A Breath of Fresh Air

The truth about pasture-based livestock production and environmental sustainability

A GREENER WORLD
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Introduction

A battle is raging over whether intensive cattle systems—where large numbers of cattle are confined in feedlots and fed a grain-based diet—represent a more environmentally friendly method of producing meat and livestock products than pasture-based livestock farming.

In response to growing public concerns over the significant greenhouse gas (GHG) emissions associated with modern livestock production, proponents of industrial farming systems have increasingly argued that intensive cattle systems are more efficient and environmentally friendly than pasture-based farming systems.

Most of the research used to present industrial farming systems as the more environmentally friendly option is limited in scope

They claim that feeding animals in confinement so they grow as quickly as possible actually increases the efficiency of production by reducing the amount of methane (an important GHG) emitted per pound of meat, and that the intuitively more environmentally friendly grassfed option has a far higher resource and environmental cost. In order to feed the growing global appetite for meat and dairy products, and to provide for the world's hungry, we are told that farmers must further intensify production.

Yet, as always, the devil is in the detail. The fact is that most of the research used to present industrial farming systems as the more environmentally friendly option is limited in its scope and—at best—tells only part of the story. These arguments ignore two major factors: First, the significant non-methane GHG emissions resulting from grain-based feedstock production and feedlot manure lagoons. Second, the potential role that carbon sequestration in pasture-based farming systems could play in offsetting the *overall* GHG emissions associated with pastured beef production.

In assessing the current science on pasture-based farming and associated GHG emissions, *A Breath of Fresh Air* confirms that the most sustainable livestock production comes from pasture. Although pastured cattle might have a slower growth rate and produce more methane per pound of meat, this is more than offset by the overall benefits of the entire pasture-based production system.

What are greenhouse gases?

Greenhouse gases (GHGs) absorb and hold heat in the earth's atmosphere. These gases allow sunlight to reach the earth's surface; however, as the sunlight warms the earth's surface, the GHGs absorb some of the energy (heat) that is radiated back, trapping this heat in the atmosphere.

The main GHGs that are produced by human activity are carbon dioxide, methane, and nitrous oxide. These different GHGs vary in their ability to absorb and hold heat in the atmosphere. The more heat that a particular GHG can absorb, the greater the potential damage it may cause. For example, methane absorbs 25 times more heat per molecule than carbon dioxide, while nitrous oxide absorbs 310 times more heat per molecule than carbon dioxide.

CARBON DIOXIDE

The main contributor to the greenhouse effect arising from human activity is carbon dioxide (CO_2). There is a finite amount of carbon on earth, which is part of a natural cycle known as the carbon cycle. Plants absorb CO_2 from the atmosphere during photosynthesis, using the carbon to grow, before releasing it back to the atmosphere when they die and decompose. The bodies of animals (including humans) also contain carbon which comes from the plants or plant-eating animals they consume. Some of this carbon can be released quickly as CO_2 when animals breathe, and when they die and decompose, or natural processes can lock it away in the soil or oceans in a more stable form. For example, fossil fuels, such as coal, oil, and natural gas, are the fossilized remains of dead plants and animals formed over millions of years under certain conditions. This is why they contain a lot of carbon, which is released into the atmosphere when they are burned to produce energy. Although many billions of tons of carbon are exchanged naturally each year between the atmosphere, the oceans, and land vegetation, a new trend has emerged with the widespread use of fossil fuels. Scientific research suggests that CO_2 levels in the atmosphere appear to have varied less than 10 percent during the 10,000 years before the Industrial Revolution. Since 1800, however, atmospheric CO_2 concentrations have risen by about 30 percent as massive amounts of fossil fuels have been burned to produce energy.

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Land use change such as deforestation is a major cause of global CO_2 emissions. When large areas of rain forests are cut down, the land is often used for crops or grasslands, uses which have considerably less capacity for storing CO_2. CO_2 also enters the atmosphere through the burning of solid waste, trees, and wood products, and also as a result of other chemical reactions (for example, during the manufacture of cement). Once released, CO_2 can stay in the atmosphere for 50–200 years, depending on how it is recycled back into the land or the oceans.

METHANE

The second most important GHG is methane (CH_4). Methane is created predominantly by bacteria that feed on organic material in conditions where there is a lack of oxygen. It is therefore emitted from a variety of natural and human-influenced sources. Natural sources include wetlands, termites, and oceans. Human-influenced sources include the mining and burning of fossil fuels, livestock husbandry (cattle, goats, sheep, and other animals eat plants that ferment in their stomachs, which causes them to exhale methane), rice cultivation (flooded paddy fields produce methane as organic matter in the soil decomposes without sufficient oxygen), and landfills (as organic domestic waste decomposes without sufficient oxygen). Methane can stay in the atmosphere for between 10–15 years.

NITROUS OXIDE

Nitrous oxide (N_2O) is released naturally from oceans and rainforests and by bacteria in soils. However, human-influenced sources include the manufacture and use of nitrogen-based fertilizers, fossil fuel combustion, and industrial chemical production using nitrogen, such as sewage treatment. Animal waste stored in liquid form in lagoons is another source of N_2O (see "Nitrous Oxide and Manure", page 8).

FLUORINATED GHGS

These are the only GHGs that do not occur naturally, but have been developed by man for industrial purposes. Although they represent just 1.5 percent of all GHG emissions from industrialized countries, fluorinated GHGs are extremely powerful. They can trap heat up to 22,000 times more effectively than CO_2 and can stay in the atmosphere for thousands of years. The best known of these gases are chlorofluorocarbons (CFCs), which are not only potent GHGs, but also deplete the ozone layer. CFCs are being phased out under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. Fluorinated GHGs are included here for thoroughness, but as their production is already being phased out, and they are not associated with agriculture, they are not considered further in this report.

Do grassfed cattle release more greenhouse gases than grainfed cattle?

