassfed beef is not produced at home but imported from countries such as Australia. Can the U.S. grassfed beef market be scaled up? Can it make the transition from a delicacy for the few to a meat for the masses in the U.S.? Can it displace the conventional feedlot system in any substantial way? Our answer is yes, but it will require a number of actions:

1. The grassfed industry needs to focus on producing high-quality, well-finished grassfed beef year-round.

Expecting mainstream consumers to change their taste preferences or to embrace poorly marbled beef is unrealistic. Grassfed beef producers will need to meet the standards of marbling that the American consumer demands; the goal should be to produce nutritious beef with marbling quality equivalent to USDA Choice or Prime. They also need to finish and sell grassfed beef year-round to compete with conventional beef and overseas grassfed production. The good news is that this can be achieved. The best grassfed finishers in the U.S. are able to utilize the right forage quality, animal genetics and management skills to produce consistent, high-quality beef year-round. Indeed, beef connoisseurs and chefs often prefer the taste of grassfed cuts to grain-fed. Additionally, aggregating seasonal production from different regions of the country can result in the coordinated production of grassfed beef at scale year-round.

Management training and technical assistance is required for producers to rise to this level. Some of the leading grassfed finishers and producer associations are already providing this type of education, and further research on animal genetics and forage quality are being conducted. But best practices on cattle and land management need to become more widespread so the industry can "up its game" more quickly. Universities and other institutions are needed to devote more resources to improving and disseminating these best practices. In addition to non-profit efforts, for-profit investments in grassfed beef production can help spur technical advancements in these areas.

2. Stronger standards for the grassfed label accompanied by national "brand-building" campaigns are required to educate consumers about U.S. grassfed beef.

The grassfed beef sector is held back by consumer confusion over multiple overlapping claims: pasture-raised, "grassfed and grain-finished," "natural," antibiotic-free, hormone-free and organic. Some producers are taking advantage of the consumer's desire for healthy, sustainably reared meat by applying the grassfed label to animals that are raised in confinement and/or fed non-forage diets. This may only lead to more consumer confusion and devalue the meaning of the term "grassfed." In addition, there are a number of grassfed certification programs, but none are well known.

A positive recent development was the coming together of multiple grassfed certification programs to agree on a common set of principles.[118] These principles specify that, at a minimum, grassfed beef production should mean: feeding animals 100% grass or forage-based diet for their entire lives, providing limited, incidental non-grain supplementation not exceeding 1% for the total lifetime consumption of dry-matter intake and allowing continuous access to pasture or rangeland (except in the case of weather conditions that temporarily preclude grazing), in addition to several requirements on supplementation, animal welfare, drug use and verification.[119]

This collaborative is working towards unified market adoption of these grassfed principles, from retail to food services, to reduce end-user confusion. Ultimately, this initiative envisages establishing a market baseline that, accompanied by concerted national "brand-building" and awareness campaigns, would educate American consumers on the reasons for consuming U.S. grassfed beef and supporting U.S. grassfed ranchers. It would also help consumers and the market to discern meaningful grassfed claims from less meaningful ones and allow "pure" grassfed beef producers to differentiate themselves. Funding of marketing efforts and awareness campaigns may need to come from the grassfed industry and outside investors and could also benefit from the formation of a U.S. grassfed trade association.

There is also a growing parallel movement around regenerative agriculture that seeks to work across

agricultural commodities to standardize a definition for food grown in a manner that restores and maintains natural systems. While this is a nascent initiative, it could become an important pillar of the grassfed movement.[120]

3. Scale and aggregation are required to unlock supply chain efficiencies.

One of the most striking findings of our report is that much of the hefty price premium charged to consumers for grassfed beef at the retail level is not passed back to the rancher. Instead, it is absorbed by an inefficient supply chain that is very different from that of the conventional beef system. Our view is that the solution to this problem is not to construct a new, parallel supply chain but to utilize the infrastructure that has been created for conventional beef. The big processing plants will happily take grassfed animals and process them much more cheaply than the small plants that most grassfed beef producers use, so long as they receive a minimum volume (at least 500 head/week). Distributors will use their trucks, cold storages and sales forces, so long as there is sufficient supply and demand to make it worthwhile. The answer to the supply chain problem is scale and aggregation.

While easier said than done, scale needs to happen through aggregation at the finisher and branded program level, which can benefit producers of all sizes. Greater coordination across the rest of the value chain is also necessary. Scale can be achieved through the growth of individual operating entities or through cooperative production and marketing arrangements.

Supply chain efficiencies resulting from scale can also help overcome the problem of whole-carcass utilization — something the conventional beef industry is better equipped to solve. The recent acquisition of grassfed beef producer BN Ranch by meal-kit provider Blue Apron is an example of a brand trying to leverage scale to better utilize whole carcasses and access the cheaper conventional beef infrastructure.[121] Scale is also part of the solution to marketing beef. Sharing resources to promote high-quality grassfed beef and telling the grassfed beef story to consumers is an important step to increase demand, but these strategies require a marketing budget that only larger organizations can afford and will require collaboration and coordination among the existing industry players.

4. Establish well-managed, scaled-up finishing systems to produce grassfed beef at low cost.

There are two ways for a grassfed producer to make money today: Sell small quantities direct-to-consumers at high enough prices to cover the extra costs of running small herds or produce at a large enough scale to bring down operating costs and sell larger volumes through branded programs. Medium- to large-scale producers may be able to increase profitability further by integrating cattle with other farming operations, such as growing crops or raising pasture-based poultry, pigs or sheep.

Our analysis indicates that scaling grass-finishing operations further and applying best-practice cattle and grazing management that builds soil health could reduce grassfed production costs substantially. The cost per pound could be brought closer to the cost achieved by conventional feedlot operations or close enough to be covered by a 20-30% premium and still be profitable for producers. This could unlock mass consumer demand and potentially displace a significant portion of the conventional grain-fed beef system. Although overseas grassfed production costs would still be cheaper, future growth of grassfed beef consumption should not be filled completely by imports because of the crucial ecological and social benefits well-managed grassfed operations bring to the U.S.

Our analysis also shows that, theoretically, there is enough land in the U.S. to support a massive scaling up of grassfed beef. This could be facilitated by parallel changes in U.S. cropping as more farmers turn to organic or ecological production methods, introducing longer and more diverse rotations that incorporate cattle grazing on cover crops and multiyear pastures. There are opportunities for investment in grassfed beef production so long as the right land assets, animal genetics and management skills are available.

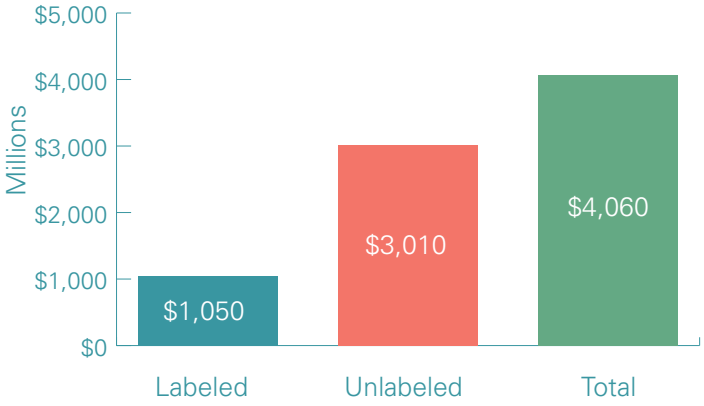
Cattle producers have long been admired for their independence and self-sufficiency. However, scaling up U.S. grassfed beef will require cooperation both among producers and between producers and other actors along the supply chain — processors, marketers, food manufacturers, chefs, retailers and investors. This type of cooperation can be hard to achieve, but the prize is great. Going back to grass can regenerate farmland, improve animal welfare and deliver a bounty of healthy, nutritious, delicious food that everyone can enjoy.

APPENDIX 1: METHODOLOGY ON MARKET SIZE ANALYSIS

This appendix explains the methodology and assumptions used to develop the analysis in Chart 2.1.

The USDA does not collect data on the size of the grassfed beef market. Therefore, determining the market size required compiling data from a variety of sources and making a number of extrapolations and assumptions to arrive at a final number. Data from marketing research firms Nielsen and SPINS, the retail marketing website of the National Cattlemen's Beef Association (Beefretail.org) and the USDA, as well as the insights of many industry professionals, all informed this process. Our total estimated U.S. grassfed beef market size in 2015 is comprised of two parts: sales of labeled grassfed beef and sales of unlabeled grassfed beef. We have used conservative assumptions throughout the analysis and believe that the actual grassfed beef market size is actually larger than what is presented here. (Note: all figures are for calendar year 2015 except where otherwise noted. Figures may not add up precisely due to rounding.)

CHART 2.1 Estimated 2015 grassfed beef market size in the U.S.



