Grade A Choice?

SOLUTIONS FOR DEFORESTATION-FREE MEAT

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

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Executive Summary

Meat consumption has a big impact on deforestation, because it uses very large amounts of land. In the last few decades, much of that land—both for pasture and to produce livestock feed, such as soybeans—has come from tropical forests, especially in the Amazon. With continuing global growth in meat consumption per capita and in world trade in meat and feed, the industry has become global, with global consumption driving deforestation.

Meat is ecologically inefficient because it effectively means eating one step higher on the food chain. The inefficiency is particularly high for beef, which uses about three-fifths of the world's agricultural land yet produces less than 5 percent of its protein and less than 2 percent of its calories. Beef production causes global warming through its effects on deforestation, both directly through pasture and indirectly through its use of feed and forage, and also because of the methane, a powerful heat-trapping gas, that comes from the stomachs and manure of cattle.

Other meat sources, such as pork and especially chicken, require much less land to produce the same amount of protein. Thus a diet shift from beef toward chicken would greatly reduce the pressure on land and the resulting pressure for deforestation. It would also have health benefits, particularly in developed countries where beef consumption is already at levels leading to heart disease, cancer, and other illnesses.

There are many practical alternatives that would reduce the impact of the meat industry on deforestation. In addition to diet shifts among kinds of meat, they include increasing the productivity of livestock, expanding production onto already cleared lands rather than forest, combining livestock and tree production (silvopastures), and reducing overall levels of meat consumption to medically recommended levels. The policies of ranchers, governments, and corporations that buy and market meat can encourage such changes, and some producer groups have already taken steps to reduce the deforestation that they cause. We conclude with recommendations for steps that people can take through all stages in the food chain, from pasture to plate, to help the meat industry become deforestation-free.

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Tropical forests in Latin America are often cleared to raise beef cattle, destroying biodiversity and contributing to climate change.

The growing global consumption of meat is driving deforestation in the tropics.

CHAPTER ONE

Introduction

The consumption of meat has a major effect on deforestation because producing meat, particularly beef, uses large amounts of land. In recent years, much of the new land for meat production has come from clearing tropical forests. Large areas, especially in the Amazon basin, have been turned into pastures for direct use by livestock or else into fields that produce soybeans to be fed to livestock. We can reverse this trend, however, and eventually reduce the net global deforestation resulting from meat production to zero.

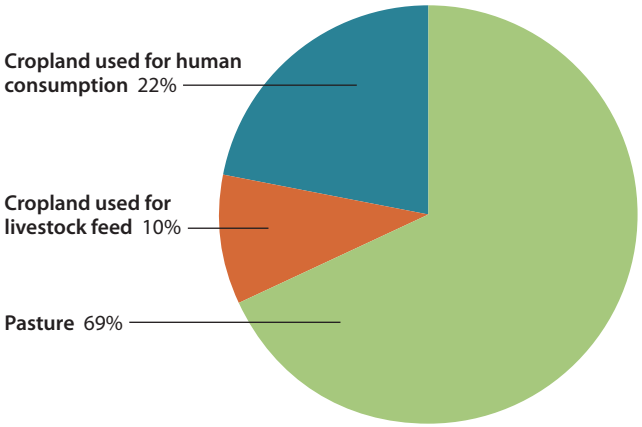
This report analyzes the pressures that meat production exerts on global land use, causing the loss of tropical forests and thereby causing the emission of large amounts of global warming pollution. But we also show how the industry—including ranchers, slaughterhouses, distributors, exporters, and supermarkets—can reduce those pressures and expand in ways other than through forest clearing. Solutions include: producers increasing the productivity of their land and livestock; businesses changing their sourcing, marketing, and pricing practices to favor meat-production options that use less land; governments modifying subsidy, tax, and procurement policies to discourage deforestation; and consumers shifting their diets toward consuming less beef and more chicken. Because most of humanity is connected to the meat industry in one way or another, whether as producers, consumers, distributors, or policy makers, we all can help transform it toward zero deforestation.

THE MEAT REVOLUTION

In the last two centuries the world has gone through a "meat revolution" (Steinfeld et al. 2010). Globally, meat production has grown 25-fold since 1800 (Galloway et al. 2010), with enormous new expanses being converted from natural ecosystems—especially forests—into pastures and land for growing feed crops for livestock (Figures 1 and 2). While much of the increased production was stimulated by population growth, per capita consumption grew steadily as well (Figure 3). For hundreds of millions of people, meat went from being an occasional luxury to the centerpiece of one or more meals per day. At first this growth was mostly in the industrialized nations, especially in Europe and North America, but in the latter part of the twentieth century meat consumption in these regions plateaued and increased consumption began spreading to large developing countries such as China, Brazil, and Mexico (Figure 3). Urban consumers tend to eat more meat than their rural counterparts, even with the same levels of income (Neumann et al. 2010). Thus, as major developing countries continue to increase in per capita income and become more urban, we can expect their per capita meat consumption to grow as well.

Figure 1. GLOBAL LAND USE FOR AGRICULTURE, 2009

Only about 20 percent of the planet's agricultural land is used to produce food that is eaten directly by people, while about four times as much is used to feed livestock. Sources: Asner and Archer 2010; De Haan, Gerber, and Opio 2010.



Note: Total does not add to 100 due to rounding.

Figure 2. CHANGES IN THE GLOBAL AREA OF CROPLAND, PASTURE, FORESTS, AND GRASSLAND SINCE 1850

The decline in natural ecosystems (forests, woodlands, and grasslands) has resulted from the expansion of agricultural land (croplands and pastures). Grasslands include the North American prairies, South American pampas, and Eurasian steppes. Source: McNeill 2006.

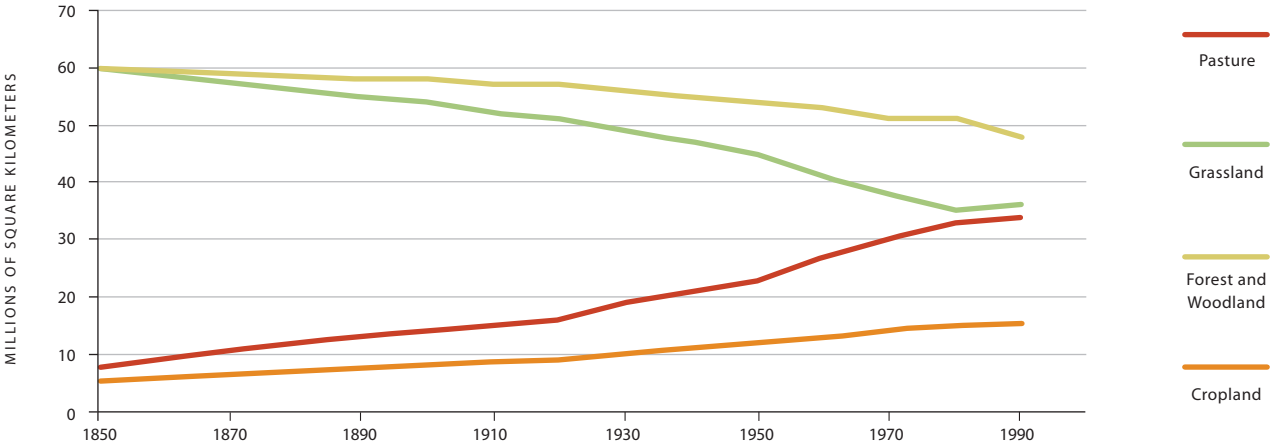
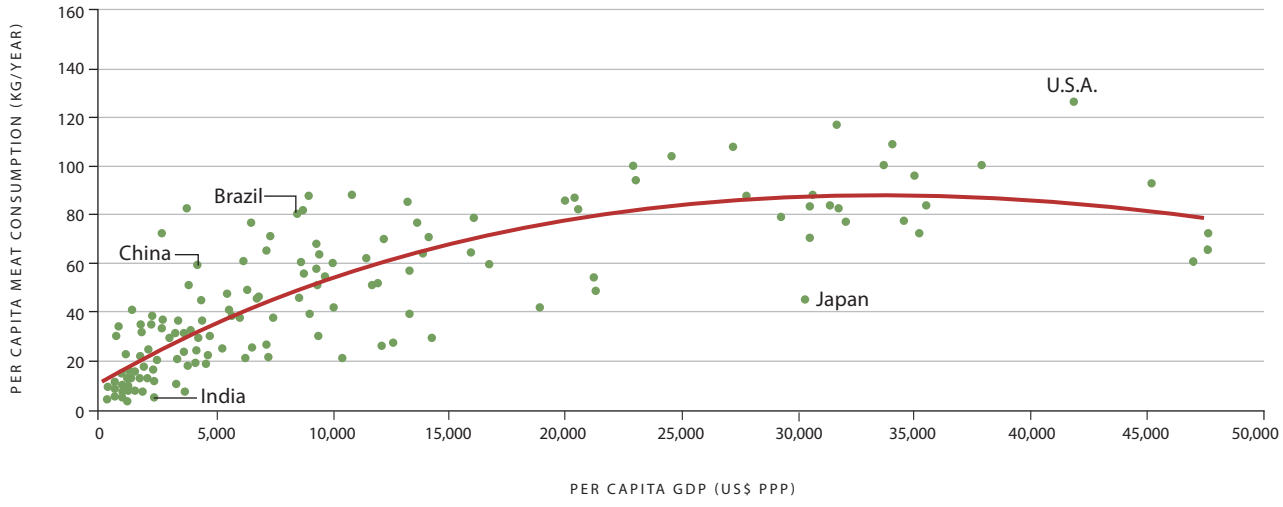


