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New Solutions

The Community Solution℠

Community, a solution for saving the environment and conserving resources with equity for all.

Food, Feed and Fuel

The modern world has reached a critical point. Humans have become dependent on consuming increasing amounts of fossil fuels – resources that are dwindling even as their consumption generates more and more deadly greenhouse gases. The nation has abandoned almost all sustainable practices of living – traditions that existed for millennia – and replaced them with practices that require fossil fuel energy. For example, people no longer dry their hair with a towel and then hang the towel on a clothesline to dry; they use an electric blow dryer.

Similar, and more significant examples abound, as hand tools and physical skills have been replaced with fossil fuel driven-machinery and fossil fuel-based chemicals. The unfortunate result, particularly in the developed world, is that much knowledge and many ordinary skills have been lost. If electricity were to suddenly disappear, not only would scientists and engineers not have slide rules to turn to but they might not know how to use them even if they could find a supply.

With food, this loss of traditional skills is particularly dangerous. Not only has much of the knowledge of how to grow food without fossil fuels been lost, but the understanding of good food and nutrition is also disappearing. Some of the most nutritious vegetables, such as kale, collard and Swiss chard, are no longer reported in the U.S. government's agriculture statistics. Many people don't even know how to cook them.

This New Solutions *report focuses on food – for ourselves and our animals – and how, in this area of life as well, we have evolved to a non-sustainable, non-life-sustaining system... which must be changed if the human race is to survive.*

Rebuilding Local Agriculture

One bright spot is an increasing appreciation of the need to grow food organically. However, truly sustainable practices require that food be grown closer to the point of consumption in order to reduce the use of fossil fuels for shipping food long distances. Many people concerned with Peak Oil and Climate Change are already familiar with the need to grow foods locally. Even on a local basis, the massive monoculture system of farming is inherently problematic.

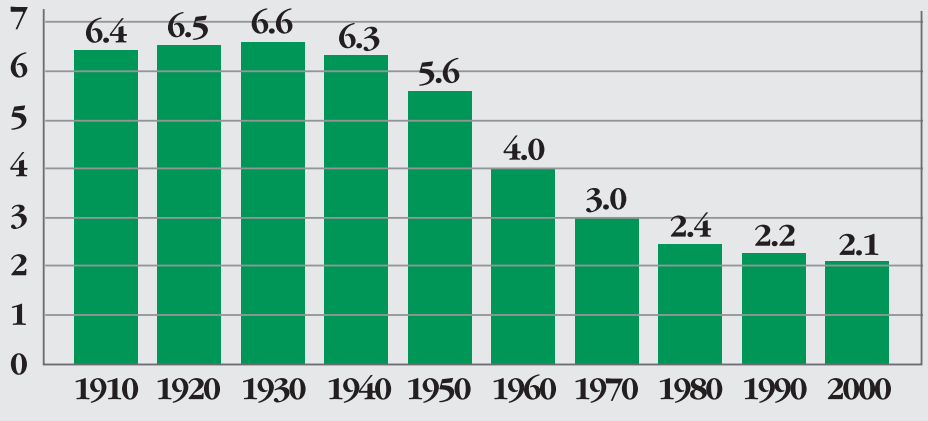
Over the last decades, much of the country's food production has become regionalized rather than local. Vegetables are grown in California, corn in the Midwest, potatoes in Idaho, and wheat in eastern Washington. These are then shipped throughout the country. Growing all the familiar foods locally may not be possible. Maybe eating the way our grandparents and great grandparents did, a way more attuned to the seasons, will be necessary.

But making such changes will not be easy. Most skilled small farmers were driven off the land by government policies, under the motto of "Get Big or Get Out," first formulated by Secretary of Agriculture Ezra Taft Benson in the 1950s[1] (see Figure 1). The result of this policy was dreadful for the people involved. They were now "free to find another line of work" but their vocation of farming and their love for the land was not considered.

Skilled small farmers have been replaced by fossil fuel-intensive agribusinesses and petrochemicals. Current farmers, who have become mere operators of machines and mixers of chemicals, may not have the skills to develop a local, sustainable agriculture. A new generation of farmers, numbering in the tens of millions, will need to be developed, trained and relocated to rural communities. Other farmers, or more aptly "gardeners," will be needed in suburban and urban agriculture.

Before a new agricultural system can be designed, it is necessary to understand the existing system created over the last 60 to70 years. Every person should recognize the agribusiness corporations that make up our food system, including growers, processors and retail stores. The geography of foods, the amounts produced, the plant varieties available, and how crops are used, as well as the basic classifications of food plants and their quality are important to know. Comprehending the role fossil fuels have played

Figure 1: Millions of farms in the U.S. 1910-2000



The decline in the number of farms reflects the serious loss of skills required to grow food.

in agriculture since World War II is also vital. At the same time it is necessary to correlate the damaging implications of today's cheap, overly processed food, which is not conducive to human health, contributes to today's expensive medical care and is a cause of global warming.

Manufacturing the American Diet

One way to analyze the food habits of Americans is to walk the aisles of a supermarket. Overwhelmed by abundance, one might recall common media statements such as, "There are 3,000 new products introduced in the market each year and only a small percent make it," or, "Today's supermarket has over 30,000 items, an amazing amount of choice for the consumer." However, such observations don't reveal what Americans eat; they only tell us what "products" are available.

There are 300,000 food and beverage products in the United States and an average supermarket carries 30,000 to 40,000. The popular view is that "the industry has brought Americans a food supply of astonishing variety, independent of season and geography."[2] The food industry works hard to create this view, but in so doing obscures the reality that these food choices are based on a large quantity of unhealthy manufactured foods.

People don't eat 30,000 different foods. In fact, they eat a relatively small number of foods. The "amazing choices" are merely different recipes, or, in the parlance of the grocery manufacturing industry, different "brands." Call it what you will – Wheaties, Wheat Thins, Yippee, Zoom, Real Crisp, Morning Delight, or any other marketing name – breakfast cereals and snacks, like so many food products, are basically wheat or corn with sugar, salt, and oil added. In most cases, food "manufacturing plants" combine white wheat flour, hydrogenated soybean oil, and corn sweeteners in various ways, with flavoring and coloring from chemicals.