Source: SLM/Bonterra

LABELED GRASSFED

The foundation of our analysis of the labeled grassfed beef market comes from Nielsen, which estimates the total retail sales of fresh grassfed beef (including beef cuts and burgers) to be $274 million. We then add SPINS' retail sales data on UPC (Universal Product Code) processed meats (refrigerated and frozen hot dogs, sausages, deli meat and shelf-stable snacks like jerky) of $33 million to arrive at a preliminary retail value of $307 million. Nielsen's and SPINS' data do not capture the entire U.S. retail universe; due to the fact that much of the nation's grassfed beef sales occur through non-conventional or specialty stores, we estimate that their data capture 70% of the whole retail universe. This implies the total fresh and processed retail market for labeled grassfed beef is $439 million.
The next step is to determine how much labeled grassfed beef is sold through retail versus food service operators (restaurants, education, healthcare facilities etc.). Experts note that the ratio of food service to retail sales fluctuates between 40 and 60%. Beefretail.org estimated that a total of 4.7 billion pounds of all beef (including conventional and grassfed) was sold at retail in 2015; similar to the case of Nielsen and SPINS, that figure does not capture the entire retail market, so we assume that it represents the same 70% coverage, resulting in an estimated total retail sales volume of 6.7 billion pounds. Assuming a conservative 5% of "shrink" (meat loss or waste along the supply chain or because of meat spoilage etc.), the implied total retail sales volume is hence 7.1 billion pounds.

Separately, based on Technomic's "Usage & Volumetric Assessment of Beef in Foodservice 2015 Edition" presentation, 7.7 billion pounds of beef were procured by the food service operator segment. Hence our estimated ratio split between retail and food service in 2015 is 48/52.
We therefore estimate the labeled food service sales of grassfed beef to be $480 million ($439 million/48%x52%).

The final component of the labeled grassfed market derives from direct-to-consumer sales. This is an opaque segment of the market comprising farmer's markets, community-supported agriculture (CSA), direct online transactions and other unrecorded transactions between farmers and their local consumers. While many farms and ranchers participate in direct-to-consumer sales, these tend to be smaller operations. We estimate the size of this segment to be $125 million based on our industry interviews.[122] When added to the other labeled sectors, this allows us to arrive at the final labeled grassfed beef sales of just over $1 billion.

UNLABELED GRASSFED

Although unlabeled grassfed beef comprises the largest segment of the overall market, data on this type of meat is difficult to come by, as it is largely mixed in with commodity trim by the time it reaches consumers. There are two sources of unlabeled grassfed beef: domestic and imported.

The unlabeled domestic grassfed derives from cull animals from both beef and dairy operations. Unlabeled domestic grassfed comes mostly from cows and bulls, rather than the steers and heifers that dominate the labeled market. According to data from the USDA Annual Meat Trade Review (AMTR), there were 2.3 million slaughtered beef cows in 2015. Of these, we estimate that 25% consumed only grass and non-grain supplements during their life. They will have been almost entirely pasture based, as they are mostly integrated with cow-calf production, but most pasture systems still supplement their animals' diets with corn feed. Similarly, the USDA reports that there were 2.9 million dairy cows slaughtered in 2015, but we estimate only 1% of these animals are likely to have been grassfed (in line with the market size of U.S. grassfed dairy). Finally, beef and dairy operations culled 467,015 bulls that same year according to the USDA AMTR; of these, we estimate just 5% to have been fed only grass during their lifetimes. Our grassfed percentage estimates for each group of cull animals are based on conversations with various grassfed industry experts.

The USDA AMTR reported that cull beef and dairy cows had an average carcass weight of 644 pounds and cull bulls yielded 916-pound carcasses on average in 2015. Multiplying these respective weights by the number of grassfed cull animals estimated above and summing them results in 405 million pounds of domestic grassfed cull animal carcass weight. At an estimated average boneless retail meat yield of 70% (average for these types of grassfed animals, according to industry experts we spoke with), we arrive at 283 million pounds of grassfed cull cuts and trim. While uncommon, there is a small portion of this amount that does enter the labeled market. To be conservative we assume 20% of the grassfed cull volume is sent to the labeled market, leaving a final weight estimate of 227 million pounds. We make another conservative assumption that most of the meat would be turned into trim, the cheapest product, even though realistically some of it may be used as cheap steak cuts. Since we were not able to obtain the 2015 average national processor price for fresh 85% trim, we have used the January 2017 price of $1.81/lb,[123] which we believe is a conservative figure since cattle prices were higher in 2015 than at the time of this report's writing. Trim prices have also bounced back since January 2017. Since this is only the processor/packer price, we apply a markup of 7% by distributors (on the low end, based on our discussions with industry experts) and another markup of 45% by retailers and food services to arrive at the price that consumers ultimately pay to purchase the product. The retail equivalent price of the trim thus becomes $2.75/lb. Multiplying this by our total volume of cull beef gives us a total domestic unlabeled grassfed market size of $625 million.

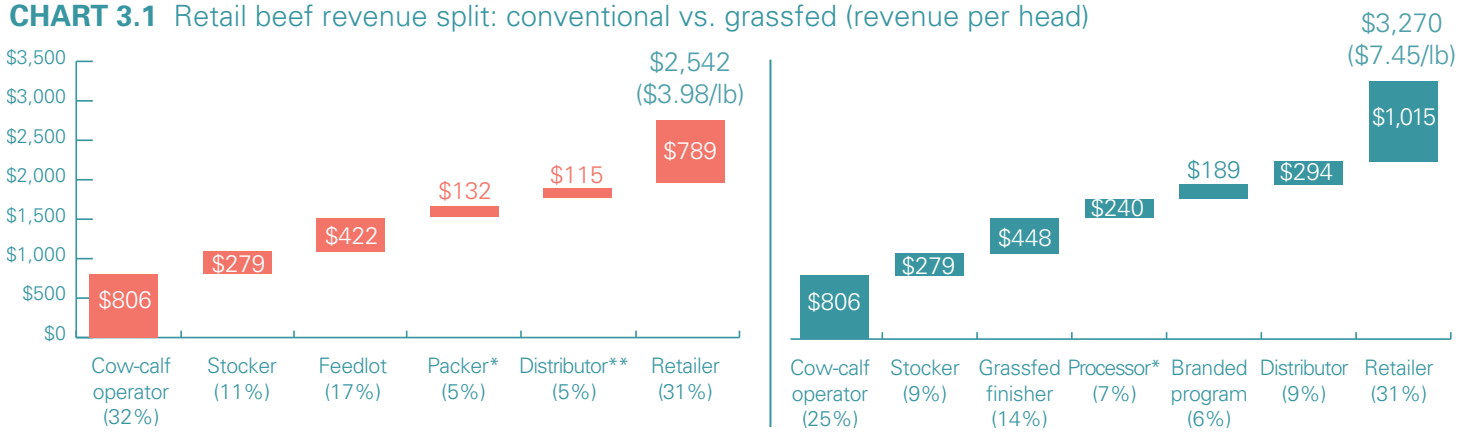
The largest source of grassfed beef is unlabeled and imported. Most of the beef imports originate from Australia. We begin by using Australia's average 10-year export volume of 589 million pounds (meat weight) for years 2006-2015, as reported by Meat and Livestock Australia (MLA).[124] MLA also reports that on average from 2011 to 2015, 97% of beef import to the U.S. was grassfed; this percentage is stable over the years.[125] Multiplying these two figures gives us a total of 573 million pounds of Australian beef. The USDA reports imports from other countries in carcass weight rather than meat weight. We make the following assumptions for the remaining top 10 importers in 2015: Grassfed makes up 75% of imports from New Zealand, Brazil, Argentina and Uruguay; and 2% for imports from Canada, Mexico, Nicaragua, Costa Rica and Honduras.[126] We then multiply each of these percentages by each country's import volume by carcass weight in 2015[127] and arrive at a volume of 735 million pounds of unlabeled imported grassfed beef by carcass weight. We again assume a retail meat yield of 70% for these animals, for a total meat volume of 515 million pounds. Adding this number to the Australian figure results in a total meat volume of just over 1 billion pounds. Again, we exclude 20% of this meat, assuming that it has been sold as labeled grassfed beef in the U.S., resulting in 870 million pounds of unlabeled grassfed meat imports. Our assumption is that most of this imported grassfed beef is used as trim (again, a conservative assumption), and the average 10-year (2006-2015) wholesale price for imported frozen 90% lean boneless beef is $1.81/lb according to the USDA.[128] We then apply the same 7% and 45% markup for distributor and retailer, respectively, to arrive at the price of $2.74/lb that consumers pay to consume the product. Multiplying this by the total imported grassfed beef volume leads us to total unlabeled imported grassfed sales of $2.4 billion. This figure is likely an underestimate: A lot of the import trim is used to make hamburgers for restaurants, and the markup they charge could be significantly higher than what we have assumed for retailers. In addition, trim prices in 2015 were higher than the 10-year average figure. Adding these imports to domestic cull meat results in total unlabeled grassfed sales of $3 billion.

The total grassfed market therefore generated an estimated $4.0 billion in sales in 2015, representing 4% of the $105 billion total U.S. beef market, with labeled grassfed capturing 1% of the total market.[129]

APPENDIX 2: METHODOLOGY ON SUPPLY CHAIN ANALYSIS

The objective of the supply chain analysis illustrated in Chart 3.1 is to show: 1) the revenue received by each segment in the conventional and grassfed supply chains for beef produced in the U.S. (or, how much each charges to the next buyer in the chain) and how that determines the price the consumer pays at the retail level (i.e., at the grocery store) and 2) the percentage split of retail revenue dollar among each of the supply chain segments (e.g., percent of the retail dollar received by the cow-calf operator vs. retailer) and how that split differs between conventional and grassfed beef. We start by determining the revenue received by the cow-calf operator and do the same for each segment that follows. In this analysis, we are solely interested in determining the revenue each segment receives and not its profitability. (Note: Due to rounding, figures may not add up precisely.)

