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AGRICULTURE FOOTPRINT BRIEF
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EATING UP THE EARTH: HOW SUSTAINABLE FOOD SYSTEMS SHRINK OUR ECOLOGICAL FOOTPRINT

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The Earth provides a perpetual bounty as long as we don't destroy its self-renewing capacity with our appetites. Today, however, we are eating up the planet.

Our global food system, with its resource-intensive production and distribution, is using almost half the planet's ecological capacity and is slowly degrading our natural resource base. To assure our well-being, we must close the gap between human demand and ecological capacity. Sustainable food systems offer viable opportunities to shrink humanity's food Footprint to a size the Earth can support.

1. AGRICULTURE TAKES A BIG BITE: THE ECOLOGICAL FOOTPRINT OF THE GLOBAL FOOD SYSTEM

After air and water, food is the most essential resource people require to sustain themselves. These resources are provided by the layer of interconnected life that covers our planet: the biosphere. Yet the way the food system provides food often severely damages the health of the biosphere through soil and aquifer depletion, deforestation, aggressive use of agrochemicals, fishery collapses, and the loss of biodiversity in crops, livestock, and wild species.[1]

The global food system has become such a dominant force shaping the surface of this planet and its ecosystems that we can no longer achieve sustainability without revamping the food system. At the same time sustainable food systems provide great hope for building a sustainable future—a future in which *all can lead satisfying lives within the means of the biosphere*.

In this brief, we use Ecological Footprint analysis to document the current food system's demand on the biosphere. Ecological Footprint accounts track the area of biologically productive land and water needed to produce the resources consumed by a given population and to absorb its waste.

The Ecological Footprint allows us to monitor a central threat to sustainability: the liquidation of the planet's natural capital as we consume more resources than nature can regenerate and create more waste than nature can recycle. Our analysis reveals the leading role played by the food system in this liquidation and underscores how profoundly a sustainable future depends on reshaping that system.

THE CASE FOR SUSTAINABLE FOOD SYSTEMS — AN OVERVIEW —

Using the Ecological Footprint concept, this policy brief addresses three fundamental questions:

1. **What does it currently take to feed us?**

   First we describe humanity's current food Footprint. By showing how cropland, pasture, fishery, and energy use affect the food Footprint, we pinpoint high impact and low impact consumption patterns to reduce our overall food Footprint.

2. **How can we avoid the clash between expanding human demand and limited ecological capacity?**

   We put food in the context of the total human Footprint and identify strategies for shrinking our impact. The food sector provides a golden opportunity to reduce our ecological deficit through sustainable consumption and production, regionalism, and steady-state economics.

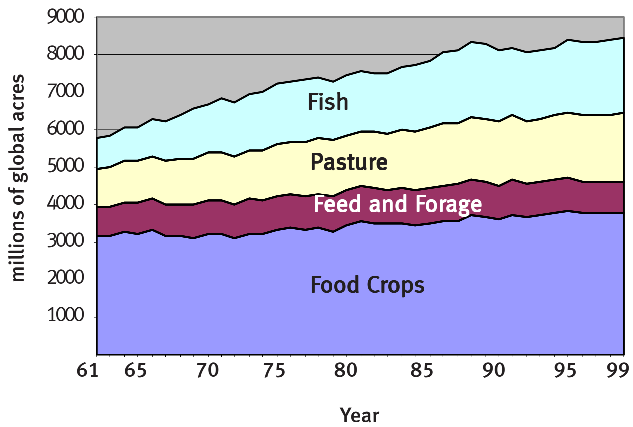
3. **What will it take to feed us all well for years to come?**

   We offer on-the-ground examples of how sustainable agriculture can reduce the food Footprint by moving from an industrial approach to small-scale, local, sustainable alternatives. Following the food chain from farm to fork, we address production, processing, packaging, and transportation of food.

The food Footprint consists of four components: **cropland**—on its own more than half the Footprint—**pasture**, **fisheries**, and **energy**. These four components account for all of the meat, fish, grain and vegetables that are consumed directly by humans, as well as all of the meat, fish, grain and energy that is used to feed, harvest and ship food products to consumers.