Figure 3. PER CAPITA GDP AND MEAT CONSUMPTION BY COUNTRY, 2005

Per capita meat consumption increases with gross domestic product up to a level of about $20,000 per capita, but then tends to level off and perhaps even drop slightly. Note: GDP per capita is measured at purchasing power party (PPP) in constant 2005 international U.S. dollars. Source: FAO 2009.



Per capita consumption of livestock products in developing countries has grown faster than for other food groups (Figure 4). Since the 1960s, meat consumption has tripled, milk consumption has doubled, and egg consumption has increased fivefold. On the other hand, growth in per capita consumption of cereals and roots and tubers has remained flat. Among the different meats, average world poultry consumption has increased the fastest—by 3.4 percent annually from 2000 to 2011, followed by pork (1.7 percent) and beef (0.4 percent) (Figure 5a).

A GLOBALIZED MEAT MARKET

The rapid increase in worldwide per capita meat consumption, along with ease of transportation, has led to major growth in the global trade in livestock products (Galloway et al. 2007; Nepstad, Stickler, and Almeida 2006). Developments such as the expansion of refrigerated transport and freezing have made it easier to ship meat and livestock long distances. Total meat exports increased from 14.3 million metric tons (Mmt) in 2000 to 24.2 Mmt in 2011—a 69 percent increase (Figure 5b). This growth was considerably faster than the growth in the production of meat, which increased only 24 percent (Figure 5a). Thus meat is increasingly a global industry, producing not only for domestic use but also for consumers around the world. Livestock feed, such as corn and soybeans, is also very much a global commodity. In such a globalized market, prices depend on total worldwide demand, and thus on the dietary patterns of consumers everywhere.

Among the developing nations, China is the largest producer of meat (accounting for 29 percent of the global production in 2010), followed by Brazil (11 percent). Brazil is now the largest net exporter of meat in the world. With a market share of 35 percent in 2010, it has considerably outpaced the United States, which is now in second place with 25 percent of net exports (FAOSTAT 2012).

EXPANDING INTO FORESTS

In the 1980s and ’90s more than 100 million hectares of agricultural land were developed in the global tropics, and 55 percent of this land came from intact forests (Gibbs et al. 2010). A further 28 percent came from previously disturbed

Figure 4. PER CAPITA CONSUMPTION OF MAJOR FOOD ITEMS IN DEVELOPING COUNTRIES, 1961–2005

In developing countries, per capita consumption of meat and other animal products has grown substantially in past decades, while changing little for cereals and root crops. Source: FAO 2009.

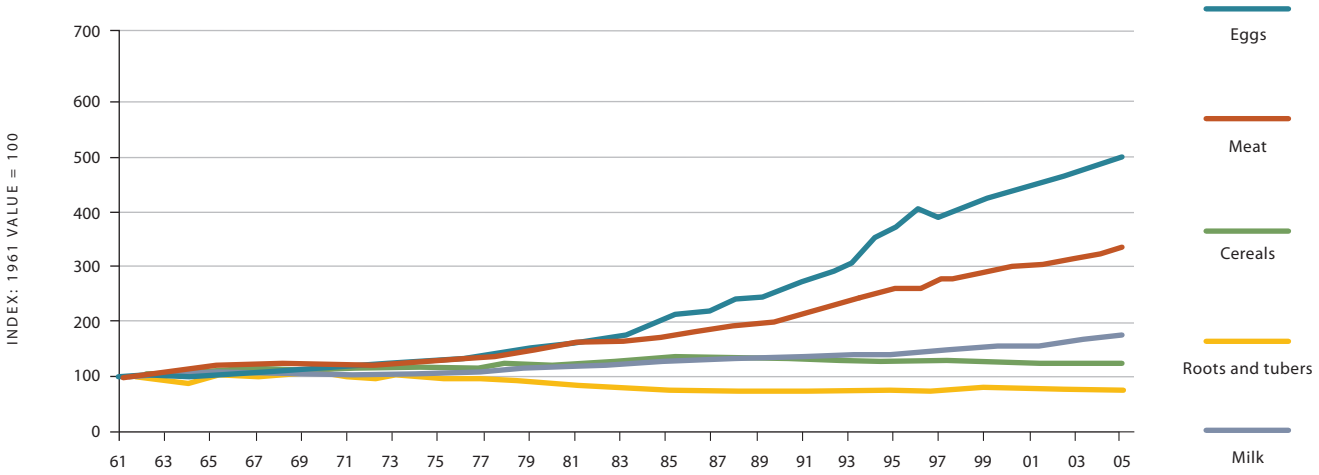


Figure 5a. GLOBAL MEAT PRODUCTION, 2000–2011

Poultry production has increased substantially, pork more slowly, and beef and veal only slightly in the last decade.
Source: FAOSTAT 2012.

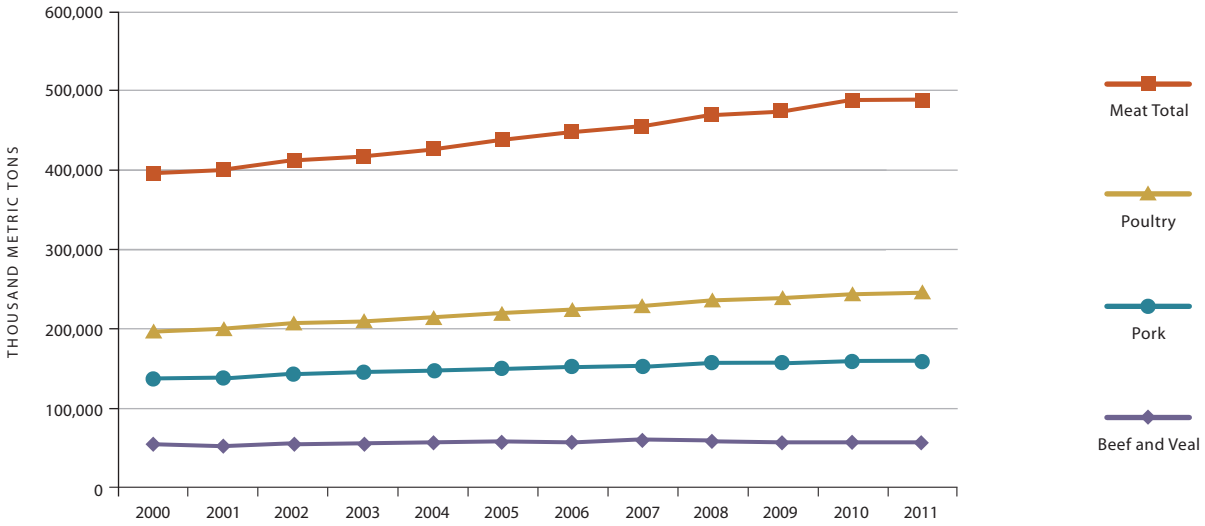
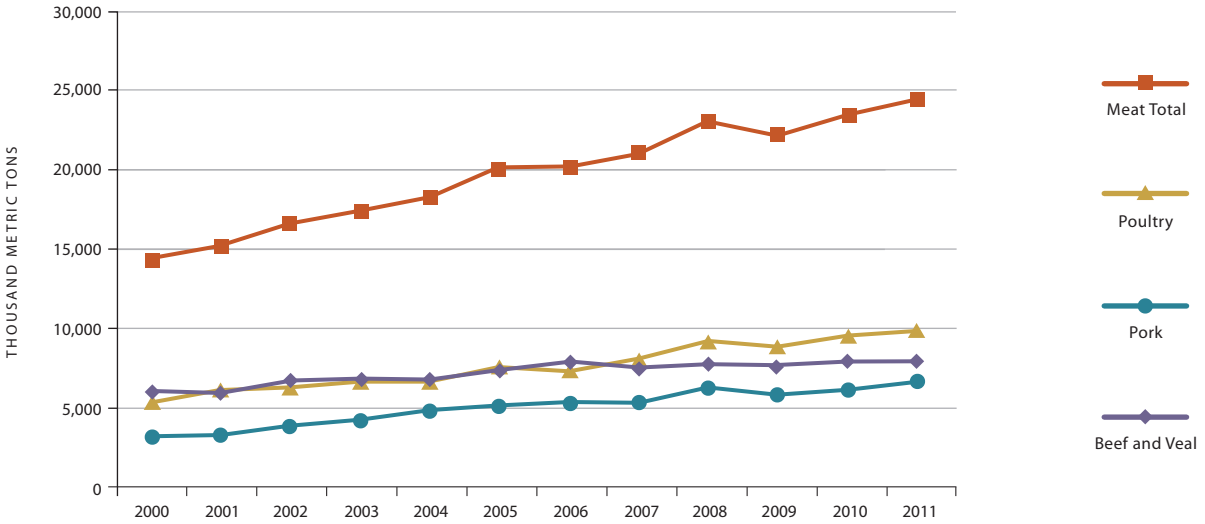