The answer to this question depends on which GHGs you measure, and what point you are trying to make. If you look solely at a single GHG produced by a ruminant animal, then the data clearly shows that pastured ruminants are producing more methane than intensively reared animals.

However, as A Greener World and many other individuals and organizations now recognize, the only accurate way to compare different methods of livestock production is to look at everything that goes into that production system—including the growing and fertilizing of feed crops—not just the direct emissions from the animal itself.

METHANE

Ruminants have the unique ability to convert forage and cellulose-rich foods into useable nutrients. Ruminant digestion is primarily a microbial process and the fermentation and digestion of fibrous feeds produces compounds that the animals can absorb and utilize, as well as methane gas which is eructated (belched) into the air.

Research shows that different grasses and forages at different stages of development cause ruminants to produce different amounts of methane. As a general rule, the more fibrous the feed the greater the methane emissions, which is where the contention originates that grassfed beef systems produce more GHGs than grainfed or feedlot beef systems. Grains, such as corn and soy, are actually much easier for ruminants to digest and the amount of methane produced by cattle fed a grain-based diet is less than that cattle fed grass-based diets (although it is important to state that high grain diets can also have harmful effects on the health of ruminants). Grain is made up of simple sugars and starch, which are much easier to break down and digest than fibrous forages, requiring less fermentation and resulting in less methane production. It is on this simple basis that proponents of intensive farming systems frequently argue that intensively raised livestock are more environmentally friendly and more resource-efficient than pasture-based livestock.

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Yet even this seemingly straightforward point can be considered in several different ways. For example, you could argue that the methane emissions from feedlots on a per acre basis will be far higher than the equivalent sized grass-based production systems, because the feedlot will have many more animals packed more closely together. However, if the comparison is made on the more equitable basis of each pound of beef that is produced, it is possible to argue that the faster growing grainfed cattle will produce less methane than their pasture-fed counter-parts. As an example, an Australian study (Peters *et al* 2009) found grain-finished beef produced 38 percent less methane than grass-finished beef. Peters *et al* pointed out (as noted above) that although the total methane emissions were higher from the area of the feedlot, the animals gained weight faster and so were slaughtered at a younger age, emitting less gas on a per pound of meat basis. But although this may appear to be a convincing argument in favor of intensive production systems, we will return to consider this point once again when we look at the overall emissions from different farming systems.

METHANE FROM MANURE

In addition to eructucation, methane is also produced during the bacterial decomposition of livestock manure when there is no free oxygen present (anaerobic conditions). These anaerobic conditions usually occur when large numbers of animals are managed in a confined area, such as cattle feedlots or industrial indoor pig and poultry farms, where manure is typically stored in large piles or disposed of in open lagoons.

The level of methane production depends on the type of manure management system used, which can be broadly divided into liquid and dry manure management systems. Dry systems include solid storage, dry feedlots, deep pit stacks, and daily spreading of the manure. Unmanaged manure from animals grazing on pasture also falls into this category. Liquid management systems often use water to facilitate manure handling. These systems include tanks and lagoons which store manure as a slurry until it is applied to cropland. Liquid systems create the ideal anaerobic environment for methane production.

Manure decomposes more rapidly when the climate encourages bacterial growth. For liquid manure systems, warm temperatures increase methane generation. For solid systems, rainfall can affect methane production, with wet climates having higher emissions than arid climates. In either case, emissions from solid systems tend to be very low.

Manure composition, which varies by animal diet, growth rate, and animal type (including the animal's digestive system), will also affect the amount of methane produced. According to the National Research Council (2003), "the greater the energy content and biodegradability of the feed, the greater is the methane production potential of the manure." The National Research Council also states that "manure from animals fed with grain-based, high-energy diets is more degradable and has higher methane production potential than manure from animals fed with a roughage diet." Therefore, liquid manures from gain-fed cattle will emit more methane than manure deposited on pasture by grazing animals.

NITROUS OXIDE

Nitrous oxide (N_2O) emissions from pasture depend on the fertility of the pasture. In dry and infertile regions annual N_2O emission will be negligible, while emissions from wet pastures are often much higher. The main source of N_2O emissions in grazed systems are the manure from the animals (whether collected and spread or deposited while grazing), emissions from applied nitrogen (N) fertilizer inputs, and emissions caused by soil aeration (the process by which atmospheric air enters the soil).

Soil aeration is affected by rainfall (or irrigation), soil compaction, and grazing management. In very wet soils, aeration is restricted because a large proportion of what could otherwise be air spaces in the soil are filled with water. N_2O emissions from dung and urine patches on pasture will be higher if soil is waterlogged and damaged. The overall emissions from animal manure and fertilizer obviously depend on the time animals spend grazing and how much fertilizer is applied, as well as the type and timing of fertilizer application. Pasture-based systems that do not rely on artificial

Do grassfed cattle release more greenhouse gases than grainfed cattle?

N fertilizer and have well-managed (not waterlogged) pastures will have relatively low N_2O emissions. In terms of grainfed feedlot beef cattle, artificial N fertilizers are not required to produce grass for grazing, as the animals are standing in dirt lots. However, this means everything that feedlot cattle eat must be grown elsewhere and trucked in. Corn and soy (primary components of the typical feedlot diet) need N to grow. The Energy Information Administration (an agency within the U.S. Department of Energy) claims that more than three-quarters of farming's N_2O emissions come from the production of artificial fertilizer used to grow feed crops like corn and soy. It is worth noting that grassfed cattle systems do not require these vast quantities of N_2O-producing artificial fertilizers. Again, we will return to this specific issue later in the paper when we discuss overall GHG emissions from different farming systems.