FIGURE 1

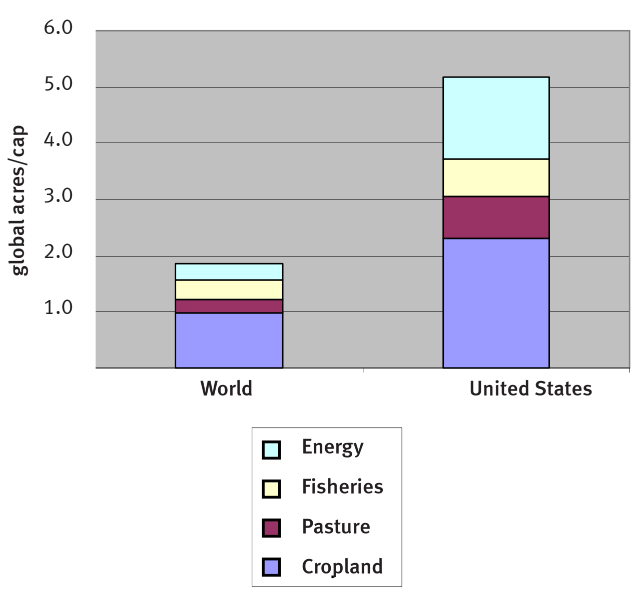
GLOBAL FOOD FOOTPRINT (EXCLUDING ENERGY), 1961-1999



All Footprints are measured in a common unit called a "global acre," which is an acre with a global average biomass productivity. Expressing Footprints in global acres allows the comparison of every Footprint to local or global biocapacity, and across regions that have different qualities and mixes of cropland, grazing land, and forest. For instance, we can compare the average American food Footprint (5.2 global acres per person) to the world average (1.9 global acres per person). Figure 2 illustrates these Footprints. The dramatic differences in every component of the food Footprint reflect drastically different consumption patterns between the U.S. and the rest of the world.

FIGURE 2

FOOD FOOTPRINT OF THE UNITED STATES AND THE WORLD



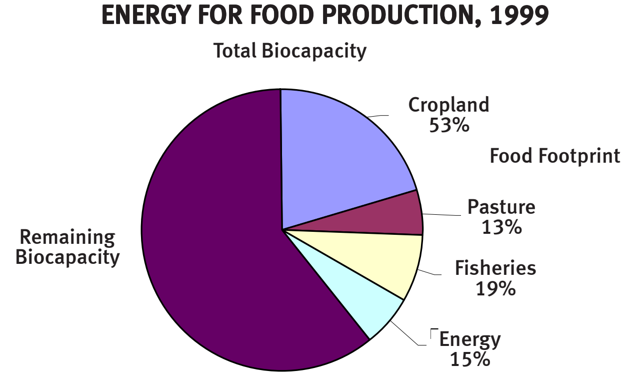
The global food Footprint is steadily increasing. In 1961, the food system occupied 27 percent of the Earth's biocapacity. Today, the food system requires 40 percent of the Earth's biologically productive area,[2] or 47 percent if unharvested crop areas and non-edible crops, such as tobacco and cotton, are included. While the remaining biological capacity may seem like ample territory for the expansion of food production, this extra area lies mostly in the world's forests and grasslands, which provide other products and critical ecosystem services and harbor much of the Earth's biodiversity.

Cropland production is highly intensive in many places around the world, degenerating the productivity of the land. Most fisheries also operate near or over capacity and have experienced declines or collapses in commercial and non-commercial populations. Urban growth and infrastructure swallows up additional productive land, further increasing the pressure on remaining ecosystems. In fact, the U.S. loses two acres of farmland every minute to urban growth. From 1992 to 1997,[3] an area the size of Maryland was converted from agriculture to urban use. As we lose our most fertile and productive land to development, and as human demand for food expands, pressure rises to put marginal land into production. Expanding production to new, less productive land is not sustainable. The only sustainable solution is bringing our food Footprint in line with Earth's sustainable capacity.

In order to create a sustainable food system, we must break down the food Footprint into its primary components: the cropland Footprint, the pasture Footprint, the fisheries Footprint, and the energy Footprint. By understanding consumption patterns by sector, it becomes easier to target specific areas of consumption.

FIGURE 3

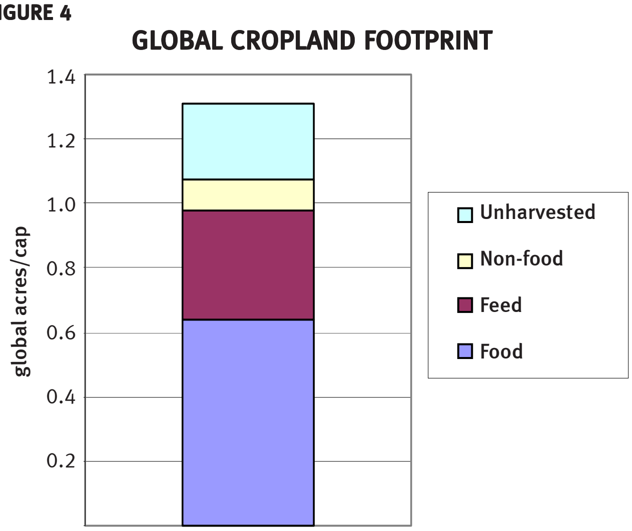
ENERGY FOR FOOD PRODUCTION, 1999



Cropland Footprint

The world's cropland produces human food, animal feed, fiber, and other non-food crops, and makes up 53 percent of the global food Footprint. Footprint accounts analyze the consumption of 75 primary crop products and 15 secondary products, following the categorization of the UN Food and Agriculture Organization (http://apps.fao.org).

FIGURE 4



The cropland Footprint has steadily increased with global population. The intensification of farming, using agrochemicals, irrigation, and monoculture cropping, has slowed the expansion of cropland: the cropland Footprint grew by less than 10 percent over the last 40 years, while the world population doubled. But these gains have ecological costs: a swollen energy Footprint and increased demands on neighboring ecosystems to cope with nutrient loading, soil erosion, toxicity, and water shortages.