Even the flavor of processed foods is manufactured. America's "flavor industry" is located along the New Jersey turnpike, a small area that produces about two-thirds

The food industry... obscures the reality that these food choices are based on a large quantity of unhealthy manufactured foods.

of the flavor additives sold in the U.S.[3] This $1.4 billion industry manufactures the additives that provide not just the flavor, but often the color, shape and texture for products as diverse as potato chips, corn chips, breads, crackers, breakfast cereals and pet foods, as well as ice creams, cookies, candies, toothpastes and mouthwashes. Once the core components have been mixed, flavored, shaped and dyed, they are placed in colorful, attractive packages. The "300,000 products" in our groceries is, in reality, nothing more than variations of a few basic foods. Unfortunately, to transform these few basic foods into manufactured foods requires massive consumption of oil and other fossil fuels.

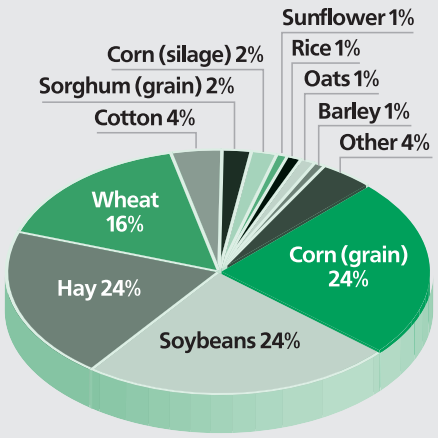
The Main Crops – Food and Feed

To determine what is actually eaten – the real foods and not the various recipes or branded products – one must figuratively walk the rows of crops in the fields, rather than the aisles of supermarkets. Food comes from the soil, either as plants grown in fields or as meat and dairy products, which come from animals eating the plants grown in the fields. More than 99.7% of all U.S. food comes from the land, while less than 0.3% comes from the ocean or other aquatic ecosystems.[4]

The United States Department of Agriculture (USDA) uses the word "food" to describe what humans eat and the word "feed" to describe what farm animals eat. The USDA also uses the term "crops" to describe the major food and feed plants that are grown. Most of the cultivated area in the U.S. is devoted to four such crops – corn, hay, soybeans, and wheat. Corn and hay are used principally for livestock, mostly beef cattle and dairy cows. Corn is also the major source of food and drink sweeteners. Soybeans are a major feed crop for livestock, mostly for pigs and chickens, and are secondarily a source of food oil. Wheat is mostly used for human food but a significant part is also used as animal feed. Figure 2 shows the distribution of the so-called "crops." (Cotton and tobacco are included since the USDA also defines them as crops.)[5]

The total acreage harvested in 2004 for the four major crops (corn, hay, wheat, soybeans) was 265 million acres – about 85% of the U.S. farmed land.[6] Other "crops" (as defined by the USDA) include the secondary grain crops of sorghum, barley, rice, oats, millet, and rye. In addition to grain crops there are several plants that provide the dietary oils that are a key part of the American diet. These oil seed crops include sunflowers, canola, flaxseed, safflower, mustard seed and rapeseed. Peanuts, cotton, sugar beets, sugar cane and tobacco are other crops that require another 6 million acres (or 2% of the nation's fields) – rather insignificant when compared to the big four.

Figure 2 – All U.S. Crops Harvested 2004



Different quantities of foods are produced from each acre of planting. For a general understanding of foods grown, the yield per acre and the total production is important. In addition, knowing the approximate calories produced from each crop is valuable in determining the food energy that each acre of land produces. Most yields are expressed in a wide variety of measures, such as tons, metric tons, long tons, cwt (hundredweight – equal to 100 pounds), bushels, etc. and must be converted into pounds for ease of comparison.

To give a more complete perspective of agricultural land use, fruits, vegetables and

nuts are included. The USDA does not define these as "crops," but places them in different categories. These three food types utilize another nine million acres, about three percent (3%) of the agricultural area (see Table 1). Most of this data was obtained from the 2006 Agriculture Statistics book[6] produced by the USDA. Because the report does not contain all data for the most recent years, 2004 was selected for purposes of comparison.

Measuring the Fields – Raw Materials for Manufactured Foods

As noted above, the industrial food system, which relies primarily on corn, white flour from wheat, soybeans and hay, has replaced the natural process of food production with a very complex manufacturing system heavily dependent on fossil fuels. The Grocery Manufacturers Association (GMA)[7] represents the world's leading branded food, beverage and consumer product companies. GMA member companies employ more than 2.5 million workers across the country and account for more than $680 billion in annual sales. The use of the word "manufacturer" in the organization's name is testimony to the industrial nature of the food products they make and sell, an industrial process that has led to soil depletion, water pollution and unhealthy food. It's important to analyze the food and feed crops that are behind this system.

Table 1 – Agriculture Land Use in the U.S. in 2004

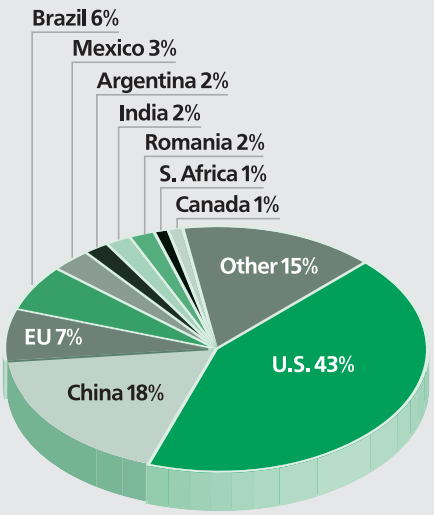
Crop	Harvested Acres	% of Acres	Yield/Acre	Yield Unit	Lbs/Unit
Grains					
Corn (grain)	73,631,000	25.2%	160.4	bu	56.0
Wheat	49,999,000	17.1%	43.2	bu	60.0
Sorghum	6,517,000	2.2%	69.6	bu	56.0
Barley	4,021,000	1.4%	69.6	bu	48.0
Rice	3,325,000	1.1%	69.9	cwt	100.0
Oats	1,787,000	0.6%	64.7	bu	32.0
Millet	595,000	0.2%	25.3	bu	54.0
Rye	300,000	0.1%	27.5	bu	27.5
Total	**140,175,000**	**48.0%**			
Hay					
Hay	61,966,000	21.2%	2.6	ton	2000.0
Total	**61,966,000**	**21.2%**			
Oilseeds					
Soybeans	73,958,000	25.3%	42.2	bu	60.0
Sunflower	1,711,000	0.6%	12.0	cwt	100.0
Peanuts	1,394,000	0.5%	30.8	cwt	100.0
Canola	828,000	0.3%	16.2	cwt	100.0
Flaxseed	511,000	0.2%	20.3	bu	56.0
Safflower	159,000	0.1%	12.0	cwt	100.0
Mustard Seed	68,700	0.0%	8.2	cwt	100.0
Rape Seed	7,800	0.0%	13.9	cwt	100.0
Total	**78,637,500**	**26.9%**			
Sugar					
Sugar Beets	1,306,900	0.4%	23.0	ton	2000.0
Sugarcane	879,500	0.3%	31.0	ton	2000.0
Total	**2,186,400**	**0.7%**			
Legumes					
Dry Beans	1,219,300	0.4%	14.6	cwt	100.0
Dry Peas	507,800	0.2%			
Lentils	329,000	0.1%			
Total	**2,056,100**	**0.7%**			
Fruits/Vegetables/Nuts					
Fruits	3,088,800	1.1%	1.0	ton	2000.0
Vegetables	3,236,890	1.1%	1.0	ton	2000.0
Nuts	926,200	0.3%	1.0	ton	2000.0
Total	**7,251,890**	**2.5%**			
Grand Total	**292,272,890**	**100.0%**			