NITROUS OXIDE AND MANURE

After manure is excreted, the nitrogen (N) component is transformed into different compounds, depending on how the manure is handled and stored. When manure is dry stacked, and where oxygen is present (aerobic conditions), the N will mainly stay within the manure as organic N or ammonium. When oxygen is not present (anaerobic conditions) some N will be lost to the atmosphere as ammonia. In liquid manure systems such as lagoons N will be given off as ammonia. A portion of the N in manure will also be gasified into N_2O.

The production of N_2O emissions from livestock manure depends on the composition of the manure and urine, the type of bacteria involved in the process, and the amount of oxygen and liquid in the manure system. For direct N_2O emissions to occur, the manure must first be handled aerobically (with oxygen) where ammonia or organic N is converted to nitrates and nitrites (nitrification), and then handled anaerobically (without oxygen) where the nitrates and nitrites are reduced to di-nitrogen gas, with intermediate production of nitrous and nitric oxides (known as denitrification). These emissions can occur from the common management technique of aerating slurry lagoons to control odor, which leads to the manure being exposed to intermittent aerobic and anaerobic conditions. It can also occur in dry manure handling systems (which are generally aerobic) when dry manure is applied to saturated land or itself becomes saturated (sometimes from being stored too long), causing anaerobic conditions.

Indirect N_2O emissions are produced when N is lost from the system through volatilization (conversion into gas or vapor) or through runoff and leaching. The vast majority of volatilization losses from these operations are ammonia. Runoff losses would be expected from operations that house animals or store manure in a manner that is exposed to weather. Runoff losses are also specific to the type of animal housed on the operation due to differences in manure characteristics.

Pasture-based systems that do not rely on artificial N fertilizer and have well-managed pastures will have relatively low N_2O emissions

If you look at poultry, pigs, and cattle, and a range of housing systems from bedding packs, slatted floors, deep litter and feedlots, the greatest housing N loss occurs when cattle are on a feedlot (Rotz 2004). Losses of 40–90 percent of the excreted N are reported by the time feedlot pens are cleaned. Most of this loss is emitted into the atmosphere, but portions are also lost through runoff from rain and leaching into the soil below the feedlot. A comprehensive feeding experiment (Bierman *et al* 1999) found that 9–19 percent of the N excreted by cattle on various finishing diets was removed in the manure scraped from the lot at the completion of the study. N lost in runoff represented 5–19 percent of the excreted N, with 10–16 percent leached into the soil. The remaining 57–67 percent was assumed to be lost by volatilization into the atmosphere —making feedlots a significant source of GHGs. Volatile loss would primarily be in the form of ammonia, but denitrification products—including N_2O—would also occur. Although papers such as the one noted here exist and quantify N_2O emissions from feedlots the results are rarely included in reports on GHG emissions from livestock production.

CARBON DIOXIDE

One source of CO_2 discussed earlier in the report is deforestation. This has mainly occurred in South America, where large areas of rainforest have been cleared. Sometimes this land is converted into pasture, but it is mainly converted into cropping land—usually to grow soy. A Friends of the Earth report from 2010 states that, based on current trends, soy farmers and cattle ranchers will destroy 40 percent of Amazon rainforest by 2050. The soy from this land is mainly exported and is being used to feed livestock. Although intensive livestock production relies on soy as a feed component, the carbon cost of deforestation to produce such feed is ignored by most of the research reviewed in this report, as well as the associated energy costs of transporting the feed and the energy required to run equipment, to mill feed, and to produce and spread fertilizer and chemicals used to grow the feed crops. This represents another carbon "cost" unaccounted for by proponents of intensive systems.

Feeding cattle instead of humans: a hidden cost of grainfed meat?

Wilkinson (2010) points out that livestock, particularly ruminants, can eat a wider range of biomass than humans. In recent years, intensive livestock production systems have moved away from allowing ruminants to graze vegetation on pasture or range, favoring approaches where animals are confined (either indoors or in feedlots) and fed a grain-based diet. This puts intensively raised livestock in direct competition with humans for high-energy crops such as cereals. Wilkinson assessed feeds consumed by livestock in terms of the quantities used and the efficiency of converting various feeds into milk, meat and eggs. The feeds were split into grassland, crops that could be eaten by humans, and crop by-products.

Today, intensively raised livestock are in direct competition with humans for high-energy crops such as cereals

Wilkinson revealed that when you compare how much edible energy or protein you get out of ruminant, pig, and poultry production systems for the amount of human-edible energy or protein you need to put in, ruminants came out on top. The researchers showed that grass-based beef systems also perform much better than cattle systems that rely on feeding grain. Wilkinson's research looked at livestock systems in the UK, but the same results were found in U.S. systems by Pelletier *et al* (2010).

It is worth noting that this area of research takes the discussion about sustainable production away from simply looking at the amount of methane a beef animal might belch in its lifetime. As Wilkinson points out, millions of tons of grass and forage crops are consumed in the production of milk and meat from ruminants, and much of the pasture land that is used would be otherwise unsuitable for the production of human food.

There are many areas of the world where the climate is conducive to the production of grass and forage crops, but the limitations of topography or soil type preclude growing crops that can be directly eaten by humans. If these grasses and forage crops are grown and grazed as efficiently as possible, or grown, cut, preserved, and then fed to ruminants, it enables us to produce food from land that could not be used in any other way for food production. In addition, the overall cost (price and environmental) of this food will be less than that from animals fed large quantities of grain.

Carbon sequestration and pasture-based livestock systems

The argument most frequently used to suggest that intensive cattle production systems are the most environmentally friendly option is that grassfed beef cattle emit more GHGs in the form of methane in their lifetimes than grainfed animals. This is because grassfed cattle tend to grow more slowly and take more time to achieve slaughter weight, and because cattle emit more methane when digesting grass than when they digest grain.