CHART 3.1 Retail beef revenue split: conventional vs. grassfed (revenue per head)



Note: % in horizontal labels indicates % of revenue received by each segment.

Percentage of revenue split shown for each segment may not add to 100% due to rounding.

No backgrounding stage is assumed in the conventional supply chain.

*Excludes "drop" revenue from selling byproducts such as offal and hide. In the grassfed beef value chain, the processor typically only provides contracted processing services and does not buy the animal.

**Packer is often also the distributor in the conventional supply chain. Some may also own feedlots. Some packers have their own beef branded programs.

Source: SLM/Bonterra

CONVENTIONAL BEEF SUPPLY CHAIN

For the conventional supply chain analysis, we use 10-year average (2006-2015) figures whenever possible in order to show a "steady state" of the conventional beef industry and to smooth out any irregularities and volatility that occur in any one year.

We assume that the cow-calf operator sells the weaned calf at 500 pounds, which is the approximate historical average weight of weaned cattle.[130] According to the USDA, the 10-year average price for a steer that weighs 500-550 pounds is $1.61/lb,[131] meaning the cow-calf operator sells the animal to the stocker operator for $806/head (500 pounds x $1.61/lb). We have not assumed a backgrounding stage in this analysis.

The stocker operator raises the animal from 500 to an average of 800 pounds[132] and sells the feeder for $1.36/lb live, which is the 10-year average wholesale price for a steer feeder weighing 750-800 pounds.[133] We have only applied steer prices throughout this analysis since the cattle industry in general sells more steers than heifers, which are often held back as replacement cows.[134] The operator sells the feeder for $1,085/head (800 pounds x $1.36/lb) to the feedlot and paid $806/head for the animal, so the net revenue received is $279/head.

The feedlot feeds the feeder from 800 pounds until the 10-year historical fed cattle weight of 1,350 pounds.[135] The 10-year 5 Area weighted average price for steers of all grades, which is a good proxy for fed cattle prices in general, was $1.12/lb (live weight) based on USDA ERS data.[136] Hence, the feedlot sells the animal to the packer/processor for $1,507/head (1,350 x $1.12) and paid $1,085 for it, so the net revenue received is $422/head. The feedlot industry is known to have very thin profit margins and suffer high price volatility.

The packing industry, being highly consolidated and vertically integrated (often owning distribution and sometimes also feedlots), is extremely opaque. Little is known and published on its actual revenue and cost structure. Just like feedlots, the packing industry operates on thin margins and can see extreme price volatility. We use the 10-year average boxed beef cutout price of $1.79/lb of carcass as the proxy for the revenue a packer receives from selling fabricated meat to its buyers. We apply the industry average carcass yield of 64% to convert the 1,350-pound animal to 864 pounds, resulting in a revenue of $1,548/head (867 pounds x $1.79/lb). At the same time, we have assumed that the packer charges a packaging cost that represents 6% of its cattle purchase, or $90/head, for turning this meat into a case-ready product for retailers. The packer's total revenue for selling meat is therefore $1,639, or a net revenue of $132/head, after deducting the cattle purchase cost. These figures exclude revenue the packer receives from selling the "drop" (i.e., animal products such as hide, offal and bones).[137]

Based on our conversations with several industry veterans, the distributor's revenue and gross margin change all the time in order to remain competitive. We have assumed a markup of 7% on the distributor's meat acquisition price, implying a total revenue of $1,753/

head or net revenue of $115/head. We have included a distribution segment in the conventional supply chain analysis to create a comparable analysis with the grassfed scenario. But in reality, the packer in conventional beef is often also the distributor, so that the cost and hence revenue could be lower and more streamlined.

Finally, the retailer purchases the product from the distributor. Interviews with various branded programs and meat buyers tell us that retailers usually apply a markup in the range of 40-45%, sometimes even higher. We assume a markup of 45%, implying an equivalent listed retail price of $2,542 per head ($1,753 x (1+45%)) or net revenue of $789/head. The average boneless retail meat yield for conventional cattle is 74%,[138] so the 867-pound carcass becomes 642 pounds of meat, hence the implied retail price per pound of meat is $3.98/lb ($2,542/642 pounds). This retail price reflects our estimated average price paid by the consumer for conventional beef during the 2006-2015 period.[139]

The revenue percentage split indicated in the graph for each supply chain segment is calculated by dividing that particular segment's net revenue by the total revenue per head at the retail level, as shown below. (Note: due to rounding, percentages may not add up to 100%.)

Supply chain segment	Revenue ($/head)	% retail revenue
Cow-calf operator	$806	32%
Stocker	$279	11%
Feedlot	$422	17%
Packer	$132	5%
Distributor	$115	5%
Retailer	$789	31%
Total	**$2,542**	**100%**

GRASSFED BEEF SUPPLY CHAIN

Since the nascent grassfed industry in the U.S. is much less studied and researched, we are not able to gather 10-year historical figures as we did for the grain-fed segment. Calculating a 10-year average for the grassfed industry would not show an accurate picture either since the industry has grown and changed drastically within the last few years. We base our assumptions on the state of the grassfed market in 2016, as explained below. (Note: The supply chain for selling directly to consumers would be shorter and would have different economics.)

We have assumed the exact same net revenues for the grassfed cow-calf and stocker operators as in the conventional supply chain since these production phases are very similar for both systems.

The grassfed finisher purchases the feeder at 800 pounds for $1,085/head and finishes it to 1,100 pounds, the industry average for grassfed animals.[140] It is sold to a grassfed branded program for $2.44/lb of carcass, equivalent to $1.39/lb live weight assuming the average industry grassfed carcass yield of 57% or a 627-pound carcass.[141] This live weight price represents a 25% premium to the 2006-2015 average fed cattle price of $1.12/lb used in the conventional supply chain analysis above, which is consistent with the range of premiums we found from speaking to various branded programs. The grassfed finisher receives a total revenue of $1,532/head or net revenue of $448/head after deducting the cattle purchase cost.

A branded program of relatively large scale purchases the finished cattle and pays an assumed $240/head for processing. Grassfed cattle producers and branded programs usually cannot work with the large, low-cost processors since they cannot deliver enough volume (i.e., headcount) on a consistent basis. Processing fees vary widely among processors of different sizes. Accordingly, larger branded programs can pay a wide range of $150-300/head for slaughtering, fabrication and packing, depending on their volume, and net of "drop" credit.[142] We have also assumed a freight cost of $32/head paid by the branded program, resulting in a total cost of $1,804/head ($1,532 cattle purchase cost + processing + freight cost). We then make the assumption that the branded program would make an 8% gross margin, resulting in total revenue of $1,961/head or net revenue of $189/head after subtracting the cattle purchase, processing and freight costs.

Distributors that deal with specialty meat tend to charge a much higher markup than the mainstream distributors. Interviews with branded programs and meat buyers reveal that distributors can charge a 12-25% (or higher) markup depending on volume. We have assumed a 15% markup on the distributor's cost or $2,255/head of total revenue, equivalent to a $294/head net revenue.

We have assumed the retailer charges the same 45% markup as in the conventional supply chain. This results in a total retail price of $3,270/head ($2,255/head x (1+45%)) or net revenue of $1,015/head. Assuming a boneless retail meat yield of 70% (the average for most branded grassfed programs), the 627-pound carcass yields 439 pounds of meat, implying a retail price of $7.45/lb for fresh grassfed beef ($3,270/439 pounds), or an 87% premium to the $3.98/lb price in our conventional beef analysis.

The revenue percentage split indicated in the graph for each of the supply chain segments is calculated by dividing that particular segment's net revenue by the total revenue per head at the retail level, as shown below. (Note: Due to rounding, percentages may not add up to 100%.)

Supply chain segment	Revenue ($/head)	% retail revenue
Cow-calf operator	$806	25%
Stocker	$279	9%
Grassfed finisher	$448	14%
Processor	$240	7%
Branded program	$189	6%
Distributor	$294	9%
Retailer	$1,015	31%
Total	**$3,270**	**100%**

APPENDIX 3: METHODOLOGY ON ECONOMICS OF BEEF OPERATIONS

This appendix lays out the methodology and assumptions used in the analysis in Table 4.1.

Financial and operational numbers in the table are to be interpreted as follows:

- The revenues for each production model are based on an assumed per pound beef price ($/lb) and finished weight, as well as a carcass yield and retail meat yield depending on whether the expected revenue would come from direct-to-consumer sales (i.e., selling meat cuts) or sales to packers or branded programs (selling live animals and getting paid by the live or carcass weight).
- Operational costs are broken down by cattle purchase costs, feed/pasture management costs and other costs.
  - Feed/pasture costs include fertilizer and herbicide (though many operations do not use chemical inputs), hay and non-grain supplements for grassfed operations and cost of grain-based rations for the feedlot model. This item also includes minerals, machinery and other feed-related costs.
  - Other operational costs include health and veterinary (which in turn includes antibiotics and hormones if applicable), hired labor, marketing, checkoff, transportation and death loss (the cost to replace animals that die from disease, usually less than 1% of the herd).
- Gross margin is the difference between total revenue and total operational costs.
- Overhead costs consist of items such as land lease rates, management (or owner's labor in some cases), maintenance (e.g., water infrastructure, machinery and fencing), utilities, fuel, property taxes and accounting costs. We focus on current operations so do not include the upfront capital expenditure associated with purchasing facilities or building initial infrastructure.
  - We have assumed that the land is leased in all scenarios.
- EBITDA (earnings before interest, tax, depreciation and amortization) equals the difference between gross margin and total overhead. We selected EBITDA as the preferred profitability metric due to considerable variation and inconsistency in reporting around interest expenses, depreciation, amortization and taxation on net income.
- Cost of feed per pound of weight gained: total feed cost divided by total weight gained during the finishing phase.
- Cost of gain per pound: Total production costs (operational costs plus overhead) minus cattle purchase cost gives total cost of gain. Dividing total cost of gain by total weight gained during finishing phase gives cost of gain per pound.