Corn

The U.S. is the largest producer of corn in the world, growing the grain on 400,000 farms. In 2004/2005, the U.S. produced 256 million metric tons, 41% of total worldwide production.[6] About 10% of the U.S. crop is exported leaving 37% of the world total to be consumed by the people of the U.S. – who constitute only 5% of the world's population.[8] Figure 3 shows how the U.S. dominates world corn production.

Of the 11.8 billion bushels produced in 2004, 1.8 billion bushels were exported, leaving about 10 billion bushels for U.S.

Figure 3 – World Corn Production 2004-05



domestic consumption. These 10 billion bushels convert to 560 billion pounds of corn, or about 1,900 pounds per person (using a 2004 population number of 295 million).[6] The significance of corn-based foods in the American diet becomes enor-

mously clear when one takes into account the fact that the average amount of food eaten per person per year in the U.S. is 2,200 pounds.[9]

Many people might be surprised at this number, knowing they don't consume 1,900 pounds of corn each year. The USDA food consumption numbers show the average person directly consumes only about 11 pounds of corn and about 30 pounds of corn flour each year. Little corn is consumed *directly*, but much is consumed *indirectly*, principally through meat and sweeteners. 6.2 billion bushels were used as feed in Contained Animal Feeding Operations (CAFO). Stated another way, the largest crop in the nation is not used for direct human consumption but as feed for cattle and as sweeteners for manufactured food products.

Wheat

The second largest grain crop is wheat, the only grain crop used mostly for food rather than feed. Wheat is the fourth major crop in terms of acreage planted and harvested, following corn, soybeans and hay. In 2004, 2,158 million bushels of wheat were harvested from 50 million acres, of which 1,063 million bushels were exported, or about 49% of the total. Domestic use was 1,172 million bushels, including 905 million bushels for human food and 79 million bushels for animal feed. There are sixty pounds of wheat in each bushel so the 905 million bushels for food is about 184 pounds of unprocessed wheat per person.

Unfortunately for human health, wheat flour is highly processed. More than 98% of the 150 pounds of wheat flour (most of the wheat grown) consumed per capita in 1997 was refined, a process that removes many of the nutrients, including fiber, vitamins, minerals, and phytochemicals.[10] Most of these nutrients are not restored to refined flour, but instead, these nutrient rich materials, removed during processing, are fed to livestock.

Other Grains

88% of the grain acreage is allocated to growing corn and wheat. The remaining six secondary types of grains grown in the U.S.

> The average American eats 2,200 pounds of food per year; consumption of corn is 1,900 pounds per person per year! Corn, in one way or another, is in virtually every processed food we eat.

utilize only 12% of the farm land devoted to grains. These grains, including sorghum, barley, oats, millet and rye, are also used for feed.

The third largest grain crop (after corn and wheat) is sorghum. In the U.S. it is used primarily as an animal feed. However, worldwide, over half of the sorghum grown is for human consumption. In the U.S. in 2004, 191 million bushels were used for feed and 55 million bushels for food, seed and industrial uses.

Barley is the next grain crop in terms of acreage harvested and is also used for animal feed. Human per capita consumption of barley was only 0.7 pounds per person in 2004.

The U.S. produces about 1.8% of the total rice grown in the world. Of the 23,236 million pounds produced in 2004 in the U.S., 11,040 million pounds were exported and 11,700 million pounds were used for food and industrial products. In contrast to the other secondary grains, which are used mostly for feed, about 60% of the rice consumed in the U.S. is eaten directly as food. Per capita rice consumption in the U.S. was 22.4 pounds per person in 2004.

Oats are fed mostly to horses, with only 5% of the world's crop eaten by people.[11] In the U.S., oats are consumed mostly in the form of breakfast cereal. Human consumption of oats is 4.7 pounds per person. Millet and rye grains are also consumed in small quantities for food. Rye per capita consumption in the U.S. is less than one pound per person.

Summarizing Grains

The amounts of different grains grown in the U.S. have important implications. One is that the food supply is much less bountiful and diverse than popularly thought. By far the leading grain product is corn, used for manufactured foods and meat rather than consumed directly; and the same is true of most of the other grains, except wheat and rice. Certainly Americans do not eat a variety of grains.

Michael Pollen suggests that North Americans are now the "corn people," a designation previously given to Central and South America, the part of the world where corn developed as a basic staple.[12] Table 2 shows the distribution of the carbon molecules that come originally from corn in a typical McDonald's meal as measured by a mass spectrometer.

Table 2 – Corn Molecules in Fast Foods

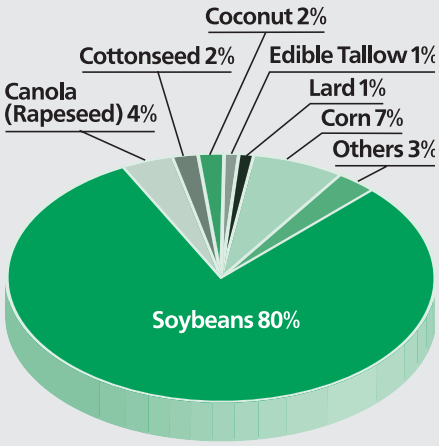
Food Type	Percentage
Soda	100
Milk shake	78
Salad dressing	65
Chicken Nugget	56
Cheeseburger	52
French Fries	23

For millennia people grew, harvested and ate food from the same land where they lived. The distance from field to plate might have been a few hundred yards. Now, in the U.S., that distance averages 1500 miles.[13] Nor did people "manufacture" food – what was picked or pulled or cut is what was eaten. Animal products were part of the diet but meat was originally obtained by hunting, and later by domesticated animals grazing on grasses. (Grasses are plants that humans cannot eat directly.) Today, few animals now graze freely. Instead they are kept in cages and pens and fed corn and other grains, as well as soybeans – feed crops grown using large amounts of fossil fuels. The changes in dietary habits are the result of the industrialization of food, an approach no longer sustainable due to dwindling supplies of fossil fuels and increasing greenhouse gases.