Studies have shown that grassfed cattle produce more methane in their lifetime than grainfed cattle. However, it is important to understand that this does not mean that grassfed cattle systems produce more GHGs in their lifetime than grainfed cattle systems. Indeed, a number of leading scientists now acknowledge that grassfed livestock systems could actually play a vital role in helping to cut global GHG emissions. How is this possible? Grassfed cattle can actually mitigate (or counter) their higher methane emissions by helping to capture atmospheric carbon dioxide (CO_2)—another key GHG—through a complicated natural process called carbon sequestration.

Carbon sequestration is the natural process of transferring CO_2 from the atmosphere into the soil through crop residues and other organic solids, and into a form that is not immediately re-emitted. As cattle and other ruminants graze pasture they fertilize the ground with their manure, tramping around and stimulating the grasses to grow and produce more leaves. As the grass grows it absorbs more CO_2 from the atmosphere and creates a mass of roots under the ground, effectively storing the CO_2 the plant has absorbed in a much more stable form of carbon within the soil, where it can remain for centuries.

When this carbon storage role is incorporated into the calculations of overall GHG emissions, many researchers now state that grassfed beef produces no net GHG emissions—and some argue that well-managed grassfed beef systems may even capture more GHGs than they emit. So why is carbon sequestration not included in the many research papers that examine GHG emissions from meat production? The problem is that accurately quantifying how much soil carbon contributes is difficult, and it can vary dramatically from place to place.

Leading scientists are at least now acknowledging that pasture land—and here we are talking about traditional pastures that are not totally reliant on imported fertilizers and pesticides—could have a vital role to play in cutting GHG emissions through capturing and storing atmospheric carbon. Indeed, the Intergovernmental Panel on Climate Change (IPCC)—the world's leading body for the assessment of climate change—now suggests that soil carbon sequestration is the mechanism responsible for most of the mitigation potential. There is more carbon locked up in the soil than there is in the atmosphere and, according to the U.S. Department of Energy, enhancing the natural processes that remove CO_2 from the atmosphere is increasingly considered to be the most cost-effective means of reducing atmospheric levels of CO_2. The FAO (2006) also agrees that rebuilding soil integrity is an integral part of reducing the livestock industry's carbon footprint: "Compared to the amounts of carbon released from changes in land use and land-degradation, emissions from the food chain are small. So for CO_2 the environmental focus needs to be on addressing issues of land-use change and land degradation. Here the livestock sector offers a significant potential for carbon sequestration, particularly in the form of improved pastures."

The vital role that pasture-based farming can play in mitigating climate change

The world's soils are the largest terrestrial reservoir of carbon, containing three times as much carbon as the atmosphere and five times as much as the world's forests. By abandoning intensive livestock systems and, instead, adopting sustainable livestock management techniques, the soils have the power to literally take CO_2 out of the atmosphere and to significantly help to mitigate the threat of climate change.

Assumptions about the impact of carbon sequestration are absolutely vital when assessing the total GHG emissions for a particular livestock system. In the section above on "Feeding Cattle or Feeding Humans," we noted that Pelletier *et al* (2010) argue that, on the basis of edible energy in versus edible energy out, grassfed animals do much better than grainfed feedlot animals. However, Pelletier *et al* also stated that feedlot animals scored better than grassfed animals on the basis of GHG emissions per kilogram of beef produced. Like many other researchers, Pelletier *et al* wrongly assumed no carbon sequestration occurred in the pasture-fed systems. However, to their credit, Pelletier *et al* carried out a sensitivity analysis as part of their research. When they applied estimates of 0.12 metric tons carbon sequestered/ha/year for improved cow-calf pastures and 0.4 metric tons carbon sequestered/ha/year for previously unmanaged pastures subjected to management-intensive grazing for pasture finishing they found that pasture-raised beef has 15 percent lower emissions than the feedlot beef, and that pasture-raised beef emissions were also lower than for the beef animals that started life on pasture but were then finished in feedlots. Pelletier *et al* went on to say that "beef produced on unmanaged rangeland may, indeed, be considerably less energy intensive than the systems we modeled, although this would also result in tradeoffs in terms of animal performance and associated emissions."

Other research further supports the importance of taking carbon sequestration into account when considering overall GHG emissions from livestock systems. For example, Subak (1999) compared U.S. intensive meat cattle production with a traditional African pastoral system.

Extensive grass-based livestock systems have lower overall GHG emissions than intensive systems

The study included assessment of both major land use and energy-related emissions and concluded that although CO_2 emissions are greater with the U.S. feedlot system, the methane intensity of the pastoral model is much larger than the U.S. system because of the lower overall productivity of system. However, Subak also looked at indirect sources of GHGs. As well as considering emissions from fossil fuels, she included the carbon storage that would be foregone by appropriating land for intensive beef production. When these factors are considered along with emissions from enteric fermentation and wastes, the carbon costs of the U.S. feedlot system (15 kg CO_2 equivalent/kg beef) are more than double that of the African pastoral system.

In 2012, the National Trust (an organization responsible for managing more than 600,000 acres of land in the UK) published a report, entitled *What's Your Beef?*, which examined in detail the GHG emissions on some of their 1,500 farms. Around 80 percent of the Trust's farmed area is grazed. As cattle and sheep are involved in most of the farming operations on Trust land, the viability of livestock is central to their agriculture and food interests. The research on the National Trust farms reinforces the value of carbon sequestration when assessing the overall GHG emissions from different farms and systems. While the GHG emissions (measured in CO_2 equivalents) of grassfed and more intensive farms were largely comparable, the carbon sequestration contribution of well-managed grass pasture on the less intensive, grass-based systems reduced net GHG emissions by up to 94 percent—and even resulted in a carbon "net gain" on some farms.

The National Trust study went on to compare beef production scenarios with other UK and overseas beef production systems. The Trust showed that incorporating land carbon sequestration into the overall GHG accounting methodology reverses the emissions ranking for intensive and livestock extensive systems, and demonstrates once again that extensive grass-based systems have lower overall GHG emissions than intensive feedlot and grain-based systems.