METHODOLOGY ON CREATING U.S. GRASSFED SCENARIOS

There is limited publicly available financial and operational data on actual grass-finishing operations in the U.S., given the nascent state of the industry. To create case studies that are representative of existing grassfed production in the U.S. at different scales, we collected data on as many "real life" case studies as possible within our short project timeframe through dozens of interviews with grassfed beef producers. Many of these producers provided full or partial financial details pertaining to their operations on a confidential basis. As another source of reference, we also reviewed academic and publicly available sources: these included the University of California Cooperative Extension budget, a production calculator and budget provided by the Pasture Project of the Wallace Center and a few others.[143, 144, 145, 146]

Most of the data we collected from existing U.S. operations are from small (selling less than 200 head/year) and medium-scale producers (selling 201-999 head/year), but some are also considered to be large-scale (selling >1,000 head/year) by today's grassfed industry standard. In cases where producers could not share their numbers because of confidentiality, we used our assumptions based on estimates from other operations and the academic studies to arrive at a complete picture of the farm or ranch's cost structure that attempts to take into account all the operational and overhead costs. Based on this information, we constructed a 2016 financial overview for 11 actual grass-finishing operations in the U.S., which include examples from most of the major cattle-producing regions. Numbers reported in the U.S. grassfed scenarios (Scenarios C-E) do not represent any actual operation as they have been modified slightly to respect the sensitive nature of information obtained from producers we interviewed.

In general, revenue from grassfed sales is the item we have the most clarity on, as almost all producers were willing to disclose this information to us. Since not all producers calculate cost metrics the same way, we have had to make our own assumptions for pasture, other operational costs and overhead in some cases. Here are some of our cost assumptions:

- Hired labor costs (included in "other operational costs"): For the producers who did not supply us with this information, we assume base annual salaries of $30,000 for a ranch hand and $10,000 for an intern or apprentice in cases where we know the operation involves hired labor.
- Management cost (included in "overhead"): We assume base annual salaries of $80,000 for a full-time ranch manager or owner and $55,000 for a foreman.
- Land lease (included in "overhead"): The 2016 national average non-irrigated pasture cost for the U.S. as reported by the USDA is $13/acre.[147] Because grass-finishing operations generally require at least some irrigated pasture (or higher-value land), we use $60/acre as a weighted average lease rate for the whole operation.

SCENARIO DESCRIPTION

We start by looking at a small U.S. grain-finishing feedlot selling 3,450 live animals per year to conventional packers (Scenario A). (Although most of the fed cattle in the U.S. are finished in much larger feedlots with one-time capacity of 32,000 head or more, enterprise budgets and estimated costs for these large operations are not publicly available.) We then look at the average returns of a grassfed/grass-finishing operation in Southern Australia selling by carcass weight to export-oriented processors (Scenario B). Southern Australia is most akin to the U.S. grassfed model in terms of climate, environment and beef production system. In Northern Australia, cattle roam across hundreds of thousands or even millions of acres of semi-arid or desert landscape. This type of system is extremely low-cost and requires little management, except for providing water points and rounding the herd up for sale once a year.

The next two scenarios are based on data collected for this report from U.S. grassfed finishers and industry experts. They are exemplary case studies that reflect two existing profitable business models used by some of the successful grassfed beef producers in the U.S. today. The first is a small-scale grassfed operation selling individual beef cuts direct-to-consumer at high prices from a production of 40 head each year (Scenario C). The second is a large-scale grass-finishing operation selling 4,000 head each year by carcass weight to branded programs (Scenario D).

Finally, we assess the economics of a very large-scale grass-finishing operation in the U.S. selling 10,000 head per year by carcass weight to branded programs (Scenario E). No such operation currently exists in the U.S. — this is an aspirational case study — but we are aware of groups that are developing this type of model to finish 10,000+ head, and it indicates what could be achieved with greater scale.

Each scenario assumes the purchase of a feeder animal weighing 750-800 pounds at the start of the finishing phase, looks at the cost of bringing this animal to a finished weight and calculates revenue based on price per pound ($/lb). All the grassfed scenarios assume a "pure" grassfed system in which cattle are raised on pastures and fed only forage and not a "grass feedlot" model as discussed in Chapter 1. Key operational metrics are the amount of weight gained by the animal each day (Average Daily Gain or ADG) and the cost of gain per pound. The key financial metric is EBITDA margin per animal (i.e., earnings before interest, tax, depreciation and amortization divided by revenue). Each of the scenarios is described further below.

CONVENTIONAL U.S. GRAIN-FINISHED FEEDLOT (SCENARIO A)

We draw our analysis from the June 2016 Iowa State Extension publication "Livestock Enterprise Budgets for Iowa – 2016" using the budget for "Finishing yearling steers — corn and hay ration."[148] The Iowa State budget is built on an assumed 1,500-head capacity feedlot; on average feedlots that market year-round have approximately 2.3 turnovers per year or 3,450 head per year.[149] Where possible, we have substituted the Iowa budget's prices with average 2016 prices.

The following assumptions are used:

- Total revenue: Using 2016 average live weight price for fed cattle of $1.20/lb,[150] which are finished to an average of 1,250 pounds as per the Iowa State budget. This results in gross revenues of $1,499/head.
- Cattle purchase costs: Using 2016 average feeder steer price of $1.45/lb.[151] The Iowa State budget assumes the feeder enters the feedlot at 750 pounds, for a cost of $1,084/head.
- Feed costs: $291/head, consisting of $174 of corn (50 bushels x 2016 average corn price of $3.48/bushel[152]), and according to Iowa State budget: $25 of fair-quality hay, $76 of modified distiller grain and $16 of supplement and minerals.
- Other operational costs: $73/head as per Iowa State budget. We have excluded the budget's 9% interest on variable cost from our calculation.
- Land lease cost: We use a nominal value of $5/head, as feedlot operations have extremely high stocking rates and do not require productive land.
- Management costs: Assuming a full-time employee with annual salary of $55,000 required to manage the total 3,450 head per year or $16/head.
- Other overhead costs: Assuming a low $25/head because of economy of scale.

AUSTRALIAN GRASSFED BEEF OPERATION (SCENARIO B)

The Southern Australian case represents 3-year average costs and revenues from July 2012 to June 2015 for operations with mother cow herd size of 200-400 head as published by MLA presented in 2015-16 Australian dollars.[153] We apply the average foreign exchange rate of 0.7283 for the 12-month period ending June 2016 to convert from Australian to U.S. Dollars. For comparison, an average grass-finishing operation in Southern Australia is estimated to finish 113 animals per year.[154] Conversion from kilograms (kg) to pounds is 2.205.

- Total revenue: The carcass weight price for finished cattle averaged $1.40/lb during the three-year period,[155] and cattle are finished at an average of 1,279 pounds (580kg), or carcass weight of 699 pounds (317kg).[156] This results in gross revenues of $982/head.

APPENDIX 3: METHODOLOGY ON ECONOMICS OF BEEF OPERATIONS

- Cattle purchase costs: The 3-year average Australian feeder cost is $577/head for a 794-pound (360kg) animal.[157]
- Pasture costs: Average pasture and feed costs are $27/head, based on A$0.17/kg of weight gain, which is comprised of: A$0.07 of fertilizers, A$0.08 of fodder and A$0.02 of pasture chemicals.[158]
- Other operational costs: Using MLA figures, the average other operational costs are $59/head based on A$0.35/kg gain of operational costs (including repair and maintenance, fuel, freight, veterinary costs, handling/marketing and contract costs) and A$0.02/kg gain of hired labor.[159]
- Land lease cost: Assuming $62/head. This is assuming A$3,500 per breeding cow unit[160] (13 DSE or dry sheep equivalent) for the FY2012-2015 period and that a feeder steer is equivalent to 9 DSE.[161] Applying 3.5% lease rate gives U.S. $62/head (A$3,500 x 9/13 x Fx 0.7283 x 3.5%).
- Management costs: Average of $96/head based on A$0.60/kg gain, according to MLA.
- Other overhead costs: Average of $42/head based on A$0.26/kg gain, according to MLA.

SMALL U.S. DIRECT MARKETING PRODUCER (SCENARIO C)

Scenario C shows a small-scale operation that raises cattle from birth to finish and sells individual beef cuts directly to consumers through farmer's markets, community-supported agriculture (CSA) and e-commerce. This scenario is based on actual data collected from profitable small-scale producers we interviewed, but with the numbers modified slightly to respect the sensitive nature of the information.