Figure 5b. GLOBAL MEAT EXPORTS, 2000–2011

International trade in all kinds of meat has increased rapidly in the past decade—considerably faster than the growth in production (see Figure 5a). As a consequence, the global market for meat has become one in which consumption in any part of the world creates demand in other parts.
Source: FAOSTAT 2012.



forests (Gibbs et al. 2010). In the Latin American tropics, that new agricultural land was overwhelmingly turned into cattle pasture—about 42 million hectares, versus only about 7 million hectares of cropland. In the Amazon basin of Brazil, the largest tropical-forest country, more than 75 percent of the deforested land had been turned into pasture by 2007 (May and Millikan 2010; Bustamante, Nobre, and Smeraldi 2009).

Conversion to pasture is not the only way in which domesticated animals have essentially eaten up tropical forests. Soybeans, overwhelmingly used as livestock feed, also expanded rapidly into the Amazon basin in the late 1990s and early 2000s, and at their peak they were responsible for nearly a fourth of deforestation (Morton et al. 2006). In Brazil, this situation has changed dramatically in the last few years, and the soy industry is now the best example of how production can expand and remain profitable *without* clearing forests, by increasing its yield per hectare and by expanding onto already cleared land (Boucher, Roquemore, and Fitzhugh 2012; Macedo et al. 2012; Rudorff et al. 2011). Nonetheless, millions of hectares that were once Brazilian rain forest are now large-scale commercial soybean fields, and in other countries in the region, such as Bolivia, Paraguay, and Argentina, soy continues to expand in other tropical and subtropical forests.

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Forests are also cleared to produce soybeans, which are used as feed for beef and other animals.

INEFFICIENT FOOD PRODUCTION CREATES PRESSURE TO DEFOREST

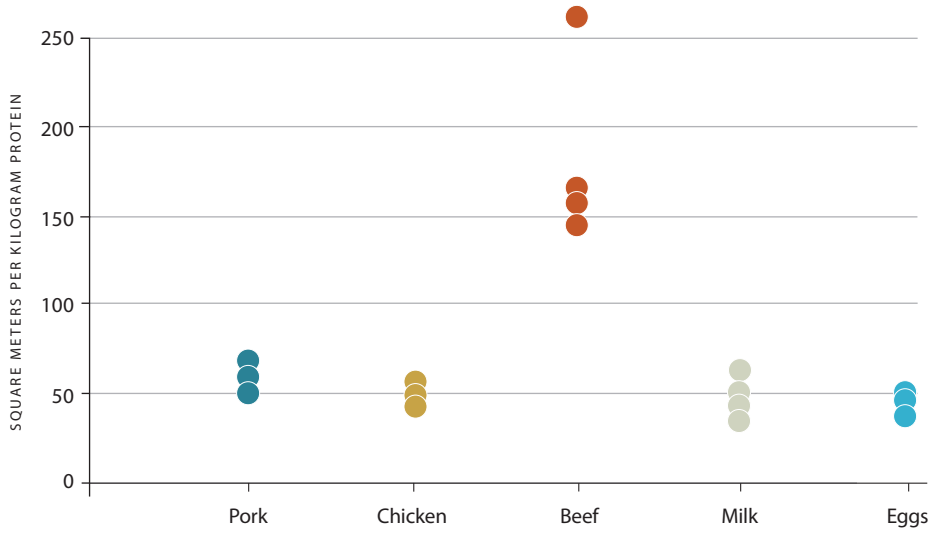
The pastures on which livestock graze make up about two-thirds of the total agricultural land in the world; only a third is used to grow crops (Asner et al. 2004) (Figure 1). And of that cropland, about a third is used to grow feed for livestock—grains such as corn, legumes such as soybeans, and forage crops such as alfalfa (cut and fed to livestock as hay)—rather than food for direct human consumption. Thus about three-fourths of the world's agricultural land does not feed humans directly (Foley et al. 2011; Pingali and McCullough 2010). Rather, it feeds the animals whose meat and other products we eat.

While using animals as food can have many advantages, as we explain in later sections, it is inherently inefficient in its use of land, in that the biomass produced by plants goes through an extra step in the food web before it reaches our stomachs (Herrero et al. 2009). The resulting loss of energy and protein can be quite large (Figure 6). Galloway et al. (2010) calculate that meat-producing animals around the world consume a total of 2,117 Mmt of plant matter annually and turn it into just 243 Mmt of meat—a ratio of 8.7 to 1. This loss of biomass going up the food chain is the fundamental reason why producing meat requires a lot of land, mostly as pasture. And that amount of land has actually been growing considerably faster than cropland over the past 150 years (Figure 2).

The link between livestock expansion and deforestation is not because the land that underlies tropical forests makes better pastures or produces higher crop yields. In fact, just the opposite is true. The soils of newly cleared tropical forest land are generally of poor quality, leading to low crop yields and sustaining few animals per hectare (McAlpine et al. 2009). But these lands are inexpensive or even free for the taking, usually increasing considerably in value once they are cleared (Bowman et al. 2012; McAlpine et al. 2009). Thus the clearing of forest to create pastures can be profitable, even though it is not a highly productive kind of land use in terms of the amount of food it produces. Though beef productivity is low, the increase in land value after clearing keeps the production system profitable in the Amazon since the ranchers can sell the land and make money (Bowman et al. 2012).

Figure 6. LAND NEEDED TO PRODUCE A KILOGRAM OF PROTEIN AS PORK, CHICKEN, BEEF, MILK, OR EGGS

Beef generally requires three to five times as much land as the alternatives to produce the same amount of protein. Data points are from 16 published estimates for developed (OECD) countries. Source: deVries and deBoer 2010.



LIVESTOCK PRODUCTION HAS GLOBAL IMPACTS

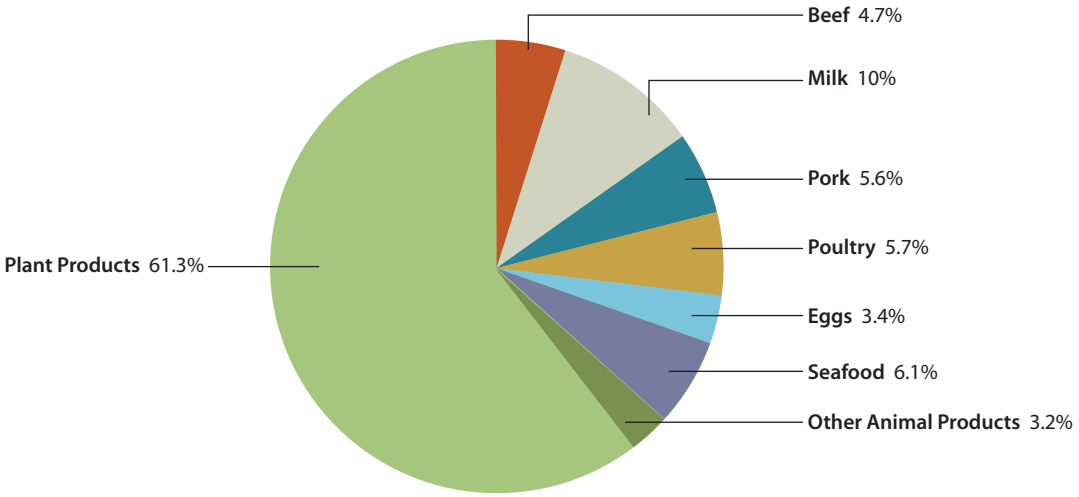
Clearing forest for pastures makes money, but it also causes global warming pollution. The effects of tropical deforestation, including the decomposition of peat in deforested tropical swamps, are responsible for about 15 percent of the world's heat-trapping emissions, not to mention the loss of biodiversity and other kinds of environmental and social damage (Boucher et al. 2011). Tropical forests are enormous storehouses of carbon, and when they are cut down and burned, large quantities of carbon dioxide—the main cause of global warming—are emitted into the atmosphere (Saatchi et al. 2010).