The environmental cost of corn

Aside from the important role of carbon sequestration, another key fact that is often ignored by proponents of intensive grainfed systems is the significant environmental cost of producing and transporting the feed for the grainfed cattle.

Grasses and many other types of forage are perennials—in other words, they grow year after year. If the mix of vegetation in the pasture is well-balanced and effectively managed then the amount of fossil fuel required to grow these grasses is minimal. Indeed, many pastures are managed with no artificial fertilizer, cultivation, or herbicide, resulting in minimal associated GHG emissions.

By contrast, in a grain-based cattle system corn must be planted every year; the ground usually requires cultivation before seeding; fertilizers and pesticides are routinely required; and the corn must then be harvested and transported to the feedlot. All of this takes gasoline, diesel, and electricity. According to Liska *et al* (2009), the combined GHG emissions from every stage of crop production equates to between 226–426 kgs of CO_2 equivalent per metric ton of corn. That means each pound of corn is responsible for 0.23–0.43 lbs CO_2 equivalent GHGs. On this same basis, David Pimentel, a Cornell ecologist who specializes in agriculture and energy, argues that a typical feedlot steer will in effect consume 284 gallons of oil in his lifetime.

An analysis by New Zealand Grassfed Beef (2012) also considered the overall GHG emissions associated with feed production for intensive feedlot cattle systems. Using figures from the (U.S.-based) National Cattlemen's Beef Association, if the average animal consumes 15–24 lbs of feed per day (of which at least 70 percent is corn), between 2.4 and 7.2 lbs of carbon is released from feed production alone for each animal per day. The National Cattlemen's Beef Association says that cattle are usually feedlot finished for an average of three to six months. Based on the "best-case scenario" (an animal eating the minimum feed for the minimum amount of time), the emissions from feeding one animal 15 lbs of 70 percent corn-based feed for three months, according to New Zealand Grassfed Beef, would represent around 201.6 lbs of carbon. To put this in perspective, according to the U.S. Environmental Protection Agency (2011), "a medium growth coniferous tree, planted in an urban setting and allowed to grow for 10 years, sequesters 23.2 lbs of carbon."

A Cornell ecologist argues that a typical feedlot steer will consume 284 gallons of oil in its lifetime

As New Zealand Grassfed Beef states, to offset the GHG emissions associated with feedlot feed only for a single "best-case" animal we would need to plant nine trees that live for at least 10 years. According to the National Cattlemen's Beef Association, 33.5 million cattle were slaughtered in the U.S. during 2011 to feed the nation's demand for cheap beef. Taking into account the small percentage of grassfed beef currently slaughtered in the U.S. each year, we would need to plant a staggering 292,455,000 trees (each living for no less than 10 years) just to offset the total GHG emissions for all the feedlot corn grown to feed one year's worth of American grainfed beef.

So shouldn't we just stop eating meat?

A not uncommon response to the array of information about livestock production and GHG emissions is for people to suggest we should give up eating meat altogether. A Greener World respects that fact that the decision to eat meat is the choice of the individual and will be based on many factors. However, from the information presented in this paper, it can be seen that this is not necessary and meat eating can be sustainable for those who choose to do so, although it is important to note that we are talking about grassfed and pasture-raised animals —*not* feedlot beef or intensively farmed chickens and pigs.

As discussed above, a growing number of leading scientists now acknowledge that grassfed livestock farming has a potentially important role to play in combating climate change and that well-managed livestock are necessary for managing the world's pastures as carbon sinks.

Regular grazing by livestock encourages grass root growth, which in turn sequesters more atmospheric carbon in the soil. Livestock also utilize the forage, much of which would be unsuitable for crop production, providing meat and livestock products as an output while helping to increase the organic matter content of the soil. By leaving behind intensive livestock systems and instead relying on grassfed livestock systems, the soils have the power to literally take CO_2 out of the atmosphere and to significantly mitigate the threat of global warming. In fact, ceasing consumption of intensively raised meat and choosing pasture-based livestock products instead will actually have a far more positive effect on reducing climate change than either side of a raging battle would have us believe.

In *Meat, A Benign Extravagance*, Simon Fairlie argues this point very eloquently. He states that the U.S. Environmental Protection Agency (EPA 2012) estimates that livestock are responsible for 34 percent of global human-made methane emissions. To eliminate the bulk of these animal-sourced methane emissions, the human race would not need to eliminate all its livestock; just its cattle, sheep, goats and other ruminants—the fiber eaters —representing about half the nourishment derived from all livestock. But before coming to any conclusions about the environmental impact of these grass-eating animals, we need to examine the opportunity costs of eliminating all beef and dairy from our diets—including that from pasture based systems.

Millions of tons of grass and forage crops are consumed in the production of milk and meat, and much of that pasture land would be unsuitable for the production of human food

Without beef, sheep and dairy production, Fairlie argues that we would actually need to consume an extra 25 percent of our current production of grains, pulses and vegetables to compensate. The Intergovernmental Panel on Climate Change (IPCC) estimates that plant crops produce 17 percent of current human made methane emissions—exactly half the amount emitted by livestock—so in theory this would increase correspondingly, eating into the methane savings made by getting rid of our ruminants.

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To further put things into perspective, Fairlie compares the methane toll of milk production against that of cars. At 25 grams of methane per kilo of milk, someone consuming a pint of milk every day would be responsible for emitting around 130 kg of CO_2 equivalent per year. This is about 3 percent of the 3.9 metric tons emitted by driving 10,000 miles per year in a small car averaging 37 miles per gallon. A more significant concern for anyone proposing to reduce or eliminate the global cattle herd is the extent to which farmed livestock would be replaced with methane-emitting wild animals. Whenever domestic animals are removed from grassland, other species move in. In other words, even if we did stop eating beef and lamb, ceased drinking milk, and got rid of all our farmed herds and flocks, wild animals (depending on where you are in the world) like deer or wildebeest will take the opportunity to utilize the now unfarmed pasture areas—the majority of which, if you remember, cannot be used to grow any crops edible for humans. And these wild animals will still emit methane.