Soybeans and Other Oil Seeds

The amount of arable land allocated to soybeans is about the same as that allocated to corn, each taking about 25% of the nations farmland. 94% of the total oil seed acreage is allocated to growing soybeans. The remaining seven oil seed crops (sunflower, peanuts, canola, flax, safflower,

Figure 4 – U.S. Fat & Oil Consumption 2004



mustard and rapeseed) account for only 6% of the acreage. Figure 4 shows that most of the fats and oils eaten in the U.S. come from soybeans.[14]

Like corn, soybeans are a modern crop. And like corn, soybeans are not consumed directly but are raw materials for other kinds of foods and feeds. When consumed by people, soybeans are normally part of highly processed foods. In the U.S. approximately 3,123 million bushels of soybeans were harvested from 74 million acres of cropland in 2004. One thousand one hundred and two (1,102) million bushels, about 35% of the total, were exported. Of the remaining roughly 2 billion pounds of soybeans (each bushel weighs 60 pounds), about 400 pounds per person went into animal feed and manufactured foods.

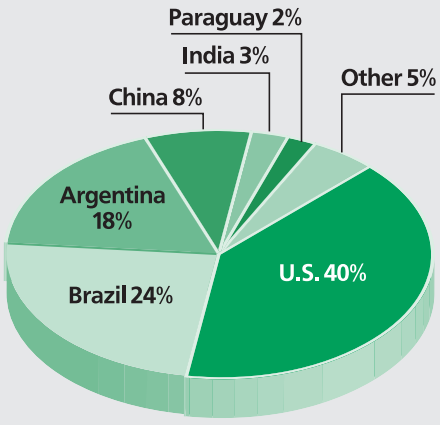
In 2004, the U.S. soybean acreage was 25% of the soybeans planted world wide. On this acreage, the U.S. grows 40% of the soybeans in the world with Brazil and Argentina growing another 42%. (The U.S. gets higher yields because of petrochemicals and more industrial equipment.) Just as in the U.S., none of the citizens of these other countries eat soybeans directly. Soybeans are raw materials for other kinds of manufactured foods and are shipped from these countries to other nations (see Figure 5).[15]

The basic products of soybeans are oil, meal, and hulls. According to the United Soybean Board, soybean oil, used in both food manufacturing and for frying and sautéing, represents approximately 79 percent of all edible oil consumed in the United States. After the oil has been extracted from the soybean, the remaining materials, mostly complex carbohydrates, are fed to livestock, mainly pigs, chickens and turkeys, consuming over 30 million tons of soybean meal yearly. The hulls are used as a component of cattle feed even though corn is the main feed crop for beef cattle.

Just as it is important to understand the role of corn in the American food system, it is important to understand the role of soybeans. Soybeans were first cultivated in northern China many centuries ago.[16] A significant breakthrough for the soybean in America occurred in 1896, when noted botanist and chemist George Washington Carver became head of the department of agriculture at Tuskegee Institute in Alabama. Carver's work led to the development of what would become the soybean's two main uses on the American continent – edible oil and animal feed.

U.S. soybean production in 1929 was 9 million bushels. Production in 1939 was 91 million bushels. 3,124 million bushels were produced in 2004 – illustrating the massive growth in soybean production. In the early 1950s, soybean meal became available as a low-cost, high-protein feed ingredient, which led to large increases in U.S. livestock and poultry production. Along with corn, soybeans helped create Contained Animal Feeding Operations (CAFO), modern concentration camps for livestock.

Figure 5 – World Soybean Production 2004[16]



Hay

Hay is the next largest planting after corn and soybeans – 62 million acres for hay versus 148 million acres for the other two crops. Hay growing uses 21% of the land (see Table 1). Hay is the product of any of a variety of perennial crops, typically grasses or legumes, which are used as feed for ruminant animals, mostly dairy and beef cattle. In 2004, 158 million tons of hay was harvested from the 62 million acres, about 1,073 pounds per person, providing meat and milk.

Sugar Cane and Sugar Beets

Sugar cane and sugar beets are relatively minor contributors to the American diet, as measured by the allocated acreage, compared to the sweeteners from corn. In 2004, the total sugar cane and sugar beet acreage planted was 2,186,400, only about 7/10ths of one percent of the farmed acreage. Initially sugar was obtained from sugar cane but later sugar beets became a key source. Both have been supplanted to a great extent by corn sweeteners. Of the 141 pounds of sweeteners consumed by each person yearly, 61.5 pounds come from sugar cane and sugar beets, while 78.1 pounds comes from corn sweeteners.[6]

Summarizing the Raw Materials

Hay, grains, oil seeds and sugars cover 96% of the U.S. cultivated land (see Table 1). Excluding wheat, which is mostly consumed as food rather than feed, the acreage devoted to these products is 79% of the total acreage. This surprising statistic shows how little of the available land is used for what are often designated as the "nutritious foods," which include legumes, nuts, fruits and vegetables (less than 4% of the cultivated land). The U.S. industrial agriculture system is very different than the systems in the rest of the world, which are less dependent on a few mass crops that serve as the raw materials for manufactured and highly processed foods. In those countries, staple crops are consumed directly.

In contrast to the rest of the world, the U.S. uses astounding amounts of fossil fuels in growing food and feed crops. The U.S.

food system uses 10 calories of fossil fuels to provide one calorie of food energy.[4] This single fact says much about the unique nature of America's industrial agriculture system. Are Americans eating food or fossil fuels? Has the long-standing government policy of subsidizing monoculture agribusinesses created an unsustainable system that will collapse with the depletion of fossil fuels?

Measuring the Fields – Natural Foods

Plant foods for direct consumption, as opposed to plants that serve as feed or for manufactured processed foods, are divided into four main categories – beans (or legumes), vegetables, fruits and nuts.