Thus the expansion of cattle production into tropical forests has been socially inefficient—low in productivity and damaging to the climate. Cattle pasture in particular is inherently *extensive:* it requires large amounts of land to produce relatively small quantities of food. The three-fifths of the world's agricultural land used for cattle (Figure 1) yields less than 5 percent of humanity's protein (Figure 7, p. 8; FAOSTAT 2012). Crop production, or even other kinds of livestock raising, is much more *intensive:* it uses less land to produce a given amount of food (whether measured in weight, energy, or protein), and produces most of what the world eats on just a small proportion of its agricultural land (Figure 1).

Cattle pasture in particular is inherently extensive: it requires a large amount of land to produce relatively small quantitities of food. And in the tropics, much of that land has come from forests.

Figure 7. GLOBAL SOURCES OF PROTEIN, 2007

Beef contributes just 4.7 percent of the world's total protein, even though it uses a large majority of the agricultural land (see Figure 1). Comparable figures for other sources of protein are 10.0 percent for milk, 9.1 percent for poultry (both meat and eggs), and 5.6 percent for pork. Source: FAOSTAT 2012.



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Because productivity is low, vast areas of forest must be cleared to feed a small number of cows.

CHAPTER TWO

The Inefficiencies of Different Kinds of Meat Production

Plant production is the most efficient of all, but some kinds of meat production are much more efficient than others, creating opportunities for continued growth in meat consumption while causing much less deforestation.

THE UNDERLYING ECOLOGICAL PRINCIPLES

There are fundamental biological reasons why meat production requires more land and resources than plant production, related to the fact that meat consumption occurs at a higher level on the food chain than plant consumption. When we eat a certain number of calories' worth of steak, we are consuming not only those calories but also, in effect, all the calories consumed by the cow that produced the steak (i.e., the calories in all the food it processed during its lifetime). Producing all the food the cow ate—pasture grasses, feed grains, soy supplements, and forages like alfalfa—requires a great deal of land. For a given amount of energy, it would take far fewer calories and less total land if you were to eat the grain and soy directly rather than feed it to the cow to make the steak. A diet primarily based on meat consumption requires far more land than a vegetarian diet.

BENEFITS OF MEAT PRODUCTION

Despite the greater land use needed to eat higher on the food chain, there are benefits to meat consumption. First, meat is higher in protein than most plants, so you do not need to eat as much to get the amount of protein necessary for a healthy diet. Second, livestock often eat things that humans cannot (or do not) directly consume: cattle eat grass, poultry eat insects (as well as grains and fruits), and pigs will eat just about anything. This allows us to produce food from land and resources that would otherwise be unusable. Cattle, for instance, are able to gain sustenance from large areas of rangeland in arid regions that are not suitable for crop production. Further, livestock offer a store of wealth and a form of food security in regions where crop production is inconsistent (Herrero et al. 2009).

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Some animals, like pigs and chickens, are more efficient at converting feed into meat.

LAND IS USED FOR MEAT BOTH DIRECTLY AND INDIRECTLY

Meat production uses land both directly and indirectly. The direct use is the land that the animals live and graze on. For cattle, sheep, and goats, this land has traditionally been pastures (human-created grasslands) and rangelands (natural ecosystems used for grazing, such as shrublands and savannas). Pigs and chickens have used the same kind of land, but much less of it, staying closer to the farmhouse and often spending most of their time in the farmyard.

In addition, animals use land indirectly—through the land used to produce feed and forage for them. "Feed" means grains such as corn, and protein-rich seeds such as soybeans, that are used in supplements; "forage" is other plant matter, such as alfalfa and hay grasses, that is grown in fields, then cut and brought in to feed the livestock in farmyards and barns. Feed and forage cost time and energy to produce and harvest, but they have two advantages: they are considerably higher in protein and energy than the plants in pastures, and they concentrate the food in one place, making it possible for the livestock

to satisfy their needs without a lot of movement to find and consume the most edible plants and plant parts. This means that the land that livestock use indirectly is actually used more efficiently than the land they use directly.

Pastures have higher productivity for meat production than does range. Pastures are found in moister climates, they are planted with high densities of faster-growing and more-edible (for cattle) grasses, and they benefit from added inputs such as fertilizer. Pastureland could also be used for crop production, such as cereal grains for bread or pasta, or for animal feed.

NOT ALL ANIMALS ARE THE SAME

Cattle, pigs, and chickens all produce meat, but in doing so they are very different animals. Cattle, sheep, and goats are ruminants; their digestive system includes a section called the rumen, which is home to a prodigious variety of bacteria and other microbes that can break down cellulose, the molecule that makes up the largest proportion of plant matter. Thus ruminants are able to eat cellulose—something that most other animals can do only poorly or not at all. Because most living plant matter on earth is cellulosic, much more of the biosphere's total productivity is potentially available to ruminants as food than to non-ruminant animals (including humans).

This ability to digest cellulose is the reason why ruminants are able to survive and produce meat, although not very efficiently, when eating rangeland plants. Pigs, chickens, and other non-ruminant livestock cannot do this. However, on better-quality agricultural land, including the areas that could potentially be used either as pasture or as cropland, the advantage shifts to pigs and chickens. There are two main reasons for this.

First, the digestive efficiency of the smaller livestock animals is considerably higher. They convert more of their food into edible meat than ruminants, especially cattle. Non-ruminants' diets need to have foods richer in protein, sugars, starches, and fats, but they convert these foods into meat more quickly, and in considerably higher proportions relative to the amounts that they eat, than ruminants. Chickens need to consume two kilograms of grain to produce one kilogram of meat, and pigs need four kilograms, but for beef cattle the ratio is 10 to 1 (Rae and Nayga 2010).

Second, land that is good enough to be used either as pasture for ruminants or as cropland to produce grain for pigs and chickens will yield much more edible feed, and of higher quality, when producing grain.

Thus ruminants are less-efficient meat producers than non-ruminants. This lower efficiency of ruminants means they produce more waste products, just as lower-mileage cars tend to

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(left) Soybeans are a high-protein, high-energy source of livestock feed. (right) Grasses are high in cellulose but low in calories and nutrient quality.

emit more pollutants. Less of what they eat is turned into meat on their bodies, while more remains undigested and becomes waste. Often those waste products can have very negative effects on the environment. For example, the microbes that digest cellulose in the rumen (particularly the multi-billion-year-old types known as Archaea) also produce methane, a potent heat-trapping gas that exits the cow from both ends and causes about 23 times as much global warming per molecule as carbon dioxide. Moreover, the large amounts of manure produced by cattle are both a leading cause of water pollution and an additional source of methane, causing even more global warming (Fiala 2008).

Overall, given the differences in productivity among livestock animals and the lands that produce most of their food, pigs and especially chickens are much more efficient meat producers than beef cattle. They use much less land to produce an equal amount of protein. This has been measured in several scientific studies, and the differences, reviewed recently by deVries and deBoer (2010), are consistently large (Figure 6).

Here are just a few examples. Wirsenius, Hedenus, and Mohlin (2010) found that it takes about nine hectares of permanent pasture plus about three hectares of cropland to produce one ton of beef. This compares with less than one hectare, almost all cropland, to produce one ton of poultry or pork. As their study focused on the European Union, where pasture productivity is high, the authors' results were not affected by the use of low-quality rangeland in cattle production; the differences they showed involved lands of comparably high quality.