In summary, changing our meat-eating habits so we cut out grainfed meat products altogether and instead choose sustainably produced grassfed products as part of a healthy diet, can actually help reduce GHG emissions. Stopping eating meat entirely will not necessarily have the same effect.

Other common myths about grass-based livestock farming systems

THE LAND ARGUMENT

Critics of grass-based livestock systems often argue that there is not enough land for pasture-based livestock systems. A figure frequently quoted is that it requires between 2–20 acres to raise a cow on grass; indeed, a journalist recently stated that if we raised all the cows in the U.S. on grass (all 100 million cattle on 10 acres apiece) the cattle would require almost half the country's land. This figure is highly dubious. Across the U.S. the area required to support a cow and calf combination varies from around 2 acres to more than 20 acres—note this is a cow and calf combination, not necessarily the area to raise a cow. Where the land area required is more than 20 acres, this is typically extensive grassland that is unsuitable for anything other than grazing livestock.

The often quoted figures also ignore the fact that sheep and/or goats are frequently co-grazed with cattle, with benefits to health, fertility, and production for all species and the land. It is also important to remember that while feedlot cattle may be physically standing on a small area of land, they need grain, which must be grown somewhere. Grain destined to feed cattle is also being grown on land that could be producing human food, unlike our cow-calf combination that might be on Midwest range that is wholly unsuitable for any crop.

The so-called land argument is also based on the "business as usual" assumption where we all carry on eating as much meat as we do now—even though for the nation as a whole this is unhealthy. The fact is that we can continue to eat meat and livestock products —and improve our environment, our health and the welfare of the cattle at the same time—by switching to grassfed meat and livestock products. We just need to do this as part of a healthy and sustainable diet.

THE COST ARGUMENT

Proponents of grainfed beef often argue that we need intensive confinement systems because we need cheap meat to feed America. First, this argument fails to take into account the external costs of producing industrial meat, such as the pollution from manure lagoons, the recalls of salmonella-infected meat, and so on. Second, stating that higher quality, healthier, welfare-friendly meat should not be considered because it might cost more is a very tenuous argument, particularly considering the huge long-term diet-related health costs of consuming too much poor quality meat. As a nation, we urgently need to look at eating less meat, but choosing higher quality meat when we do eat it, which could amount to the same weekly spending on meat, but fewer pounds purchased. This would bring a health benefit from (for example) grassfed beef with higher omega-3 fatty acids, and from a reduction in the risk of obesity, diabetes and other diet-related diseases.

We also know that as pasture-based production becomes more widespread, the resulting economies of scale will reduce the costs at the checkout counter. For example, in the UK (where 50 percent of the sow herd is now in outdoor, free range production) the price of pork from outdoor-raised herds is only a few pennies per pound more than "standard" indoor pork. Similarly, grass-based beef and lamb may often be cheaper to produce in certain climates where forage will grow but grain will not.

No time to rest on our (grassfed) laurels

We know that grassfed beef production systems are better in terms of overall GHG emissions than intensive confinement systems. But recent research suggests that it may be possible for managed rotational grazing systems to improve productivity from grass—and potentially reduce methane emissions, too.

Harper *et al* (1999) developed a technique to measure methane production by cattle in pasture and feedlot conditions. Measurements were taken continuously under field conditions over several days. Methane production showed a marked variation through the day, with greater emissions during periods of rumination as opposed to grazing. When the cattle were grazed on pasture, they produced 0.23 kg methane per animal per day, which corresponded to the conversion of 7.7–8.4 percent of gross energy into methane. When the same cattle were fed a highly digestible, high-grain diet, they produced 0.07 kg methane per animal per day, corresponding to a conversion of only 1.9–2.2 percent of the feed energy to methane. These measurements clearly document higher methane production (about four times) for cattle receiving low-quality, high-fiber diets than for cattle fed high-grain diets.

As previously discussed, this evidence suggests once again that grassfed cattle produce more methane than grainfed cattle. However, Harper *et al* make the point that the biggest differences in methane production are between cattle fed low quality high fiber diets and those on grainfed diets. Methane emissions from animals fed higher quality forages compare much better with grainfed animals. This corresponds with the conclusion of Peter *et al* (2009) that the quicker animals gain weight, the lower the methane per pound of meat produced.

In other words, the pounds of meat that can be produced from each area of pasture, and hence the amount of methane produced per pound of meat, is determined by the number of animals kept per acre and how quickly those animals grow. So by taking action to improve the overall management of land, forage, and cattle with methane production in mind it may be possible for managed pasture-based farmers to further reduce the amount of methane for each pound of pasture-raised beef.

Work on feeding animals to reduce their methane emissions has been going on for some time. We know, for example, that feeding cattle on high quality forages like legumes (such as clover) generally yields lower methane emissions than pasture that is simply composed of grasses. Some legumes like birdsfoot trefoil and sainfoin contain compounds called condensed tannins. As well as having a potentially beneficial effect on controlling internal parasites—an important consideration as heavy burdens of parasites reduce growth rates and increase the methane produced per pound of meat harvested—these compounds have also been shown to reduce methane emissions from grazing cattle by 15 percent (Waghorn and Woodward 2006).