Designated "natural," these foods require minimal processing, and contain more vitamins, minerals and phytochemicals than manufactured products. Essentially they contribute more to health both because of their more nutrient-intense nature and also because they are lower in fats and refined carbohydrates. They are also the foods that require more care and attention in growing and harvesting. These kinds of food don't deplete the soil as much, require less fossil fuels, and are not subsidized as are grains and oil crops.

Beans (Legumes)

This group includes dry beans, dry peas, chickpeas, dry broad beans, lentils, pigeon peas, garbanzos, lupines, vetches and other minor pulses. (Vetch is also a term sometimes used to describe this kind of plant). The U.S. consumes a disproportionately large amount of the world's grains and oil seeds but consumes far fewer beans than other nations.

The main beans consumed in the U.S. are pinto, black, navy, red kidney, lima, and great northern. Historically beans have been a staple crop for protein in much of the world. Only in recent times has meat become a replacement source of protein. Table 3[17] shows that the same weight of beans provides more protein but much less fat than meat. Only 0.7% of the harvested acreage in the U.S. is allocated to beans, peas and lentils.

Vegetables

Vegetables are typically reported by the United States Department of Agriculture (USDA) as fresh vegetables and vegetables for processing. They include artichokes, asparagus, snap beans, lima beans, beets, broccoli, cabbage, carrots, cauliflower, celery, sweet corn, cucumbers, eggplant, endive, escarole, garlic, head lettuce, romaine and leaf lettuce, mushrooms, onions, bell peppers, potatoes, radishes, spinach, sweet potatoes, tomatoes, green peas, chili peppers, spinach, and other miscellaneous vegetables. The consumption of vegetables per year in the U.S. is 423 pounds per person. Only 1.1% of farmland is used for growing vegetables.[6]

Fruits

For reporting purposes the USDA also divides fruits into the categories of fresh fruits and fruits for processing. These include apples, apricots, avocados, bananas, cherries, cantaloupes, cranberries, grapes, grapefruit, honeydew, kiwifruit, lemons, limes, mangoes, nectarines, oranges, papayas, peaches, pears, pineapples, plums, prunes, strawberries, tangelos, tangerines, temple oranges, watermelon, blackberries, boysenberries, cranberries, dates, figs, loganberries, olives, raspberries, and other miscellaneous fruit and berries. On average each American consumes 271 pounds per year.[6] 1.1% of farmland is allocated to fruit production.

Nuts

The major nuts consumed in the U.S. are black walnuts, English walnuts, filberts, hazelnuts, almonds, cashews, peanuts (actually a legume), Brazil nuts, pecans, pistachios, macadamia, and chestnuts. The per capita consumption of nuts in the U.S. is about 4 pounds per year. The acreage for growing nuts is 0.3% of all acreage.[6]

Table 3 – Protein from Beans and Meat

Food		Kidney Beans	Beef Chuck
USDA NDB No		16027	13936
Nutrient	*Units*	*Value/100gr*	*Value/100gr*
Energy	kcal	333.0	129.0
Protein	g	23.6	19.5
Total lipid (fat)	g	0.8	5.1
Carbo-hydrate	g	60.0	0
Fiber	g	24.9	0

Note: NDB is Nutrient Data Bank.

Measuring the Fields – Summary

The American agricultural system provides two kinds of food. One kind is used as feed and materials for manufactured foods, such as hay, corn, and soybeans. The second kind are eaten directly, such as wheat, vegetables, nuts, beans and fruits.

All of the hay crop, most of the corn crop and a sizable part of the soybean crop are turned into human food in the form of meat, dairy products, and eggs. Corn also provides sweeteners in the form of high fructose corn syrup and soybeans provide fat in the form of hydrogenated soybean oil. About 80% of agricultural land is devoted to hay, corn and soybeans, with the remaining 20% allocated to wheat, vegetables, nuts, beans and fruits.

The preceding analysis puts into perspective the kinds of plants grown, their uses, (particularly feed versus food), and the amount of land allocated for the various kinds of crops. Except for the major crops, the analysis does not include exports and imports. Thus percentages of acres grown do not completely reflect consumption. However, except for the large-volume food crops, the impact of exports and imports is relatively small.

World Meat Consumption

Popular wisdom holds that as societies become wealthier they eat more meat; they also drive more cars, build larger houses and fly longer distances. Since this wealth is primarily based on fossil fuel consumption, it could also be stated that as societies use more fossil fuel energy (and generate more CO_2), they then eat more meat, drive more cars, etc. Thus, the nation's so-called increased standard of living, as measured by these items of consumption, is based on increasing per capita consumption of fossil fuels. This is obvious with houses and cars, since their larger size and energy intensive

features are apparent. But the relationship of food to energy consumption is less apparent.

Historically, animals have provided food for people by grazing on lands that were not easily cultivated, such as steep hillsides and other marginal land. Cows, goats and sheep can live on grass and turn this plant source, indigestible by humans, into meat and milk that humans *can* digest.

For most of history people ate a diet with large amounts of vegetables and small amounts of meat and fish. The U.S. diet changed dramatically with the rapid increase in the use of fossil fuels that began at the end of World War II. From then until now, world consumption of oil increased eightfold, from 11 million barrels per day to 84 million barrels per day.[18] During the same period global meat production increased five fold.[19] Fossil fuels made this increase possible.

In 1961 world per capita meat consumption was 51 pounds per person per year, divided into 21 pounds per person in the developing world and 116 pounds per person in the developed world. Today world meat consumption is 92 pounds per person for the world, 68.2 pounds per person in developing countries and 187 pounds per person in developed countries.[20] Per capita consumption almost doubled in less than 50 years. Table 4 shows annual per capita meat consumption for various world regions.[21] North Americans eat over 100 pounds more per person than Europeans.

Table 4 – Regional Yearly Meat Consumption per Person

North America	271 lbs.
South America	154 lbs.
Asia	62 lbs.
Sub-Sahara Africe	29 lbs.
Europe	163 lbs.
Central America	103 lbs.
North Africa	57 lbs.

Around the world, the consumption of meat varies in proportion to the use of fossil fuels. Americans have grown accustomed to eating large quantities of meat, though this was not always true. In 1999, total U.S. meat consumption (red meat, poultry, and fish) amounted to 197 pounds (boneless, trimmed-weight equivalent) per person, 91 pounds more than the 106 pounds in the 1930s. During the Great Depression the amount of meat eaten was about half today's per capita consumption.[11] It has not been millennia but only decades since Americans ate less meat.