- Operational information: We chose 40 head sold per year as a representative small operation; this was the smallest number of head sold by the successful producers we interviewed. The exemplary small-scale producers we interviewed achieved an average daily gain (ADG) of 2.2 pounds. The retail meat yield of 55% is based on our interviewed producers' average for direct-to-consumer sales. Retail meat yield varies considerably depending on how the animal is fabricated and the skill of the processor; animals processed by larger processors with the right equipment and better-trained staff usually end up with a higher retail meat yield, which would increase producers' revenue.
- Total revenue: A finished weight of 1,150 pounds (higher than the grassfed industry average of 1,100 pounds) and a retail price of $8.90/lb of meat represent the average across our direct-to-consumer models.
- Cattle purchase costs: We assume an opportunity cost even though the producer does not have to buy the animal. We assume a price of $1.36/lb (the average price from producers we interviewed; it is also the 10-year average feeder steer price from 2006-2015 based on USDA data) for an 800-pound animal and per head cost of $1,088.
- Pasture costs: $340/head is the average across the profitable small-scale operations we interviewed.
- Other operational costs: Assuming $230/head, the average cost of the producers we interviewed.
- Land lease cost: $120/head assumes the same $60/acre rental rate as described earlier at a stocking rate of 0.5 head/acre.
- Management costs: Assuming a base annual salary of $80,000 for a full-time owner/ranch manager. A cost of $500/head represents 25% of this person's time. Selling direct-to-consumer requires significant time and resources, but cattle tend to represent just one part of a small-scale operation.
- Other overhead costs: Assumed to be 10% of total production costs (operational costs plus total overhead), including costs associated with direct marketing.
- Processing costs: Assuming $500/head for processing animals in order to sell directly to consumers. This cost is a good average for small-scale abattoirs based on interviews with industry experts, but varies widely ($400-800/head) among small producers.

LARGE-SCALE U.S. OPERATION SELLING TO BRANDED PROGRAMS (SCENARIO D)

Scenario D represents a large-scale operation selling 4,000 head per year to branded grassfed programs, which pay by carcass weight. This is a scenario created based on performance figures gathered from profitable grass-finishing operations of this size, but with the numbers modified slightly to respect the sensitive nature of the information.

- Operational information: An ADG of 2.5 lbs/day and carcass yield of 59% are the averages for the profitable large-sized producers.
- Total revenue: A finished weight of 1,240 pounds and a price of $2.52/lb by carcass weight (achieved by the producers included our case studies) yields per head revenue of $1,844.
- Cattle purchase costs: Same as Scenario C above.
- Pasture costs: $300/head reflects the average of the large-sized producers in our case studies.
- Other operational costs: $142/head based on the average of producers included in our case studies, including hired labor.
- Land lease cost: $78/head assumes the same $60/acre rental rate as above, with a higher stocking rate of 0.89 head/acre.
- Management costs: Assuming the same base salaries, $80,000 for a full-time ranch manager/owner in addition to a foreman at $55,000 per year, resulting in $48/head.
- Other overhead costs: Assumed to be $140/head or 8% of total production costs.

ASPIRATIONAL VERY LARGE U.S. OPERATION SELLING TO BRANDED PROGRAMS (SCENARIO E)

We have developed a hypothetical case study (Scenario E) based on some of these models and on our own analysis of what can be achieved with scale. In this scenario, the proposed operation finishes 10,000 head annually and sells by carcass weight to branded programs. This scenario represents a "steady state" operation and does not reflect the startup costs associated with such a program, e.g., the initial land and herd purchase and adding or retrofitting irrigation infrastructure.

- Operational information: Same ADG and carcass yield assumptions as Scenario D.
- Total revenue: Same assumptions as Scenario D.
- Cattle purchase costs: Same as Scenario D.
- Pasture costs: A lower value of $200 per head reflects more intensive grazing practices, but with the benefits of significantly larger scale than the one presented in Scenario D. Although this is an aspirational figure, some of the producers we collected data from of small and large scale are already approaching this level of feed cost.
- Other operational costs: $90/head represents 7% of total operational costs. Again, some of the producers we collected data from of small and large scale are approaching if not already achieving this level of cost.
- Land lease cost: $42/head assumes $60/acre rental rate, with a high stocking rate of 1.43 head/acre, which some producers have already surpassed.
- Management costs: A total cost of $27/head represents two full-time ranch managers and two foremen at $80,000/year and $55,000/year each, respectively.
- Other overhead costs: Assumed to be $80/head or 5% of total production costs due to cost savings from operating on a large scale.

GLOSSARY

Adaptive multi-paddock (AMP) grazing: A form of intensive rotational grazing that is highly flexible and adaptive and allows grazers to adjust daily to conditions. The farm is divided into multiple paddocks with temporary fencing that is built to a size appropriate for the nutritional needs of the livestock and how long they will be there. Stocking densities can vary widely depending on conditions and the needs of the grazer.[162] Also see "intensive rotational grazing."

Animal feeding operation (AFO): See "feedlot."

Average daily gain (ADG): The total weight gained by the animal in the finishing phase, divided by the number of days required to achieve that gain. ADG is expressed in terms of lbs/day.

Backgrounding: A stage in the cattle production lifecycle that sometimes replaces the stocker phase. Like the stocker phase, it occurs after the cow-calf stage and before finishing, but the diet involves some ration of mixed feeds (including grains) or stored forages to prepare the animal for feedlot grain finishing.

Branded program: A line or series of products marketed under a company or store brand instead of being sold as generic products.

Bull: An uncastrated male bovine animal that weighs more than 500 pounds. In the beef industry, bulls are primarily used for breeding new calves rather than for meat.

Butcher counter: The staffed butcher area at a retail store where fresh meat is sold. Also known as "fresh meat case."

Calf: Any animal less than 1 year old. According to the USDA NASS survey, classification calves are animals that weigh less than 500 pounds.

Carcass weight: Also known as the hanging or dressed weight, this refers to the weight of the animal carcass after it has been slaughtered with the skin, head, non-usable organs and hooves removed. It is measured in pounds in the U.S. Also see "carcass yield."

Carcass yield: Carcass weight (see definition) expressed as a percentage of the live weight of an animal. In the U.S., carcass yield is usually around 64% of the live weight for conventional cattle and around 55-59% for grassfed cattle.

Case-ready meat: Broad term for meat that is packaged in a processing plant and ready to be placed into display cases upon arrival at a retail store.[163] Also called "retail-ready."

Cattle on feed: Defined by the USDA to mean cattle and calves that were fed a ration of grain or other concentrates that will be shipped directly from the feedlot to the slaughter market and are expected to produce a carcass that will grade Select or better. This category excludes cattle that were pastured only, background feeder cattle and veal calves.[164]

Community-supported agriculture (CSA): An alternative model of food distribution in which one or more farms sells produce and/or meat directly to a specific group of members or subscribers.

Concentrated animal feeding operations (CAFOs): Feedlots that discharge manure or wastewater into a natural or man-made ditch, stream or other waterway and are hence regulated by the U.S. Environmental Protection Agency (EPA).[165] Also see "feedlot."

Conventional beef: Beef that is finished on non-organic grains in feedlots. This represents the most commonly consumed beef in the U.S.

Cost of gain: Total cost required to put each additional pound of weight on the animal, expressed in $/lb.

Cow: A female bovine animal that has birthed at least one calf.

Cull cow/bull: A cow or bull removed from the herd due to sale, slaughter or death. Older animals are often culled when they have reached the end of their reproductive phase.

Cutting yield: See "retail meat yield."

Direct marketing: Describes the way a producer sells and markets his/her products directly to consumers, retailers and restaurants through channels such as farmer's markets, CSA and internet sales. Also see "CSA."

Distiller's dried grains with solubles (DDGS): A co-product of dry-milled ethanol production (corn byproduct) utilized as a feed ingredient as both an energy and a protein supplement.[166]

Dressed weight: See "carcass weight."

EBITDA: Earnings before interest, tax, depreciation and amortization.

Fabrication: The process of using any or all of the techniques of cutting, deboning and trimming beef carcasses and primals into subprimals (see definitions).[167]

Fed cattle: Cattle finished on grain and other concentrates in a feedlot that are ready to be sent to packing plants for slaughter.

Feeder: Cattle ready to enter the finishing phase or to be "finished" (see definition).

Feedlot: Also known as an animal feeding operation (AFO), it is defined as a facility where cattle are confined and fed for a total of 45 days or more in any 12-month period and where crops, vegetation, forage growth or post-harvest residues are not sustained in the normal growing season over any portion of the premises.[168] Also see "CAFOs."

Feedlot cattle: In this report, feedlot cattle refers to those that are finished on grains in a conventional feedlot that makes use of confinement feeding. Also see "feedlot."

Finished: Once cattle reach market specifications (especially weight and degree of finish) and are ready for processing, they are described as "finished."[169] Cattle can be either grass- or grain-finished. Contrast with "unfinished."

Finisher: Someone who is responsible for the finishing phase of cattle production, i.e., the last phase, feeding the cattle to reach the desired weight before they are slaughtered or processed.

Food service distributors: Businesses that procure and market food products to food service operators.

Food service operators: Businesses that sell and serve food to consumers, such as restaurants, education and healthcare facilities, other types of cafeterias and catering and hospitality companies.