Work on feeding animals to reduce their methane emissions has been going on for some time

Similarly, UK researchers found that feeding red clover forages to sheep also appeared to reduce methane emissions. In a trial with lambs, they found that methane production was 33 percent lower when the lambs were fed red clover silage rather than grass silage. So improving pastures where appropriate —which might simply involve sowing grass-legume mixes—could help to reduce overall methane emissions. The management of grassland can also influence emissions of methane. As explained above, we know that the quality of grass can have an effect on the methane emission per pound of beef produced. Research shows that consuming higher quality grasses mean that the animal can grow faster: UK researchers found that feeding high sugar grasses to sheep could reduce the associated methane emissions by 20 percent for every pound of weight gained. Temperate grasses tend to be more digestible than tropical grasses, while younger grass of any kind has less fibrous material in its cell walls. Planting particular grass and forage species and using rotational grazing so animals are always eating plants at the optimum growth stage can help increase animal productivity, resulting in a reduction of methane per pound of beef produced.

There are other options for those farmers who cannot or do not want to manage their animals as entirely grassfed. Some pasture-based farmers use small amounts of supplemental feed when forage quality or quantity is low, particularly when the demands on the animals are high, such as when cows are nursing their calves. These supplements can still be managed to reduce GHG emissions. For example, UK researchers (Defra 2011) found that adding small amounts of crushed canola seed to the diet of dairy cows resulted in a 20 percent reduction in methane emitted for every liter of milk produced.

They also found that feeding sheep naked oats—a variety that has a less fibrous husk than traditional oats—reduced their methane emissions by up to a third. Supplementing ruminant diets with both garlic extract and linseed oil have also been found to reduce methane production. The only downside of the garlic extract is that it can cause taint in meat and dairy products if used to excess. Yeast supplements are frequently added to dairy cow diets as a way to balance pH in the rumen and improve feed digestion, and research has shown that these supplements have the potential to reduce methane emissions, too.

Clearly, much work still needs to be done before we can recommend specific feeding plans for ruminants that not only maintain their health and welfare, but also reduce their contribution to GHG emissions. Researchers do not yet know exactly why some of these compounds seem to work better for sheep than cattle, or why some additives that looked promising in the laboratory have not performed as expected when fed to live animals. Nevertheless, this area of research deserves far greater investment.

Summary

In recent years, the intensive livestock industry has attempted to promote itself as being the only environmentally friendly solution for future livestock production. However, this is almost always based on the overly simplistic argument that grassfed cattle produce more methane than grainfed cattle. While this may be true, this report shows that methane is just one part of a much bigger picture. N_2O, the most potent GHG with the ability to absorb 310 times more heat per molecule than CO_2—and around 12 times more heat per molecule than methane—is frequently directly emitted from the vast manure lagoons associated with intensive livestock production. Perhaps more importantly, however, is the N_2O emissions associated with the production and use of nitrogen-based fertilizers that are used to grow the grain necessary to feed the millions of intensively kept animals in feedlots across the U.S.

Different ways of comparing intensive and grassfed meat confirm the overall benefits of grassfed production. When we look at the amount of food that could otherwise be used to feed humans per pound of edible meat produced, then grassfed meat wins hands down. Grass- and forage-based livestock systems frequently utilize land that would be other-wise unsuitable for the production of crops for human consumption. Utilizing this vegetation in a sustainable way is therefore a positive benefit for us all—and for the planet.

By grazing livestock on these grassland and pasture areas, pasture-based livestock systems help to encourage carbon sequestration—another part of the jigsaw that is often ignored by proponents of intensive livestock systems. As shown in this report, when you take into account the positive role that pasture-based livestock systems can play in mitigating climate change through carbon sequestration, this often completely reverses the position when intensive and grassfed meats are compared. Although carbon sequestration can be variable, and is still difficult to measure, this is not a reason to discount it or to ignore it completely.

Instead of looking at maximizing efficiency in one part of meat production—the amount of methane per pound of meat produced—we should be looking at optimizing production. Grassfed cattle might have slower growth with more methane produced per pound of meat, but this is offset by the benefits of the entire grass-based production system—no environmental costs of producing corn and grain, no pollution from manure, and the positive impact of carbon sequestration on total GHG emissions. All this and we have not even begun to consider the human health and animal welfare benefits of pasture-based livestock production (see A Greener World's *The Grassfed Primer*, page 22).

There is no question that agriculture as a whole is still a major contributor to global GHG emissions. While we must not ignore this fact, when it comes to assessing our best options for livestock production in the future we cannot allow important factors like carbon sequestration to be ignored simply because they are more difficult to measure—and less likely to make the headlines—than the amount of methane that a ruminant belches. Optimizing our future meat production means making our meat production truly sustainable—and grassfed systems can help achieve this.

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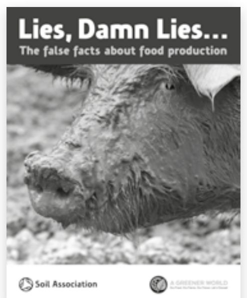
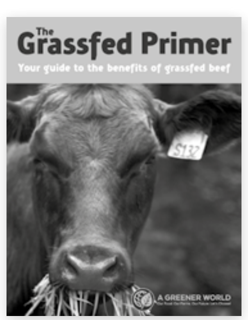
A Greener World publications



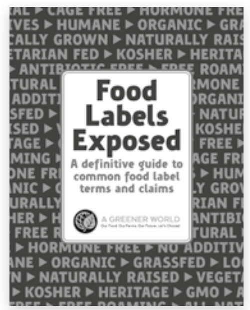
LIES, DAMN LIES...

Over the last decade, two key statistics have come to dominate the discourse on global food security. Leading scientists, politicians, and agriculture and GM industry representatives alike have frequently claimed that we the need to increase global food production by 50 percent by 2030—and for food production to double by 2050—in order to feed a future population of 9 billion people. Published in partnership with the UK's Soil Association, *Lies, Damn Lies... The false facts about food production* investigates the sources and basis of these two key statistics, and reveals how the UK Government's Chief Scientific Advisors, the US Secretary of Agriculture, the Chief Scientist of the US Department for Agriculture, Syngenta, Monsanto and many US and UK politicians have all got their facts very wrong indeed.