Meat and the Green Revolution

The rapid increase in meat consumption is related to the rapid increase in the production of grains, especially corn. And the rapid increase in grain production is due to the increased use of fossil fuels in industrial agriculture. The Green Revolution was not the result of discovering some new plant or finding an innovative way to naturally increase yields. Rather it was a discovery that crop yields increased when artificial fertilizers, made from fossil fuels (mostly natural gas), were applied to hybridized seeds.

New fertilizers, combined with the automation of the farming process and the use of fossil fuel based chemical pesticides, fungicides and herbicides, led to the planting of huge tracts of land in single crop monocultures of a few grains and oil seeds. This is what gave the Green Revolution its name. The fundamental issue is the yields, as seen in Table 5, which shows the Green Revolution's six-fold increase.[22]

Table 5 – Increased Corn Yield from Artificial Fertilizers

U.S. Corn	1931	2005	Percent Change
Acres Planted	109 mil	81.6 mil	-25
Acres Harvested	91 mil	73.4 mil	-18
Production	2.2 bil Bu	11.03 bil Bu	+401
Yield (Bu/Acre)	24.5	148.4	+506
U.S. Population	123 mil	281 mil	+128

The "Green Revolution," with its increase in corn yields, led to the "Livestock Revolution," an increase in meat production. This represented a change from the sustainable agricultural practices of natural fertilizers and solar energy for growing grass (the natural food for ruminants) to unsustainable practices using fossil fuel energy for growing grain (an unnatural food for ruminants).

Meat and Fossil Fuels

Only in recent years has the relationship of the economy to fossil fuel consumption become obvious. A significant part of the economy is devoted to producing food. As previously noted, the major changes in agriculture since World War II have involved an increasing reliance on fossil fuels in a variety of forms – as fertilizers, herbicides, fungicides, and pesticides, as well as for drying, refrigeration, storage, and transportation. A major danger to American society is that the depletion of fossil fuel resources will make modern agriculture practices obsolete. Nowhere is this more apparent than with meat.

Gasoline prices as well as natural gas and electricity bills make it obvious that our cars and houses (along with their furnaces and appliances) are machines that consume energy. As stated earlier, it is less apparent that our food is also based on fossil fuel consumption. Yet the modern industrial food system is as dependent on fossil fuels as is the modern transportation system. As fossil fuels become less available and more expensive, similar kinds of tradeoffs must be made. Just as people will choose energy efficient cars and buildings, so will they need to choose energy efficient foods.

Of the ten calories of fossil fuels necessary to provide one calorie of food energy,[4] one third is allocated to growing the food and feed crops, another third to processing and packaging (the manufactured version of foods) and a final third to distribution and cooking. The U.S. food system uses about 17% of the total fossil fuels consumed each year in the nation. This is the equivalent of 400 gallons of oil per person per year or about 9.5 BOE "barrels of oil equivalent" per person per year for food alone.[4] Compare this to the *total average energy use* of the third world (5.4 billion people) of 7.3 barrels of oil equivalent per person per year.[23] In other words, the amount of fossil fuel each American uses *for food alone* exceeds the amount of fossil fuels used by citizens of the third world *for all purposes*.

Today, the average U.S. citizen consumes directly 202 pounds per year of food grain and indirectly (through meat eating) 1,795 pounds of feed grains. The average Chinese person consumes directly 851 pounds per year of food grains and indirectly 154 pounds of feed grains. Essentially the Chinese are eating the grain grown in the fields while Americans are passing the grain through animals, a highly inefficient process.[4]

The energy differential between generating protein from plants and generating protein from meat is profound. To produce one Calorie of plant protein requires 2.2 Calories of fossil fuel energy, while to produce one Calorie of animal protein requires 25 Calories of fossil fuel energy. Thus it takes 11 times as many fossil fuel calories to get the same amount of protein from meat as from plants.[9]

> ...it takes 11 times as many fossil fuel calories to get the same amount of protein from meat as from plants.

It is important to understand that the energy required to produce a given amount of protein is different for different animals. In the U.S. livestock factory farming industries are very efficient at turning corn and soybeans into meat. 15 pounds of corn and soy are eaten by pigs to produce 2.2 pounds of pork, a 6.9 to 1 ratio. David Pimentel estimates that 30,000 calories of fossil fuel energy are used to produce a kilogram of pork which contains 2,160 calories.[24] The ratio of energy input to protein output is 57 to 1 for lamb, 40 to 1 for beef cattle, 39 to 1 for eggs, 14 to 1 for pigs, 14 to 1 for milk, 10 to 1 for turkeys and 4 to 1 for chicken broilers. Note this analysis is for protein, not total calories.[9]

Meat and Beans

How does the rest of the world use so little fossil fuel energy for their food? First they eat less high-fat food. Diets in other parts of the world do not include large amounts of meat; additionally, the meat that is consumed is grown without fossil fuels by allowing animals to graze on grass and forage rather than being force fed in Contained Animal Feeding Operations (CAFO). Such people have not converted their natural pastures to corn fields nor do they use fossil fuel energy to grow their crops.

Table 6 – Plant Foods To Meat Comparison

Food		Soybean	Kidney Beans	Sweet Corn	Beef Chuck
Nutrition DB No		11450	16027	11167	13936
Nutrient	**Units**	**Value**	**Value**	**Value**	**Value**
		/100 gr	/100 gr	/100 gr	/100 gr
Energy	kcal	147.0	333.0	86.0	129.0
Protein	g	12.9	23.6	3.2	19.5
Total lipid (fat)	g	6.8	0.8	1.2	5.1
Carbohydrate	g	11.1	60.0	19.0	0
Fiber	g	4.2	24.9	2.7	0

Production of meat in the U.S. is very different than in the rest of the world. Animals account for 70% of domestic grain consumption in the U.S. while India and sub-Sahara Africa feed just 2% of their grain harvest to livestock.[24] Furthermore, in many countries, people eat soybeans rather than feed them to animals. Table 6[17] shows that soybeans and beef have similar amounts of nutrients. Generally speaking, beans are an important part of the diet in other parts of the world. Kidney beans, for example, provide more protein than beef.

The issue of eating meat is a complex one. Some people argue against it because of the suffering of farm animals. Others suggest that a vegetarian diet is healthier. Still others point out the environmental implications of feedlots, the excessive use of water for meat production, and the amount of land used for feed crops. Whatever the viewpoint, it is clear the world's increased meat consumption will be affected by depleting fossil fuels. Humans can live well without eating such large quantities of meat. One wonders if North American meat consumption should be considered gluttony.