Food service (providers): Refers to both food service distributors and operators (see definitions).

FSIS (Food Safety and Inspection Service): The public health agency in USDA responsible for ensuring the safety, wholesomeness and correct labeling and packaging of the commercial supply of meat, poultry and egg products in the U.S.[170]

Further processing: Turning subprimals into ground beef and other case-ready cuts. Also includes turning simple meat cuts into value-added products through processes such as smoking, curing, cooking and seasoning. This may be done at a processing facility or at the butcher counter.

Grass-finished cattle: Cattle that have been fed and finished on only grass and forage, with limited supplementation, for their entire lives.

Hanging weight: See "carcass weight."

Heifer: A female bovine animal that has not calved and weighs more than 500 pounds.

Holistic planned grazing: A grazing method that incorporates a holistic decision-making framework into integrating livestock production with crop, wildlife and forest production while working towards land regeneration, animal health and welfare and profitability.[171]

Intensive rotational grazing: A grazing method by which cattle are moved together as a herd across many divided-up paddocks, instead of being allowed to continuously graze or set-stock graze over many acres. This process helps prevent overgrazing and can allow optimal rest periods for pasture grasses. Temporary fencing is usually used to create paddocks. Also see "adaptive multi-paddock grazing."

Labeled grassfed beef: Beef that is marketed or claimed as grassfed, i.e., contains the term "grassfed" on the food label. The product does not need to have a specific label or seal that certifies it as grassfed, but to label or use the term "grassfed" on a product package requires approval by USDA FSIS. Contrast with "unlabeled grassfed beef."

Large CAFOs: CAFOs with a capacity to feed at least 1,000 head of cattle at one time.[172] See "CAFOs."

Live weight: The weight of the entire living animal before it is slaughtered, measured in pounds.

Meatpacker: A company that owns and operates facilities to slaughter, cut, pack and package animals into meat products that are then sold to the retail and food service operators. A meatpacker can also be vertically integrated by also owning its own feedlot and/or distribution business. Sometimes referred to simply as a "meat processor."

Middle meats: Meat made up of the loin and rib primal cuts of a beef animal. The loin is made up of the short loin and sirloin.

Packaged meat: Value-added beef products such as pre-packaged lunch meat and precooked sausages.

Primal: A piece of meat separated from the carcass at fabrication with the intent to break down further into subprimal and/or fabricated cuts. Primals include the beef round, loin, rib and chuck.[173] Primals are usually further processed into subprimal cuts prior to retail sale. For example, the beef chuck is a primal cut that comprises the shoulder region of the carcass. It can be broken down into various fabricated cuts such as flatirons, petite tenders, denvers, chuck short ribs etc. Also see "subprimal."

Processing: Includes the process of slaughtering, cutting the carcass into primals (see definition) and fabricating (see definition) into smaller cuts. After fabrication, sometimes the cuts are also further processed (see definition).

Producers: In this market study, refers to ranchers who raise cattle and produce beef meat.

"Pure" grassfed beef: Meat from cattle raised on pastures and fed a 100% forage diet, with limited, incidental non-grain supplementation not exceeding 1% for the total lifetime consumption of dry-matter intake.[174] It is distinct from beef with a grassfed label that comes from animals that are confined in "grass feedlots."

Regenerative agriculture: Refers to farming and grazing practices that, among other benefits, reverse climate change by rebuilding soil organic matter and restoring degraded soil biodiversity, resulting in both carbon drawdown and water cycle improvement.[175]

Retail channel: Generally refers to grocery stores, warehouse clubs, butcher shops etc.

Retail meat yield: The percentage of carcass weight (see definition) that ends up as meat. The boneless retail meat yield is around 65-75% of carcass weight for grassfed animals, but including the bones would be higher. Also called "cutting yield."

Steer: A castrated male bovine animal that weighs more than 500 pounds.

Stocker: Refers to young, growing cattle on pasture and given very little other feed, with the intention of increasing weight and maturity before entering the finishing phase.[176]

Subprimal: Cuts taken from one of the four major primals (see definition) that are broken down into major pieces, but not into trim or portioned, case-ready cuts. Subprimals include whole brisket, short plate, whole flank and whole shank.[177]

Trim/Trimmings: Smaller pieces of beef muscle usually resulting from the deboning of beef carcasses and cuts and/or the production of retail or institutional cuts. Trim is used for grinding into ground beef based on the percentage of lean (relative to fat) in the trimmings (e.g., 50%, 75%, 90%).

Unlabeled grassfed beef: Beef that is grassfed but is not marketed or claimed as such in its product name or packaging. Contrast with "labeled grassfed beef."

Unfinished: Cattle that are slaughtered but did not reach market specifications for desired finished weight or degree of finish (i.e., marbling and backfat deposition), usually resulting in a lower price and/or lower-quality beef. Both grass- and grain-fed cattle can be unfinished. Contrast with "finished."

UPC (Universal Product Code): A standardized 12-digit barcode uniquely assigned to each trade item that is mainly used for scanning and tracking products at point of sale.[178]

USDA: United States Department of Agriculture.

ENDNOTES

[1] Age and weight ranges vary considerably. E.g., a calf weaned late will generally have a shorter stocker period and vice versa
[2] https://www.epa.gov/npdes/animal-feeding-operations-afos
[3] USDA "Alternative Beef Production Systems: Issues and Implications" 2013 and Grass Fed Insights, LLC
[4] USDA. https://www.ers.usda.gov/topics/animal-products/cattle-beef/background.aspx
[5] Interview with Dr. Derrell Peel, Oklahoma State University
[6] Grass Fed Insights, LLC
[7] An estimated 230,000 head of grassfed cattle plus an estimated 619,000 head of grassfed cull beef and dairy animals (see Appendix 1 for cull animal estimate) equals 851,000 head of grassfed animals in 2015. Divide this figure by the 29 million head of slaughtered cattle in 2015 according to the USDA gives 3%, implying 97% of slaughtered cattle are fed grains in their lives.
[8] USDA. "Overview of U.S. Livestock, Poultry, and Aquaculture Production in 2015" https://www.aphis.usda.gov/animal_health/nahms/downloads/Demographics2015.pdf
[9] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/livestock/afo/
[10] USDA ERS. "Economics of Antibiotic Use in US Livestock Production" Report Number 200. November 2015. https://www.ers.usda.gov/webdocs/publications/err200/55529_err200.pdf
[11] Grass Fed Insights, LLC, corroborated by other grassfed beef producers and marketers
[12] Our definition of "pure" grassfed beef is derived from a joint letter submitted to the USDA by four leading grassfed certification programs in the U.S. See https://www.regulations.gov/document?D=FSIS-2016-0021-4629
[13] USDA defines "natural" as meat that has been "minimally processed" and is devoid of artificial flavors, coloring ingredients, chemical preservatives, or other artificial or synthetic ingredients. https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/food-labeling/meat-and-poultry-labeling-terms
[14] Daley, Cynthia A. et al. "A Review of Fatty Acid Profiles and Antioxidant Content in Grass-fed and Grain-fed Beef." Nutrition Journal 9, no. 1. September 10, 2010.
[15] Ibid.
[16] Ibid.
[17] National Cattlemen's Beef Association. "Conjugated Linoleic Acid and Dietary Beef". http://www.beefresearch.org/CMDocs/BeefResearch/CLA.pdf.
[18] Correspondence and interview with Dr. Urvashi Rangan
[19] Ibid.
[20] Daley et al.
[21] Garg, M.I. et al. "Means of Delivering Recommended Levels of Long Chain n-3 Polyunsaturated Fatty Acids in Human Diets." *Journal of Food Science* 71, no. 5 (2006).
[22] Daley et al.
[23] Ibid.
[24] Nagaraja, T.G. and Titgemeyer, E.C. 2007. "Ruminal acidosis in beef cattle: the current microbiological and nutritional outlook." Journal of Dairy Science 90 Suppl 1:E17-38.
[25] Owens, F.N., Secrist, D.S., Hill, W.J. and D.R. Gill. 1998. "Acidosis in cattle: a review". Journal of Animal Science 76: 275-286
[26] Callaway, T.R., Carr, M.A. et al. 2009. "Diet, Escherichia coli O157:H7, and Cattle: a Review After 10 Years." Curr. Issues Mol. Biol. 11: 67-80. http://www.horizonpress.com/cimb/abstracts/v11/67.html
[27] USDA ERS. November 2015.
[28] US FDA DHHS. Center for Veterinary Medicine. Antimicrobials Sold or Distributed for Use in Food-Producing Animals. 2009.
[29] Chee-Sanford et al. "Fate and Transport of Antibiotic Residues and Antibiotic Resistance Genes following Land Application of Manure Waste." *Journal of Environment Quality* 38, no. 3 (2009): 1086.
[30] Beef Report, Consumer Reports, 2015. http://www.consumerreports.org/content/dam/cro/magazine-articles/2015/October/Consumer%20Reports%20Food%20%26%20Sustainability%20Center%20Beef%20Report_8-15.pdf
[31] http://animalscience.tamu.edu/2015/05/22/the-five-freedoms-of-cattle/
[32] Euken, Russ et al. Beef Feedlot Systems Manual. Report no. PM 1867. Extension and Outreach, Iowa State University. 2015.
[33] Bagley, Dr. Clell V., "Acute and Subacute Ruminal Acidosis." Acute and Subacute Ruminal Acidosis. 2000. http://extension.usu.edu/files/publications/newsletter/pub__5621800.html.
[34] Ammonia is produced when microbes decompose nitrogen in animal manure, but ammonia volatilization mainly occurs in solid manure, the form in which manure is handled in feedlots.
[35] Michigan Department of Environmental Quality. *Concentrated Animal Feedlot Operations (CAFOs) Chemicals Associated with Air Emissions*. 2006. https://www.michigan.gov/documents/CAFOs-Chemicals_Associated_with_Air_Emissions_5-10-06_158862_7.pdf
[36] Ibid.
[37] Ibid.
[38] Teague, W. R. et al. "The Role of Ruminants in Reducing Agriculture's Carbon Footprint in North America." Journal of Soil and Water Conservation 71, no. 2 (2016): 156-64.
[39] Ibid.
[40] National Center for Appropriate Technology. 2010. "Rotational Grazing". National Sustainable Agriculture Information Service, ATTRA. https://attra.ncat.org/attra-pub/download.php?id=245
[41] https://www.nrdc.org/experts/lara-bryant/organic-matter-can-improve-your-soils-water-holding-capacity
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[43] Liebig, M. A. et al. "Grazing Management Contributions to Net Global Warming Potential: A Long-term Evaluation in the Northern Great Plains." *Journal of Environment Quality* 39, no. 3 (2010): 799-809.
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[47] Teague et al.
[48] Christine Jones "Soil carbon – can it save agriculture's bacon?" Agriculture & Greenhouse Emissions Conference, May 2010.
[49] Interview with Dr. Allen Williams, Grass Fed Insights, LLC
[50] Interview with Mark Schatzker
[51] http://www.eater.com/2016/12/5/13492700/best-restaurants-inamerica?&_ga=1.201635857.1490836225.1488302852#roty
[52] Estimates based on Union of Concerned Scientists report "CAFOs Uncovered – The Untold Costs of Confined Animal Feeding Operations", April 2008 and conversation with Dr. Marcia DeLonge, Union of Concerned Scientists.