THE GRASSFED PRIMER



As the range of products making grassfed claims continues to expand, A Greener World's *The Grassfed Primer: Your guide to the benefits of grassfed beef* is designed to cut through the confusion. Written in an accessible and informal style, this publication provides an informative, easy-to-digest introduction to the benefits of grassfed and pasture-raised beef for animal welfare, the environment and, of course, for human health. The report includes extensive scientific references for further reading and research.

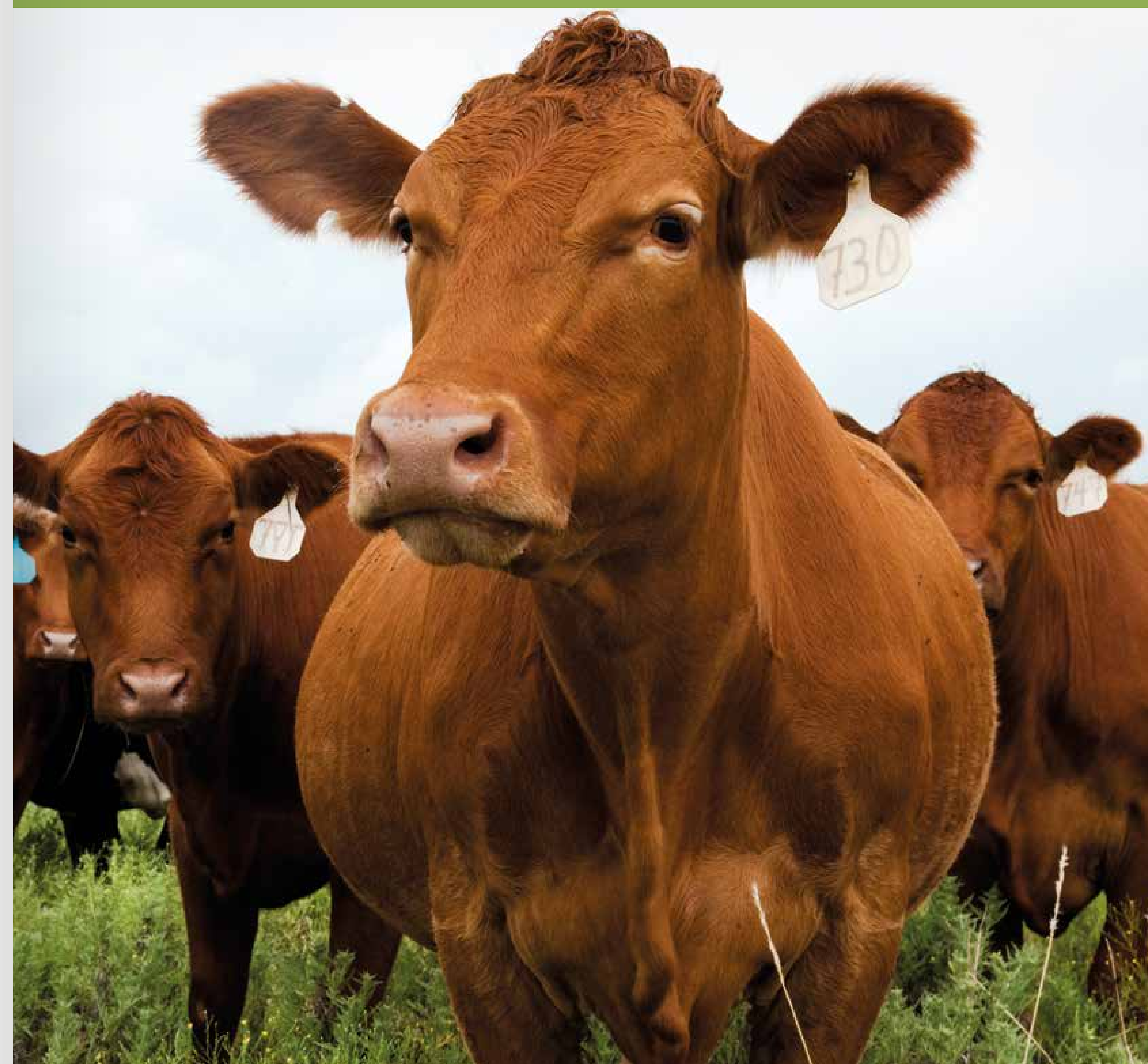


FOOD LABELS EXPOSED

Food Labels Exposed: A definitive guide to common food label terms and claims is designed to help consumers decipher the most common terms and claims found on today's food packaging. From "free to roam" and "locally grown" to "all natural" and "humane," *Food Labels Exposed* uses a simple, user-friendly symbol system and clear definitions to explain exactly what all these terms and claims mean—and if they have been independently verified.

Download these publications at **agreenerworld.org**.

Printed copies are also available upon request. To order call **(800) 373-8806** or email **info@agreenerworld.org**.



A GREENER WORLD

Our Food. Our Farms. Our Future. Let's Choose!

With so much negativity around food and farming today, A Greener World serves as a beacon of positive change. We exist to promote and support real-life farming models to the public and to offer practical guidance on achieving truly sustainable livestock farming systems to farmers.

We believe the way we farm, the nutritional quality of the meat, milk and eggs produced, and the impact of farming systems on wildlife, the environment and wider society are all connected. Our goal is to offer a 'one-stop shop' for anyone interested in food, farming and sustainability, providing simple solutions based on your own personal concerns. We're proud of our reputation among consumer groups, farmers and the wider food industry as a pragmatic organization driven by practical science and common sense.

Our growing family of trusted certifications includes AWA, Certified Grassfed by AGW and Certified Non-GMO by AGW. Each program is designed to have positive and measurable impacts on the environment, society and animals, and to encourage truly sustainable farming practices. AGW's standards and procedures are robust, transparent and achievable.

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