Similarly, Stehfest et al. (2009) calculated that ruminants need six hectares of land to produce a kilogram (kilo) of protein, while pork production needs only 3.6 hectares. A totally vegetarian alternative using beans, peas, or other legumes reduces this area to 2.7 hectares; no estimate was given for chicken production.

Looking at feed consumption, Smil (2002) calculated that beef cattle needed to consume 31.7 kilos of total feed to produce one kilo of edible meat, compared with 13.7 kilos of feed for pork and just 4.2 kilos for chickens. Beef cattle converted only 5 percent of the protein in their diet into edible meat, versus 13 percent for pork, 25 percent for chicken, and 30 percent for egg production.

A diet shift from beef toward chicken would greatly reduce the pressure on land and the resulting pressure for deforestation.

These are just a few examples of what is a consistent pattern. The 2010 review by deVries and deBoer of 16 different studies shows how researchers have found that beef generally requires several times as much land as the alternatives. These studies were all done in developed (Organisation for Economic Co-operation and Development [OECD]) countries in order to avoid the effects of differences in production techniques or land quality, and the results are expressed in terms of land needed to produce a kilo of protein to avoid the bias that would come from comparing foods with different amounts of water (e.g., milk vs. beef). As Figure 7 shows, beef generally requires several times as much land to produce the same amount of protein as the alternatives.

Beef makes up about 24 percent of the world's meat consumption; poultry accounts for about 34 percent and pork more than 40 percent, with much smaller amounts coming from other sources such as lamb, goat, and guinea pig, as well as bushmeat (Box 1, p. 12) (FAOSTAT 2012). But in terms of protein, less than 5 percent of what humanity consumes comes from beef, and in terms of calories, less than 2 percent. Beef cattle produce this meat using about 30 million square kilometers (km^2) of land—27 million of that for grazing, and the rest for the feed and forage they eat (Stehfest et al. 2009), while pork and poultry take less than 2 million km^2 each.

All in all, then, one way to reduce the global demand for agricultural land, and thus decrease the pressure to expand pasture and croplands for feed at the expense of tropical forests, would be to shift our meat consumption toward the more efficient sources. The best candidates are dairy (Box 2, p. 13), pork, or chicken. Global trends are already moving in this direction, but a variety of policies could speed them up.

Box 1

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Hunting for wild animals can lead to forest degradation and local extinction of species.

Meat from the Forest

Demand for meat products, and their correspondingly high prices, in tropical forest countries is responsible for the overconsumption of wildlife, or the "bushmeat crisis." The hunting and consumption of wild animals is one of the most significant threats to tropical forest biodiversity (Harrison 2011). Local extinction of species is common (Milner-Gulland et al. 2003), especially large primates such as monkeys and other large mammals such as tapirs (Robinson and Redford 1991). It is estimated that one person per square kilometer is the highest population density at which tropical forests can maintain high levels of biodiversity (Robinson and Bennet 2004), but this is a level that many areas exceed. Exploitation of bushmeat not only causes significant defaunation, a phenomenon commonly known as "empty forest syndrome," but can also have deleterious effects on the flora. Animals play an important role, for example, in seed dispersal (Nasi, Taber, and Van Vliet 2011), which in turn is critical to maintaining our high-carbon-storing forests (Brodie and Gibbs 2009).

However, bushmeat is a vital source of protein to millions of people around the world. While it is considered a delicacy for some, the bulk of the roughly 6 million tons of animals extracted from tropical forests annually (Nasi, Taber, and Van Vliet 2011) is a main source of protein for many indigenous people and rural and low-income communities (Rushton et al. 2005). This is unsurprising, as bushmeat is often the cheapest and most readily available source of protein in these areas (Nasi, Taber, and Van Vliet 2011; Apaza et al. 2002). However, consumption of wildlife varies with the price of close substitutes—in one Bolivian example, a doubling in the price of beef increased bushmeat consumption by 744 percent (Apaza et al. 2002). Thus, in order to decrease bushmeat consumption, which is desirable from a conservation point of view, other meat must be readily available.

The hunting and consumption of wild animals is one of the most significant threats to tropical forest biodiversity.

Box 2

How Dairy Is Different

Milk, cheese, and yogurt are important non-meat animal products that face some of the same land-use issues as beef production. However, there are some important differences between beef and dairy that make dairy production superior in terms of food value and land use. First, unlike meat, dairy offers unique nutritional value that is difficult to get from other sources. Meat's major nutritional feature, protein, can be replaced by plant sources, such as beans, soy, or nuts. However, some nutritional values of milk, such as calcium, are not easily replaced by other sources. These benefits are particularly important for pregnant women, young children, and the elderly.

Second, dairy farms tend to be less extensive than beef ranches. Dairy cows are generally brought in daily for milking, so it is difficult to have really large farms, as is the case with beef cattle ranches. Further, in most countries there are far fewer dairy cows than there are beef cattle—e.g., nearly a five-to-one ratio in Canada (Vergé et al. 2008)—so dairy cows' overall impact is much lower. Thus the U.N. Food and Agriculture Organization's recent analysis of the impact of dairy production concluded that, "The expansion of pastureland into forestland is generally not driven by the dairy sector" (FAO 2010a).

One important aspect of dairy farming worth noting is that it inevitably produces substantial amounts of beef as a by-product. Male calves, excess female calves, and cows whose milk production has declined with age are sold to the beef market. In the United States, 18 percent of beef comes from the dairy sector (Lowe and Gereffi 2009) and in the European Union the proportion is 50 percent (Oomen et al. 1998). Globally, it has been estimated that at least 57 percent of beef production originates in the dairy sector (FAO 2010a).

There are important differences between beef and dairy that make dairy production superior in terms of land use.

Dairy products require much less land than beef to produce equal amounts of protein.

CHAPTER THREE

Alternatives to Current Production and Consumption Patterns

Global meat production is projected to approximately double—to 465 Mmt—in 2050, with the majority of the increase expected in developing countries (FAO 2006). As demand for livestock products grows and the sector expands, land requirements for producing livestock will also grow, competing for land with other kinds of food production and with crops grown for bioenergy. However, based on the information summarized in previous sections, we can describe several alternatives that would reduce the pressure for deforestation caused by global meat production. Most of these alternatives would also reduce the impact of meat on the global climate, and some would also bring important benefits to our health.

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Improving pasture quality can increase the amount of beef produced in a given area.

INCREASING PRODUCTIVITY FROM CURRENT LANDS

One way to meet this heightened demand is to increase the productivity of land already being used and thereby reduce the need for expansion into forests. This option is sometimes called intensification, and we use this word here simply to mean increasing yield per hectare, without any implication that it involves increased inputs, genetic modification, or other means. In particular, it does not mean moving to production systems based on confined animal feeding operations (CAFOs), which have considerable disadvantages from an environmental point of view (Box 3). Higher stocking rates (more cattle per hectare of pasture), more productive pastures, rotational grazing, and the use of breeds suited to tropical conditions are some of the ways to increase land productivity (Steinfeld et. al. 2010; Herrero et. al. 2009). The Brazilian research and extension service EMBRAPA *(http://www.embrapa.br/english)*, for example, has shown that with improved pasture grass mixtures, rotational grazing, weeding, and improved cattle breeds, average stocking rates in the wet tropics could be increased from 1.1 animals per hectare to two or three. As deforestation in the Brazilian Amazon has declined, there is not as much cheap forestland newly available for cattle pasture, giving these kinds of practices an increasing advantage.

EXPANDING LIVESTOCK PRODUCTION ONTO ALREADY CLEARED NON-FOREST LANDS

With moderate investments, it is possible to raise cattle on abandoned and inexpensive land where grass is already growing, although necessarily with some sacrifice of yield (FAO 2010b). Other options include supporting more sustainable grazing systems such as silvo-pastoralism (Murgueitio et al. 2011) (Box 4, p. 17), which can increase livestock production and at the same time protect soil against nutrient depletion,

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Box 3

CAFOs

One way to reduce the land needed for extensive pasture and free-range meat production is to produce meat in what are called confined animal feeding operations or CAFOs. These systems crowd large numbers of animals into buildings or other enclosures and bring processed feed to the animals rather than allowing them to forage naturally. While this practice may offer some advantages from a land-use perspective, CAFOs also come with considerable environmental and animal health costs, as well as serious concerns about animal welfare.

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While CAFOs use less land than pasture production, they cause many other types of environmental damage.