[53] USDA reports a US total beef industry "retail equivalent value" of $105 billion in 2015, obtained by multiplying the total volume of beef consumed in the U.S. by the average price per pound for USDA Choice grade beef. https://www.ers.usda.gov/topics/animal-products/cattle-beef/statistics-information.aspx.

[54] Technomic Usage & Volumetric Assessment of Beef in Foodservice, 2015 Edition. http://www.beefresearch.org/CMDocs/BeefResearch/MR_Presentations/Beef_Volumetric_2015.pdf

[55] Retail meat weight estimated by multiplying 24.8 billion pounds of beef (U.S. 2015 total beef consumption by carcass weight including imports, as published by USDA) by estimated carcass to boneless retail meat yield of 70%, yielding 17 billion pounds.

[56] *Beef Report*, August 2015.

[57] National Restaurant Association. "What's Hot" 2016 Culinary Forecast. http://www.restaurant.org/Downloads/PDFs/News-Research/WhatsHot2016

[58] "Why Grass-fed Beef Is on a Roll" The Wall Street Journal, September 20, 2016.

[59] Fresh meat comprises fresh/refrigerated and frozen meat including patty and burger

[60] UPC items only.

[61] USDA data. http://www.nationalchickencouncil.org/about-the-industry/statistics/per-capita-consumption-of-poultry-and-livestock-1965-to-estimated-2012-in-pounds/

[62] Ibid.

[63] Ana Ananthakumar et al. "What Drives Meatier Returns?" March 10, 2016 http://changingtastes.net/assets/uploads/content/Meatier_Returns_Summary_Presentation.pdf

[64] The amount of meat an animal yield is calculated by multiplying live weight by carcass yield by boneless retail meat yield. Assumptions for conventional: 1,300 pounds x 62% carcass yield x 74% boneless retail meat yield = 596 pounds, or 46% of live weight. For grassfed: 1,100 pounds x 57% carcass x 70% boneless retail meat = 439 pounds, or 40% of live weight

[65] Umberger et al. 2009. "Role of credence and health information in determining US consumers' willingness-to-pay for grass-finished beef" *Australian Journal of Agricultural and Resource Economics* 53:603-623

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[68] https://www.ams.usda.gov/grades-standards/carcass-beef-grades-and-standards

[69] Grass Fed Insights, LLC

[70] USDA "Food Safety and Inspection Service Labeling Guideline on Documentation Needed to Substantiate Animal Raising Claims for Label Submissions" September 2016. https://www.fsis.usda.gov/wps/wcm/connect/6fe3cd56-6809-4239-b7a2-bccb82a30588/RaisingClaims.pdf?MOD=AJPERES

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[77] http://www.panoramameats.com/our-story

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[79] http://www.globalanimalpartnership.org/5-step-animal-welfare-rating-program

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[81] Meat processed in state-inspected plants that adhere to requirements "at least equal to" those imposed on federal-inspected plants can also be sold to bordering states. See https://www.fsis.usda.gov/wps/portal/fsis/topics/inspection/state-inspection-programs/state-inspection-and-cooperative-agreements/requirements-for-state-programs.

[82] Based on calculation of 16,212,800 head being slaughtered by the 13 largest plants in the U.S., assuming they work 50 weeks/year and 5 days/week. USDA Livestock Slaughter 2015 Summary. April 2016. http://usda.mannlib.cornell.edu/usda/current/LiveSlauSu/LiveSlauSu-04-20-2016.pdf

[83] Interviews with industry experts

[84] Based on calculation of 147,000 head being slaughtered by 469 plants that slaughter less than 999 head per year. These facilities also handle other livestock. http://usda.mannlib.cornell.edu/usda/current/LiveSlauSu/LiveSlauSu-04-20-2016.pdf

[85] Grass Fed Insights, LLC and interviews with other industry experts

[86] Interviews with various grassfed beef producers and industry experts

[87] Interview with industry experts

[88] Conventional conversion: ($2,542/head/1,350 pounds live weight)/carcass yield 64%/boneless retail meat yield 74% = $3.98/lb. Grassfed conversion: ($3,270/head/1,100 pounds/carcass yield 57%)/boneless retail meat yield 70% = $7.45/lb. See Appendix 2 for further information.

[89] Interviews with industry experts

[90] Production defined by USDA to include operations that span from cow-calf to the finishing stage, including feedlots

[91] USDA "Overview of the United States Cattle Industry" June 24, 2016 (http://usda.mannlib.cornell.edu/usda/current/USCatSup/USCatSup-06-24-2016.pdf) and USDA Livestock Slaughter report January 2017 (http://usda.mannlib.cornell.edu/usda/nass/LiveSlau//2010s/2017/LiveSlau-01-19-2017.pdf)

[92] USDA 2012 Ag Census

[93] Grass Fed Insights, LLC. "Trends in the Grass Fed Industry" January 19, 2017.

[94] Survey was submitted through American Grassfed Association and Grassfed Exchange

[95] USDA 2012 Ag Census Highlights https://www.agcensus.usda.gov/Publications/2012/Online_Resources/Highlights/Farm_Demographics/

[96] USDA "2012 Census of Agriculture Highlights – Cattle Industry" February 15, 2015. https://www.agcensus.usda.gov/Publications/2012/Online_Resources/Highlights/Cattle/Cattle_Highlights.pdf

[97] Grass Fed Insights, LLC

[98] Grass Fed Insights, LLC, corroborated by numbers from our market size analysis in Appendix 1

[99] USDA ERS data on imported beef (https://www.ers.usda.gov/data-products/livestock-and-meat-international-trade-data/) and domestic beef production (https://www.ers.usda.gov/webdocs/DataFiles/Livestock__Meat_Domestic_Data__17992/RedMeatPoultry_ProdFull.xls?v=42765).