Meat and Climate Change

The change from eating grains directly to eating animals fed by grains has devastated the environment. Livestock are a major emitter of the greenhouse gases that contribute to climate change. As meat consumption increases around the world, changing our diets may prove to be as important, and as difficult, as changing our transportation vehicles.

A 2006 report by the Food and Agricultural Organization of the United Nations, entitled "Livestock's Long Shadow,"[25] found that the world's rapidly growing herds of cattle are a major threat to the climate, to forests and to wildlife. While the report also analyzes the damage done by sheep, chickens, pigs and goats, it is the world's 1.5 billion cattle that do the most damage.

Livestock generate nine percent of all CO_2 emissions, 37 percent of methane emissions, and 65 percent of nitrous oxide emissions. Methane has 23 times the global warming potential of CO_2, and nitrous oxide has 296 times the potential. When methane and nitrous oxide are measured in CO_2 equivalent units, livestock are responsible for 18 percent of the total greenhouse gases that cause global warming worldwide – *more greenhouse gas than that generated by cars, planes and all other forms of transportation combined.*

These "emissions" are not simply cattle flatulence and manure. Changing from pastures to feed crops as the basis for raising food for animals requires more use of fossil fuel energy to produce fertilizers, pesticides, herbicides, and fungicides, along with electricity to pump water. Additionally, deforestation in third world countries removes one of the "sinks" for greenhouse gases. Ranching is the major driver of deforestation worldwide, and overgrazing is turning grasslands into deserts.

Cows also drink vast amounts of water, requiring 990 liters to produce one liter of milk. Pollution from this modern form of industrial meat production also washes down to the sea, creating "dead zones" devoid of life. One such dead zone, in the

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Gulf of Mexico, is largely the result of U.S. beef production waste that is carried down the Mississippi.

The Power of Choice

Like many modern day practices, the process of providing meat for our tables has grown increasingly problematic. As climate change worsens, factory meat farming will become unsustainable. The system of Contained Animal Feeding Operations (CAFO) is only 50 years old. Thus, more sustainable ways of producing meats should be neither hard to comprehend nor difficult to implement. It will still be necessary to eat less.

Author and farmer Joel Salatin,[12] raises healthy animals in a humane environment, providing an excellent example of what's possible. As fossil fuels become ever more limited and expensive, a return to humane practices – using sunlight to grow grasses rather than fossil fuels to grow grain – will most likely occur. Animals will again be raised on the same farm with crops so that their manure can be used as fertilizer. However, it will be necessary to change perspectives because growing meat in a sustainable manner will cost more and supplies will be more limited.

As with houses and cars, consumer food choices have a major influence on the environment. A recent study by researchers at the Union of Concerned Scientists named food as one of the most environmentally harmful consumer activities. According to this study, the second most effective environmental choice that a consumer can make is to eat less meat and poultry (second to driving less and/or driving an energy efficient car). The authors list buying organic produce as a very effective environmental choice after eating less meat. They suggest that such food choices have a greater positive environmental impact than household changes such as installing energy-efficient lighting and appliances, and certainly more impact than the much less significant options of 'paper versus plastic' or throwing away a disposable cup.

The difference in fossil fuel energy required to sustain a meat-based versus a vegetarian diet is surprising. David Pimentel calculates that providing a 3,600 daily Calorie diet with 1,000 Calories coming from animal products requires about 35,000 Calories of fossil fuel energy whereas a 3,600 Calorie vegetarian diet (with more than sufficient levels of protein) takes about 18,000 Calories of fossil fuel energy – about half that of the non-vegetarian diet. A lacto-ovo vegetarian diet (including milk and eggs) requires around 25,000 Calories of fossil fuel energy**.** From a CO_2 generation standpoint, choosing a vegetarian diet, or at least one greatly reduced in animal products, significantly reduces the environmental impact.[26]

Other Considerations

Torturing Food Animals

The Green Revolution led to the Livestock Revolution which led to a system of meat production that causes incredible suffering to animals. Animals, like people, have a natural way of living. Cows and sheep graze, pigs root and chickens scratch in the dirt – traditionally, animals ate foods readily available in the natural world around them. Today, animals live in unnatural conditions that cause great suffering.

First the animals are confined in buildings removed from the natural world. As an analogy, imagine a child born in a hospital who never leaves the building. Or, more aptly, imagine a child born who never leaves its crib – the crib being sized to allow full growth to six feet or so. This large crib would be located so that the child would never see the outside world – appalling, but still not as bad as that which millions of animals actually face every day.

Veal calves and pigs, for example, are imprisoned in cages so that they can never turn around. They spend their life facing one direction with a view of another animal in a cage in front of them. Chickens are placed six to a cage with a floor area about the size of a place mat. The animals live their lives constantly breathing fecal matter. Beef cattle are allowed to live in small pens and can move around, but they are always standing in fecal material and urine. Pig fecal material drops into vats beneath their cages from which a powerful odor constantly assail their nostrils.

Most of the antibiotics used in the country are to fight the bacteria rampant in these feeding enclosures. The antibiotics keep the animals alive but do nothing to alleviate their suffering. Their lives are agony from birth to death, and the mortality rate is high. The diets are foreign to their natures and designed to produce as much meat as fast as possible. By the end of their short lives, their bodies are unhealthy, with dangerous levels of fat embedded in the meat.[27, 28, 29]

Harming Ourselves

Of all the industrialized rich nations, Americans are the unhealthiest. By way of example, the U.S. now spends about $6,000 per person per year on health care and its citizens' life expectancy is 77 years, while Canada spends about $3,200 per person per year on health care and Canadians have a life expectancy of about 80 years.[30] U.S. medical costs per capita are twice those of Europeans.[31] In other parts of the world, in fact, as people begin to eat more meat, they tend toward Western disease patterns, a trend so common that it has been named the "nutrition transition."

The U.S. is known for its cheap food (per capita food expenses are about $3,410 per person)[32] and its citizens buy a lot of it. Two-thirds of Americans are overweight or obese.[33] Overweight is defined as a body mass index (BMI) greater than or equal to 25 and 66.3% of Americans fall in this category. Obese is defined as a BMI greater than or equal to 30 and 32.2% of Americans fall in this category. Incidentally, vegetarians are demonstrably healthier than meat eaters.[2] Those who eat no meat of any kind suffer less from heart disease and certain cancers.

The U.S. economy is committed to

growth, implying continuous increases in consumption for a wide range of products, including homes and cars. The governing assumption has been that this is beneficial, even if environmentally costly.