The often massive scale of CAFOs, their tightly crowded conditions, and the unnatural diets of the animals (especially cattle) each contribute to the above problems. Concentration of animals leads to concentration of nitrogen-rich manure, often collected in large lagoons that can rupture, overflow, or leak—thereby polluting waterways and drinking-water sources, degrading fisheries, and contributing significantly to coastal "dead zones" where marine organisms cannot live (Gurian-Sherman 2008). CAFOs also are among the largest domestic sources of airborne ammonia, a component of smog and fine particulate pollution that contribute to respiratory disease; in addition, ammonia reduces terrestrial biodiversity and acidifies soil (Gurian-Sherman 2008). Finally, CAFOs often rely on the routine use of antibiotics to promote growth and stave off disease in the crowded, stressful conditions. These nontherapeutic uses of enormous amounts of antibiotics—some 80 percent of all antibiotics sold in the United States are used in these ways in animals rather than for human medicine—lead to the development of antibiotic-resistant bacteria that ultimately threaten human health (Gurian-Sherman 2008).

CAFOs have persisted despite these serious drawbacks partly because the costs of the resulting pollution and antibiotic resistance are borne not by CAFO operators but by taxpayers, the health care system, and society at large. These costs amount to billions of dollars annually, although current estimates are not comprehensive and therefore likely underestimate actual societal costs (Gurian-Sherman 2008).

continued on next page

Box 3, continued

For minimizing the full range of environmental, land-use, and health costs of meat production, CAFOs are not the only, and certainly not the best, of the alternatives.

Moreover, for beef and dairy production it is not clear that CAFOs are inherently superior to pasture-based systems from a land-use perspective. At present, the grain feeds used in confinement systems tend to produce higher yields per unit of land, and grain is often a more efficiently metabolized source of calories compared with pasture forages. However, for cattle and other ruminants, these advantages depend greatly on the productivity and feed efficiency of specific pasture crops. While agricultural researchers have made extensive investments to optimize grain-based systems, there remains considerable potential to improve the productivity and feed efficiency of pasture systems (Gurian-Sherman 2011).

For minimizing the full range of environmental, land-use, and health costs of meat production, CAFOs are not the only, and certainly not the best, of the alternatives. Pasture-based systems and other alternative ways of raising livestock can also have significant environmental costs if practiced poorly—as with overgrazing. But smart, well-managed pasture systems produce meat and other animal products while avoiding many of the problems associated with CAFOs (Gurian-Sherman 2008).

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The unhealthy conditions of CAFOs require the dangerously excessive use of antibiotics.

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Environmentally friendly alternatives to CAFOs are preferable whether producing chicken, pork, or beef.

Box 4

Trees and Livestock Together

Silvopastures are areas where both trees are grown and livestock is raised. In the tropics, silvopastures can create multiple benefits: improving the nutrition and health of livestock, reducing the amount of land needed to meet the demand for meat and wood, sequestering carbon, and providing other environmental advantages (Murgueitio et al. 2011).

First, parts of the trees themselves can be used as forage to improve livestock diet. Second, the trees can improve soil fertility and encourage growth of ground forage. Finally, the trees provide protective shade for the livestock.

In addition to improving livestock production, the trees in silvopastures provide additional farm income. The tree species range from those that provide nuts and fruit for consumption to those that can be sold on the timber market. By combining the growth of trees, forage, and livestock in one area, the demand for two products—wood and cattle—that are otherwise the major drivers of tropical deforestation can be met using the same land.

Silvopastures also provide multiple environmental benefits. Trees grow roots deep into the soil, creating a system that cycles water and nutrients much deeper than most other plants and that sequesters more carbon than a pasture alone (Haile, Nair, and Nair 2010). However, because ruminants themselves are a major source of heat-trapping gases, silvopasture systems with cattle will still be sources of emissions (Montagnini and Nair 2004)—just at lower levels than those of pastures without trees. Trees grown along creeks and rivers also protect waterways by preventing soil erosion and nutrient pollution. Further, silvopastures can provide wildlife habitats and corridors (Murgueitio et al. 2011) and improve farm aesthetics.

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Silvopasture systems provide a way to raise cattle while maintaining some forest cover.

Silvopastures require careful planning and management, without which they can lead to soil compaction and reduced species diversity, resulting in little improvement over conventional pastures (Montagnini and Nair 2004). However, silvopastures' potential benefits, when well implemented, make them an attractive alternative for tropical livestock production, both from an economic and ecological point of view.

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compaction, and erosion. What these kinds of alternatives have in common is that they use previously cleared land for expansion, and they adopt production systems that improve the health of the land rather than degrade it.

REDUCING MEAT CONSUMPTION

Another alternative to help move the meat industry toward zero deforestation is to reduce overall meat consumption. While this objective runs counter to the general trend of increasing meat consumption in recent decades, there have been signs of a reduction in some countries, particularly the wealthier ones. There has been a 15 percent drop in Germany, for example, and a 10 percent drop in France (Smil 2002).

The negative effects of high levels of meat consumption on health are well documented (Neumann et al. 2010; Friel et al. 2009; McMichael et al. 2007). These impacts include higher risks of cardiovascular disease, diabetes, obesity, and certain kinds of cancer, as well as greater numbers of premature deaths (Clark et al. 2009; Mackenbach et. al. 2008). Thus, lowering overall meat consumption would have beneficial impacts on health and health care costs.

How much could the demand for land, and thus the pressure for deforestation and the amount of global warming pollution, be reduced by this alternative? One way to gauge the outcome is to first look at the extreme case: what would be the effects of hypothetical total shifts in consumption—eliminating all beef, all other meat, or even all animal products consumed worldwide?

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People increasingly consume more beef than is considered healthy.

Stehfest et al. (2009) calculated that reducing beef consumption to zero by 2050 would cut the need for pasture by 27 million km^2, an 80 percent reduction, as well as reduce the need for cropland. Eliminating all meat consumption would have the same impact on the need for pasture, and eliminating all animal products (including milk and eggs) would reduce pasture needs by a further 5 million km^2. Eliminating ruminant meat would cut agricultural heat-trapping emissions nearly in half; eliminating all meat would reduce emissions a further 6 percent, and eliminating all animal products would cut emissions another 12 percent beyond that. Stehfest et al. used scenarios in which the meat reductions were compensated for by increased consumption of plant protein, rather than by switching to dairy or other kinds of meat.

Foley et al. (2011) and Foley (2011) also looked at the possibilities of increasing food supply through diet shifts, and found the gain to be very large. They calculated that the world could increase its supply of food calories by 50 percent—a staggering 3 quadrillion calories per year—by shifting to an all-plant diet. This would be a drastic change, but they also recommended looking at diet changes that retain meat consumption, such as shifting from beef to more chicken and pork.

SHIFTING MEAT CONSUMPTION TO MORE LAND-EFFICIENT KINDS OF MEAT

As noted earlier, even in Europe where land productivity is high, it takes nine hectares of pastureland and three hectares of cropland to produce one ton of beef (Wirsenius, Hedenus, and Mohlin 2010). In contrast, it takes only one hectare of cropland to produce a ton of pork or chicken. In tropical countries, where beef production is mostly pasture-based, the land required to produce a ton of beef is even higher. Thus, shifting consumption from beef toward pork and especially poultry would be a good way to reduce the pressure for more land.

Several aspects of this alternative are worth underscoring. Because chickens turn grain into meat more efficiently than beef cattle, there would not only be a savings of grazing land but also of the cropland needed to produce feed grains. The shift would be of considerable help in terms of global warming, as methane emissions from non-ruminants are much lower than those from ruminants such as cattle.

Bouwman et al. (2011), studying human alteration of the nitrogen and phosphorus cycles, modeled the impact of a

Supermarkets can help drive consumption patterns by the ways they display and price different meats.

10 percent shift of beef consumption to poultry, and found that it would reduce fertilizer use, manure production, and the surplus of nitrogen that is a source of pollution. They also noted that this option would be most appropriate for countries with intensive production of ruminants and intensively managed grasslands (i.e., developed countries).

One strong argument for this kind of diet change relates to feasibility. Such a switch would be consistent with current trends in developed and developing countries alike toward increased per capita chicken and pork consumption relative to beef. In developing countries, this change reflects only a slower rate of growth for beef, but in developed countries per capita beef consumption is already declining in absolute terms (Rae and Nayga 2010).