ENDNOTES

[100] USDA ERS. https://www.ers.usda.gov/data-products/livestock-and-meat-international-trade-data/
[101] Meat & Livestock Australia (MLA) 2016. "Market Snapshot, Beef – North America" (https://www.mla.com.au/globalassets/mla-corporate/prices--markets/documents/os-markets/red-meat-market-snapshots/mla-north-america-beef-snapshot---2017.pdf)
[102] Interview with Dr. Allen Williams
[103] Meatingplace "Colorado considers reinstating COOL" April 3, 2017. http://www.meatingplace.com/Industry/News/Details/72458
[104] Southern Australia is most akin to the U.S. grassfed model in terms of climate, environment and beef production system. In Northern Australia, cattle roam across hundreds of thousands or even millions of acres of semi-arid or desert landscape. This type of system is extremely low-cost and requires little management, except for providing water points and rounding the herd up for sale once a year.
[105] University of Illinois Farm Doc http://www.farmdoc.illinois.edu/manage/uspricehistory/us_price_history.html
[106] Interview with Dr. Allen Williams, corroborated by other industry experts
[107] Drovers "Profit Tracker: No triple digit losses" March 15, 2016. http://www.cattlenetwork.com/news/markets/profit-tracker-no-triple-digit-losses
[108] EWG's Farm Subsidy Database https://farm.ewg.org/progdetailphp?fips=19000&progcode=corn&page=states&regionname=Iowa
[109] Our exemplary large-sized producers achieve an average carcass yield of 59%, implying a live cattle price of $1.49/lb. The average 5-Area weighted cattle price in 2016 was $1.20/lb as per Iowa State Extension (https://www.extension.iastate.edu/agdm/livestock/html/b2-12.html).
[110] Dr. Allen Williams, "Can We Produce Grass Fed Beef at Scale?" Aug 31, 2016 (https://grassfedexchange.com/blog/can-we-produce-grass-fed-beef-at-scale)
[111] Average 1,350-pound live weight with 64% carcass yield for a grain-fed animal
[112] Live weight of 1,200 pounds with carcass yield of 59% for a well-finished grassfed animal
[113] According to American GrazingLands Services founder, Jim Gerrish, as cited in Dr. Allen Williams' article
[114] A beef animal requires roughly 3 tons of forage dry matter to gain 2.1 lbs/day, the ADG required to put on 400 pounds to reach the finishing weight of 1,200 pounds. See "Can We Produce Grass Fed Beef at Scale?" by Dr. Allen Williams
[115] Assuming less productive acres yield on CRP land of 2 tons of forage, for a stocking rate of 0.67 head per acre annually
[116] Additional research is needed on this possibility of converting CRP areas but given the ecosystem benefits associated with regenerative livestock grazing systems, such a shift would not result in negative environmental impacts and could even regenerate previously degraded land if managed properly.
[117] Howell, J. "Can we do it on Grass Alone? Beef Production and the Unrealized Capacity of Grasslands". Quivira Coalition presentation 2012. http://quiviracoalition.org/images/pdfs/1/5241-Howell_Quivira_2012.pdf
[118] The groups are American Grassfed Association, Pennsylvania Certified Organic (PCO), A Greener World and Food Alliance.
[119] https://www.regulations.gov/document?D=FSIS-2016-0021-4629
[120] https://thecarbonunderground.org/definition/
[121] https://www.washingtonpost.com/lifestyle/food/a-pioneer-of-humanely-raised-meat-sees-the-future-and-it-is-meal-kits/2017/03/21/5981c19c-0a92-11e7-93dc-00f9bdd74ed1_story.html?utm_term=.984edba4f461
[122] Grass Fed Insights, LLC, corroborated by other grassfed beef producers interviewed
[123] Fresh 85% trim, FOB - National, processor: https://www.ams.usda.gov/mnreports/lm_xb460.txt
[124] The 10-year average provides a better estimate than 2015, which saw an unusually high export volume.
[125] MLA "Market Snapshot, Beef – North America"
[126] Grassfed percentage estimates based on conversations with industry experts
[127] Beef import volume by country is available at USDA ERS website: https://www.ers.usda.gov/data-products/livestock-and-meat-international-trade-data/
[128] USDA historical wholesale prices are available at: https://www.ers.usda.gov/webdocs/DataFiles/Livestock__Meat_Domestic_Data__17992/WholesalePrices.xls?v=42731
[129] USDA reports a U.S. total beef industry "retail equivalent value" of $105 billion in 2015, obtained by multiplying the total volume of beef consumed in the U.S. by the average price per pound for USDA Choice grade beef. https://www.ers.usda.gov/topics/animal-products/cattle-beef/statistics-information.aspx.
[130] Interview with Dr. Derrell Peel
[131] USDA ERS wholesale data https://www.ers.usda.gov/webdocs/DataFiles/Livestock__Meat_Domestic_Data__17992/WholesalePrices.xls?v=42731
[132] Interview with Dr. Derrell Peel
[133] USDA ERS wholesale data
[134] The historical ratio of steers to heifers placed into feedlots was 65:35 according to Dr. Lee Schulz at Iowa State University. Heifer prices in general are only a little lower than steer prices but the difference is not significant. Incorporating heifer prices in our calculation would not change our figures and overall analysis in any meaningful way.
[135] Conversations with multiple industry experts have confirmed this number.
[136] USDA ERS wholesale data
[137] "Drop" represents an important source of revenue for conventional packers as they export a lot of the drop overseas. In fact, the drop can be so lucrative that packers sometime slaughter animals for free so that they can keep and sell the byproducts.
[138] Interview with Dr. Derrell Peel and Grass Fed Insights, LLC
[139] The USDA 10-year average Choice beef retail value was $4.84/lb of meat, however this does not take any retail discount into consideration. By comparing USDA retail value with price per pound data from scanned retail transactions provided by Nielsen from June 2011 to June 2016, we are able to estimate that in these five years, the final (or discounted) price of beef was on average 82% of the retail value published by USDA. Therefore, if we apply an 18% discount to USDA's 10-year average retail value of $4.84/lb, we arrive at an estimated average retail price of $3.98/lb of fresh beef paid by the consumer during the 2006-2015 10-year period.
[140] Grass Fed Insights, LLC, corroborated by other grassfed beef producers and marketers
[141] Grass Fed Insights, LLC, corroborated by other grassfed beef producers and marketers

[142] Interviews with various grassfed beef producers, branded programs and marketers
[143] Forero et al. 2012. "Sample Costs for Finishing Beef Cattle on Grass." University of California Cooperative Extension.
[144] http://pastureproject.org/resources-2/calculators/
[145] Cascadia Foodshed Financing Project. 2016. "Differentiated Cost of Production in the Northwest: An Analysis of Six Food Categories."
[146] Acevedo et al. 2006. "Organic, Natural and Grass-Fed Beef: Profitability and constraints to Production in the Midwestern U.S."
[147] USDA National Agricultural Statistics Survey. https://quickstats.nass.usda.gov/results/58B27A06-F574-315B-A854-9BF568F17652#7878272B-A9F3-3BC2-960D-5F03B7DF4826.
[148] Iowa State University. Livestock Enterprise Budgets for Iowa – 2016. http://www.extension.iastate.edu/agdm/livestock/html/b1-21.html
[149] Interview with Dr. Lee Schulz, Iowa State University.
[150] Iowa State University. Historic Cattle Prices. https://www.extension.iastate.edu/agdm/livestock/html/b2-12.html
[151] Ibid.
[152] University of Illinois Farm Doc http://www.farmdoc.illinois.edu/manage/uspricehistory/us_price_history.html
[153] MLA, October 2016. "Cost of production: Australian beef cattle and sheep producers 2012–13 to 2014–15." https://www.mla.com.au/globalassets/mla-corporate/prices--markets/documents/trends--analysis/abares-farm-survey/costofprod_austbeefandsheep_2016_v1.0.0.pdf
[154] Based on national breeding cow herd size of 9.605m multiplied by 80% (assumed number of calves from the cows) minus 15% of calves held back as replacement heifers, divided by total number of beef cattle farms of 57,820: 9,605,000*80%*(1-15%)/57,820=113. "A review of the Structure and Dynamics of the Australian Beef Cattle Industry" (http://www.agriculture.gov.au/SiteCollectionDocuments/animal-plant/animal-health/livestock-movement/beef-movement-ead.pdf)
[155] Three-year average carcass price for "Heavy steer" at 500-600kg of A$4.25/kg as published by MLA was used as proxy for grass-finished cattle price. MLA prices available at https://www.mla.com.au/globalassets/mla-corporate/prices--markets/documents/trends--analysis/cattle-projections/mla_australian-cattle-industry-projections-2016.pdf.
[156] Average carcass yield for grassfed animals in Australia is 54% (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/103992/dressing-percentages-for-cattle.pdf). Finishing weight per Impact Ag Partners
[157] Estimated Australian trade steer 3-year average price was A$2.2/kg live according to MLA. Feeder entry weight provided by Impact Ag Partners.
[158] MLA, October 2016.
[159] Ibid.
[160] Land lease data as per Impact Ag Partners.
[161] Stocking rate as per industry experts and Government of Southern Australia "Grazing livestock – a sustainable and productive approach" http://www.naturalresources.sa.gov.au/files/sharedassets/adelaide_and_mt_lofty_ranges/land/grazing-livestock-fact.pdf
[162] The Pasture Project. http://pastureproject.org/pasture-management/rotational-grazing-systems/
[163] North American Meat Institute. 2015. "Case-ready meats modified atmosphere packaging" fact sheet. https://www.meatinstitute.org/index.php?ht=a/GetDocumentAction/i/93528
[164] USDA *Census of Agriculture* report, Appendix B. 2012. https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/usappxb.pdf
[165] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/livestock/afo/
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[168] https://www.epa.gov/npdes/animal-feeding-operations-afos
[169] https://www.mla.com.au/general/glossary/#glossarySection_F
[170] https://www.fsis.usda.gov/wps/portal/informational/aboutfsis
[171] http://savory.global/assets/docs/evidence-papers/about-holistic-planned-grazing.pdf
[172] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/livestock/afo/
[173] See https://www.beefboard.org/library/files/BeefCutsGuide.pdf for list of primals
[174] Our definition of "pure" grassfed beef is derived from a joint letter submitted to the USDA by four leading grassfed certification programs in the U.S. See https://www.regulations.gov/document?D=FSIS-2016-0021-4629
[175] https://thecarbonunderground.org/wp-content/uploads/2017/02/Regen-Ag-Definition-7.27.17-1.pdf
[176] https://www.ers.usda.gov/topics/animal-products/animal-production-marketing-issues/glossary/
[177] Grass Fed Insights, LLC
[178] https://en.wikipedia.org/wiki/Universal_Product_Code