Toward a similar end, industrial food companies have grown by changing the way people eat; specifically, instead of consuming plants directly (including grains and beans), advertising encourages people to eat the *animals* that eat the plants as well as to eat numerous manufactured, highly processed foods made from combinations of plants. Because these companies' products are "food," one result of their "growth" has been larger (fatter) unhealthy consumers. Thus, food companies have achieved growth at the cost of poor health for the consumer – and a deteriorating environment. A "silver lining" of fossil fuel depletion may be the return to a more traditional – and healthier – diet.

Killing the Soil

A square foot of healthy soil contains thousands of living creatures. In a natural cycle, food comes from the soil and is consumed by animals, including humans, who then give nutrients back to the soil in the form of feces, urine and corpses, enabling the soil to produce more food, which is consumed again by animals, etc., etc.

Humans have broken this cycle in dangerous ways, particularly with Contained Animal Feeding Operations (CAFO). Now, instead of the natural food-waste cycle, there are enormous amounts of animal sewage to contend with, along with declining soil fertility. Wendell Berry, well-known agricultural writer, notes that the nation has turned a solution that has existed for millennia into two problems, one being the accumulation of animal wastes in huge amounts and the other being the depletion of soil fertility.

Failure to return decaying matter (both animal and plant) to the soil, combined with the aggressive use of machinery for tilling and harvesting, also leads to erosion, further undermining the natural cycle. Currently, the U.S. is losing about an inch of topsoil from its croplands every 34 years. Under an ideal agriculture situation where soil is supplemented with large amounts of fertile organic matter, an inch of soil would be rejuvenated in perhaps 30 years. Unfortunately, left to heal itself, land takes approximately 500 years to form an inch of soil.[4]

...the nation has turned a solution that has existed for millennia into two problems, one being the accumulation of animal wastes in huge amounts and the other being the depletion of soil fertility.

A significant danger is that the country's agricultural land is so damaged that it will take several years of active rebuilding – using organic methods of soil restoration – to regain the fertility lost by unsustainable practices. Currently many farm fields are so void of nutrients and life that yields would be extremely poor without fossil fuel inputs. Such practices become less and less sustainable each year.

Exploiting Farmers and Farm Workers

Our system is cruel to animals, damaging to other wild life and destructive of the soil. It has also caused great harm and suffering to farmers. The suicide rate among farmers is three times that of the country as a whole.[34] Government policies since WWII have deliberately driven the small farmer off the land. People who love their farms, care about the farm animals and protect the soil for future generations have been replaced with agribusiness farms and Contained Animal Feeding Operations (CAFO). The loss of the personal touch of the dedicated farmer at the expense of fossil fuel based methods of growing has increased yields while damaging land, waterways and lives.

While the ranks of small farmers are being decimated, farm workers, most of them immigrants, take on the dangerous, arduous and toxic work of laboring in the fields. The average U.S. farm worker has a life expectancy of just 49 years. Farm laborers are generally paid piecework rates. Their average earnings are $7,500 a year, or $150 a week, the lowest wage of any occupation. Few receive overtime pay, medical insurance, or sick leave and rarely are they permitted to organize. In many states, farm workers are excluded from workers' compensation and unemployment benefits.[35] Agricultural interests and government ignore the plight of the farm worker. The 1935 Wagner Act, allowing workers to organize unions without interference from employers, and the 1938 Fair Labor Standards Act both excluded farm workers.

It would cost about two percent of the national grocery bill to pay all farm workers decently. The retail food industry is famous for large markups at each of the stages of wholesaling, transportation, preparation and packaging, and retailing. In 2000, U.S. consumers spent $661 billion on food. Of that, only 19 percent went to growers themselves. The rest, 81 percent, went to wholesalers, manufacturers, retailers and restaurants. It would require a raise of $3,203 a year for every farm worker today to earn the minimum wage. This would cost the average American household about $50 per year.

Since the 1970s, the public has demanded that Congress pass laws to protect the physical environment. Businesses in the United States are now forced to consider environmental factors as part of the cost of doing business. Environmentally abusive industrial methods might produce cheaper consumer products, but such an approach is no longer considered acceptable. Unfortunately human misery is not considered part of the environment. Consumers may criticize environmentally unsound growing practices but rarely speak up for exploited farm workers. Farmers are more at risk than any other group for cancer caused mortality.[36] Farming is one of the top ten most hazardous occupations after logging, fishing, commercial pilots, construction workers and refuse workers.[37]

Part of a sustainable world is to provide decent livings for both farmers and farm workers, benefits sadly missing in this country. America's exploitation of illegal immigrants helps to obscure the poor working conditions of farm laborers. And the American disdain for manual work, plus the people's insistence on cheap food, exploits and destroys our own native family farmers.

Summary

The industrial agricultural system may prove to be as damaging to the planet and people as the private car – perhaps more so. The current system is not economically, socially, or environmentally sustainable.

Modern meat is one of the most destructive products of this system, having enormous negative impacts: current production and consumption practices harm the climate; feed crops lead to loss of topsoil and pollution of waterways; and meat eating affects the physical health of people. (Mental health may also be an issue, particularly if one considers the plight of agricultural workers, like packing house employees, who deal day in and day out with cruelty to animals.) The only sustainable way to raise meat is free range, where animals live outside and eat what Mother Nature intended for them to eat: grass, bugs, seeds, and other wild stuff, along with some hay in the winter. This would alleviate the suffering caused by modern providers of factory meat.

Americans eat far more meat than people in other countries. So they must face up to the meat issue and its contribution to global warming. Many Americans will find the prospect of giving up meat (or eating less or only eating grass fed meat) as challenging as giving up their automobiles! But like the personal car, a heavy meat diet is not sustainable; both cars and meat use too much fossil fuel and produce deadly greenhouse gases. Meat is the most fossil fuel intensive food per unit of energy or of nutriments.

A new diet is necessary to deal with the coming limits of fossil fuels as well as with a deteriorating medical system and climate. People must eat less. The average person consumes 3,600 Calories (actually kilocalories) per day; however, humans only need 2,500 Calories (kilocalories) per day so food consumption could be reduced by 1/3. The most effective way to change the food system is to eat differently. America's new diet will rely on local foods, mostly plants, eaten as fresh as possible with much less meat and only meat from animals eating the diets nature intended. Manufactured foods need to be avoided. People's health will improve and the degradation of the environment will decrease. Toxic farming practices will no longer be needed and the soil will begin the long journey of rebuilding itself.

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