One of the drivers of this trend is the health advantage of reducing beef consumption. A very large, 20-year-long study has strongly confirmed this advantage recently (Pan et al. 2012), and eating less beef is now part of official dietary recommendations in countries such as the United States and the United Kingdom. While a recent review assessed beef consumption as being "possibly" or "probably" associated with increasing coronary heart disease as well as higher rates of breast, colon, and prostate cancer, it found that poultry consumption is associated with reduced rates of two of these illnesses and "probably no relation" to the other two (Neumann et al, 2010). In other words, there could be benefits both from the reduction in beef consumption and also from the increase in poultry consumption.

CHAPTER FOUR

Policies That Affect Meat Production and Consumption

Given their potential benefits, what kinds of policies could help advance these alternatives? On the other hand, what policies are negatively affecting tropical forests and ought to be phased out?

PRODUCTION POLICIES

Historically, government policies on meat and other commodities were designed to increase production. These policies came in many forms, such as offering free or inexpensive land for farmers and ranchers, providing tax credits for producers of specific goods, or guaranteeing price supports for commodities. Although these policies regarding meat production began to decline in developed economies after World War II, they expanded in developing countries in the 1970s and '80s. Wherever they are applied, they have the effect of increasing the meat supply, reducing its price, and encouraging its consumption (McAlpine et al. 2009).

Beginning in the 1990s with the Agreement on Agriculture, an international treaty developed by the World Trade Organization to lower barriers to international trade, countries started to reduce their direct subsidies for agricultural production. Although direct subsidies for meat have decreased substantially, nations are finding other ways to support meat and other commodities. For example, policies that subsidize inputs to meat production, such as soy and other feeds, act as an indirect subsidy for meat, given that cheaper inputs allow for cheaper production.

In fact, total government support for agriculture in most developed countries has remained nearly constant since the implementation of the Agreement on Agriculture, and beef and dairy (as well as sugar) tend to be those commodities with the highest rates of tariff protection in the OECD (developed) countries (Rae and Nayga 2010). As Rae and Nayga point out, "Such protection encourages a higher level of livestock production than would otherwise be the case." Thus, reduction of such supports for meat production, particularly for beef, is one way to reduce deforestation.

Other kinds of production policies are aimed at affecting where meat is produced rather than how much is produced, but they still affect total output. These policies include agroecological zoning to discourage or prohibit production in areas that are ecologically unsuitable, and transferable quota systems to limit the density of particular kinds of farms or livestock in places where the pollution they produce (e.g., manure) would be socially or environmentally harmful (Menzi et al. 2010). Changing the sizes of the zones for livestock production or the total number of quotas made available could effectively increase or decrease the total output of meat.

Businesses, too, can adopt policies—individually or sectorwide—to reduce deforestation. The successful 2006 soy moratorium in Brazil (Macedo et al. 2012; Rudorff et al. 2011) is an example of how an industry can change where it produces a product in response to pressure from civil society; it also shows how a policy change can have a salutary impact on deforestation in just a few years. The 2009 cattle moratorium (Box 5) is an ongoing attempt to achieve similar successes in the Brazilian beef and leather industries.

CONSUMPTION POLICIES

With the decline of direct support for meat production, many countries have developed other kinds of policies to increase consumption of meat. These policies come in two major forms: direct purchase and commodity promotion.

Governments often make large purchases of meat and other commodities to support nutrition programs or to provide food in government-owned facilities. In the United States for

Box 5

Businesses and NGOs Leading the Way

A Voluntary Moratorium on Cattle from Newly Deforested Areas in the Amazon

In 2009, Greenpeace produced a report showing that the beef industry was the single largest driver of Amazon deforestation (Greenpeace 2009). Because of this pressure from Greenpeace and other nongovernmental organizations (NGOs), Brazil's top three beef retailers—CBD, Wal-Mart, and Carrefour—decided to ban the purchase of beef originating in deforested areas of the Amazon (Reuters 2009). Later that year, four major companies in the Brazilian cattle industry also agreed to a moratorium on the purchase of cattle from newly deforested areas of the Amazon (Barrionuevo 2009). The deal included Bertin, the world's largest leather exporter and Brazil's second-largest beef exporter; JBS-Friboi, the world's largest beef producer and global exporter of processed beef (which has since purchased Bertin); Marfrig, the world's fourth-largest beef trader; and Minerva, one of the largest producers and sellers of beef in Brazil.

Recent analyses (Gibbs et al. 2012; Walker et al. 2011) indicate that this moratorium may be beginning to show positive effects, as has an earlier moratorium on soybean production that was causing deforestation (Macedo et al. 2012). However, an update from Greenpeace in March 2012 indicated that at least one of the major companies in the agreement (JBS) was falling behind on its commitments (Greenpeace 2012). The long-term viability of the agreement will depend on the changing global demand for meat, the pressures in the market that favor forest protection, and the ways in which beef producers in Amazonia take action to respond to the moratorium.

Extending the Moratorium: Leather Retailers

Leather, a major by-product of cattle raised for beef, is shipped around the world for everything from shoes and handbags to car interiors. In 2009, while pressuring slaughterhouses and retailers of beef on zero deforestation, NGOs around the globe were also pushing companies that produce or use leather to make similar commitments. Many companies, such as Nike and Timberland, came out with deforestation-free pledges in 2009 (The Telegraph 2009). In addition, these and other companies belong to the Leather Working Group, a multi-stakeholder entity that assesses the compliance and environmental performance of tanners and promotes sustainable and appropriate environmental business practices within the leather industry.

Through the Leather Working Group, a protocol for traceability has been established so that businesses can know where the leather they buy comes from. The protocol requires hides originating in the Amazon biome to be traceable to a direct-supplying farm with no post-2009 deforestation. However, the group does not yet have a way to trace back to all farms in the supply chain, and while the slaughterhouses claim their supplies are deforestation-free, they do not provide evidence of this. Also, because the protocol only traces to the direct-supplying farm, and not to the intermediate ones or calving ranches, the protocol cannot ensure totally deforestation-free leather (Gibbs et al 2012; Walker 2012). Nonetheless, it is a step in the right direction.

Changes can be made through all stages of the food chain, from farm to plate, to ensure that the meat industry is deforestation-free.

example, the federal government purchases large amounts of meat through its school lunch, nutrition for the elderly, and child nutrition programs. Combined, these programs serve more than 16 percent of Americans. While these policies are based in part on meeting the nutritional needs of the recipients, they are also designed to take excess quantities of commodities off the market and thus keep farmers' received prices high. Thus, their effect is to raise production, not only in the United States but in other countries as well, given that global prices are increased by these policies.

Promotion programs are a less direct way by which governments support meat production and consumption. These programs are run by commodity boards—industry groups whose goal is to encourage the consumption of their specific commodities. Many of the slogans for campaigns run by these groups will be familiar to U.S. consumers: "Beef: It's what's for dinner," "Pork: The other white meat," "Got milk?," and "The incredible, edible egg." While the groups that produce these campaigns are not part of the government, they are largely funded by government-mandated "check-offs," which are fees paid by producers of the commodity. As with direct purchases by governments, when these kinds of programs are applied to beef they tend to increase its world price and thus increase the pressure for deforestation.

Beyond the policies directly connected to meat production and consumption, governments' nutritional and agricultural policies can have positive or negative impacts on forests. The first step toward encouraging alternatives to deforestation is simply to understand how current policies may be unknowingly promoting it.

CHAPTER FIVE

Recommendations

Beef production has been a major driver of deforestation in the Amazon over the last 30 years, both directly and indirectly. But even if the global demand for meat continues to rise, there are many steps that companies, governments, and consumers can take so that meat production becomes deforestation-free.

RECOMMENDATIONS FOR MEAT PRODUCERS IN TROPICAL REGIONS

Increase productivity. Meat producers, particularly the most dominant cattle ranchers, can increase their productivity per hectare to help take pressure off forests. This objective can be achieved through methods such as improving pasture, increasing stocking rates, and using rotational grazing. Silvopastoral systems—options that effectively combine meat production with tree restoration—have economic and environmental advantages as well. On the other hand, the pollution, animal welfare problems, and other issues associated with CAFOs make this form of meat production an unacceptable solution to deforestation.

Use already cleared lands. Further expansion of land for meat production, to the extent that it is necessary at all, should not come at the expense of forests. Increased productivity, coupled with strongly enforced agricultural zoning policies, can help ensure that the growth of the meat industry is directed to land areas that have already been cleared.

RECOMMENDATIONS FOR MEAT PRODUCERS GLOBALLY

Use deforestation-free inputs. Producers in all countries should ensure that their inputs, such as feed grains, soybean meal, and other supplements, come from deforestation-free sources.

RECOMMENDATIONS FOR CORPORATE MEAT BUYING

Commit to buying deforestation-free meats. Retailers and distributors should develop relationships with their suppliers to ensure that the meat they purchase does not come from recently deforested land.

Change pricing, marketing, and promotion policies. Supermarkets and other retailers can change their pricing and retail strategies to promote the sale of low-deforestation meats. Meat tends to have some of the highest elasticities of demand among food products (Andreyeva, Long, and Brownell 2010), meaning that consumption will respond quite significantly to increases in the retail price of one kind of meat (e.g., beef) and decreases in the price of another (e.g., chicken).

Switch to other meats. Manufacturers of processed foods that contain meat should switch, whenever possible, to meats that have the lowest impact on forests and the atmosphere. In most cases, this means switching away from beef to poultry or pork for products such as meatballs, burgers, and sausages.

RECOMMENDATIONS FOR TROPICAL-COUNTRY GOVERNMENTS

Eliminate direct subsidies. Governments should eliminate policies that favor the expansion of beef production and that promote subsidies based on per-hectare payments, which encourage the use of more land and the practice of deforestation in particular.

Eliminate or modify indirect subsidies. Governments can, for example, eliminate subsidies for cattle feed. They can also direct infrastructure projects toward non-forested regions rather than

tropical forests. Road building and improvement, for example, is strongly associated with deforestation because access to the forest makes it easier to clear for pasture and ship cattle to market.

Enforce strong agricultural zoning laws. Governments should develop and enforce zoning regulations that protect forests and promote the shifting of agricultural development and intensification away from forests and other natural areas. Meat and feed production should be directed to settled areas where forest has already been cleared, when ecologically suitable.

RECOMMENDATIONS FOR ALL GOVERNMENTS

Change purchasing policies. Governments should change the types of meats they purchase for their own facilities (e.g., hospitals, employee cafeterias, military mess halls) and food programs they administer (e.g., school lunch programs) by favoring products that require less land and exert less pressure for deforestation.

RECOMMENDATIONS FOR CONSUMERS

Eat less meat. Meat production is inherently more land-intensive and inefficient than plant production. Consumers who are concerned about deforestation—particularly those in developed countries, where meat consumption levels are already high and probably detrimental to people's health—can eat less meat in order to lessen its adverse impact on the planet's biodiversity and climate and on their own well-being.

Eat less beef. In addition to reducing the total amount of meat they eat, consumers can change the types of meat they eat. Beef production is by far the most land-intensive, so consuming less beef can go a long way toward relieving pressure on tropical forests. Substituting equal amounts of pork or poultry does not require a major shift in diet, yet greatly reduces the need for land and the global pressure for deforestation (Shulman et al. 2012).

Pressure businesses and governments. Consumers should use their collective power in the marketplace to urge grocery stores and companies to purchase and sell only deforestation-free meats. Likewise, consumers should pressure their governments to a) enact and enforce policies that protect forests and b) eliminate policies that promote meat production that leads to deforestation.

These recommendations can be adopted by businesses, governments, and consumers in many different countries, but they are especially appropriate for developed nations and those middle-income developing nations where meat consumption is rapidly increasing. These are the places that will have the most impact on the global demand for meat, and thus for land, in coming years. They are also the places where meat consumption, especially that of beef, is already greater than recommended or is approaching unhealthy levels. Finally, these countries have the greatest economic capacity to change their patterns of production and consumption in the direction of zero deforestation. By doing so, they can make an important contribution to the environment and climate of the entire planet.

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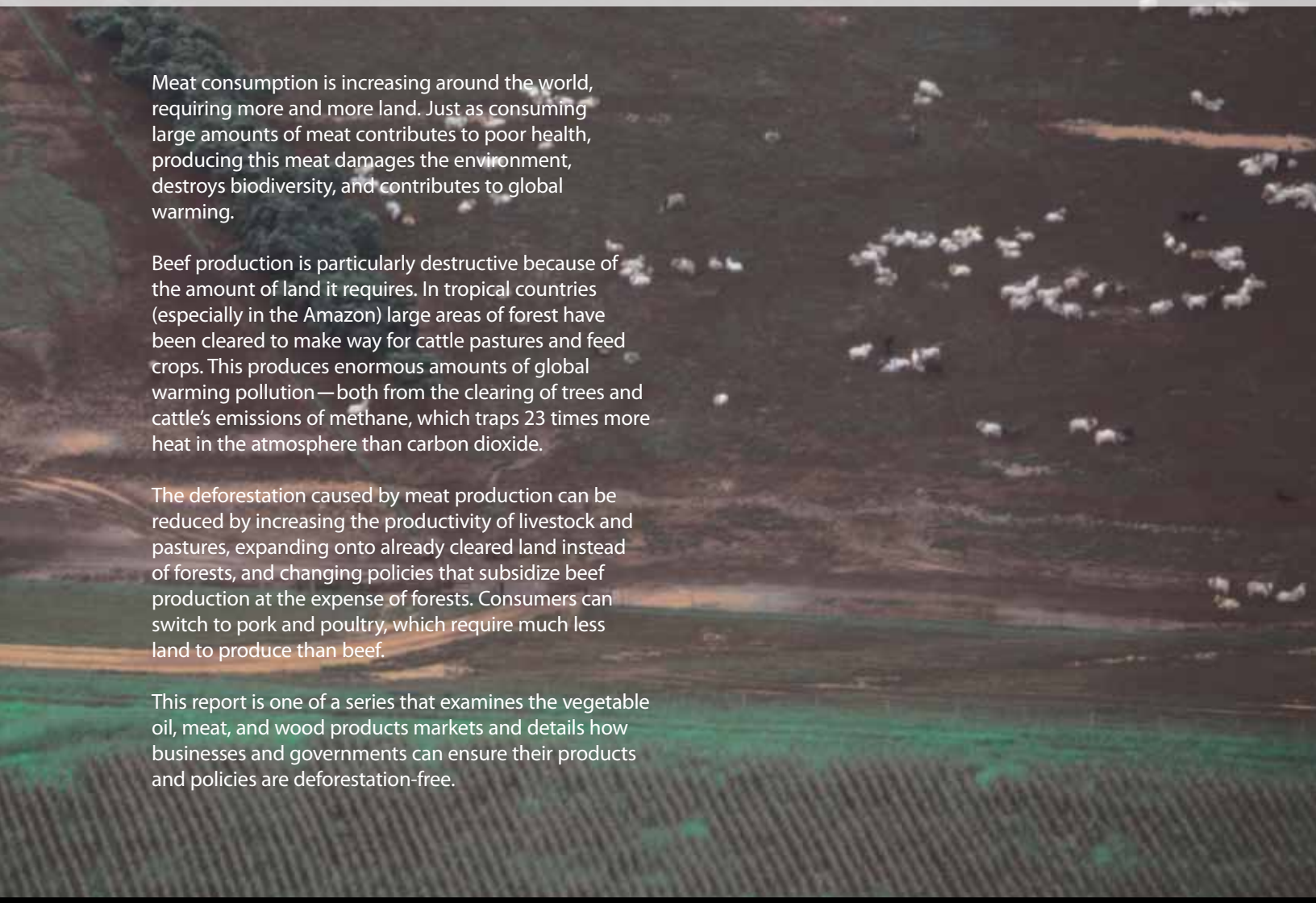
Grade A Choice?

SOLUTIONS FOR DEFORESTATION-FREE MEAT



Meat consumption is increasing around the world, requiring more and more land. Just as consuming large amounts of meat contributes to poor health, producing this meat damages the environment, destroys biodiversity, and contributes to global warming.

Beef production is particularly destructive because of the amount of land it requires. In tropical countries (especially in the Amazon) large areas of forest have been cleared to make way for cattle pastures and feed crops. This produces enormous amounts of global warming pollution—both from the clearing of trees and cattle's emissions of methane, which traps 23 times more heat in the atmosphere than carbon dioxide.

The deforestation caused by meat production can be reduced by increasing the productivity of livestock and pastures, expanding onto already cleared land instead of forests, and changing policies that subsidize beef production at the expense of forests. Consumers can switch to pork and poultry, which require much less land to produce than beef.

This report is one of a series that examines the vegetable oil, meat, and wood products markets and details how businesses and governments can ensure their products and policies are deforestation-free.

This report is available on the UCS website at *www.ucsusa.org/deforestationfree.*

The Union of Concerned Scientists is the leading science-based nonprofit working for a healthy environment and a safer world.

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