The concentration of global food production under the control of a few transnational corporations, bolstered by free trade agreements, structural adjustment policies, and subsidies for the overproduction of crop commodities, has created North-South food trade imbalances and import dependencies that underlie a growing food insecurity in many countries. Production of cash crop exports in exchange for food imports can undermine food self-sufficiency and threaten local ecosystems, adding to the global Footprint.

Agribusiness consolidation and large-scale, monoculture cash-cropping also leads to the loss of crop and livestock diversity. Wheat, rice, and corn are now the three most abundant plants on Earth, providing 60 percent of human food.[4] At the same time, industrial agriculture threatens crop diversity through the replacement of native varieties with hybrid strains and the contamination of crop and wild species from the introduction of genetically modified organisms.[5] As the global food supply relies on a diminishing variety of crops, it becomes vulnerable to pest outbreaks, the breeding of superbugs, and climate disruptions, all of which could further expand the human Footprint even as it must shrink.

Pasture Footprint

The world's grazing lands provide us with meat, milk, wool, and hides and represent 13 percent of the global food Footprint. Footprint accounts analyze eight pasture-dependent categories and show a growing pasture Footprint as the world consumes more animal products. While the pasture and grassland Footprint has not grown as rapidly as the consumption of animal products, this is due to the increased use of fertilized pastures for grazing, breeding and managing livestock to boost production efficiency, and feeding livestock from cropland production. In many countries, livestock are at least partially, sometimes exclusively, fed from corn, soybeans, other crops and crop residues, and fishmeal. A third of the world's harvested

WHAT THE ECOLOGICAL FOOTPRINT MEASURES

Ecological Footprint accounts track people's use of six bioproductive areas, each corresponding to the Earth's major ecosystems:

- Cropland provides crops for food, animal feed, fiber, and oil;
- Grasslands and pasture support grazing animals for meat, hides, wool, and milk;
- Forests provide timber, wood fiber, and fuelwood;
- Forest sinks sequester carbon dioxide (CO_2) emitted from the burning of fossil fuels;
- Marine and inland waters supply fish and other products;
- Built-up land accommodates infrastructure for housing; transportation; industry; and for capturing renewable energy.

Because people use resources from all over the world and pollute far away places with their waste, Footprints sum up all these areas, wherever they may be located on the planet.

Dividing all of the planet's biologically productive land and sea area by the number of people living today results in an average of about 4.5 acres per person. In order to preserve biodiversity, some of this biocapacity needs to be left for other species to use.

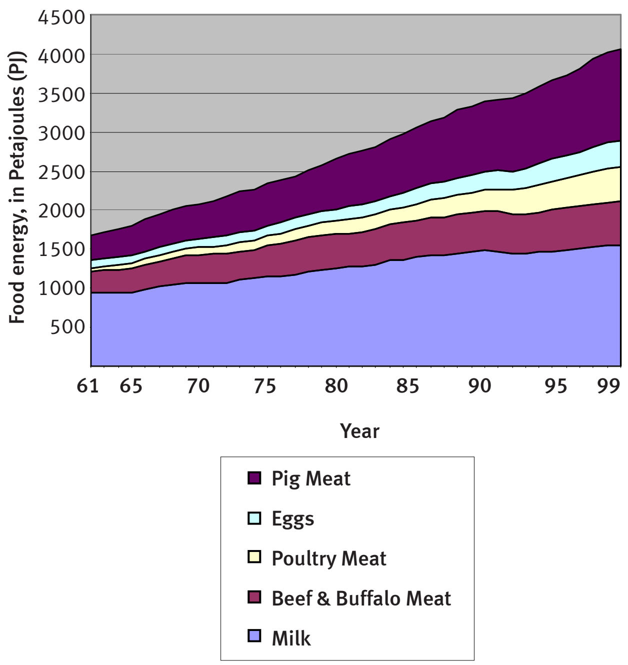
Humanity's Footprint has increased over the last forty years from 70% of the biosphere's capacity in 1961 to 120% in 1999. This 20% overshoot means that it would take the 1999 biosphere 1.2 years to regenerate what humanity used in that single year.[6]

cropland grows feed and forage for animals. In the U.S., animals eat two-thirds of all cereals. Thus the cropland and pasture Footprints have both expanded with the increasing demand for animal products.

As shown in Figure 5, over the last 40 years global per capita meat production has increased more than 60 percent. This has led to more industrial breeding with more stress for animals and a growing demand on nature—such as increased use of crops for feed and increased water pollution due to livestock density and fertilizer use.

FIGURE 5

WORLD CONSUMPTION OF LIVESTOCK PRODUCTS (1961-1999)



Fisheries Footprint

Industrial scale fisheries are rapidly changing the ecology of ocean ecosystems, while an increasing number of studies document the damaging effects of aquaculture and farmed fish.

Footprint accounts analyze 22 fish and aquaculture categories, incorporating 40 species groups. The global fisheries Footprint has risen more dramatically than other food categories, as the world craves more and bigger fish—that is, fish higher on the food chain.

Overall, the world's fisheries are losing productivity. There are fewer and smaller fish. While the catch tonnage remains constant, the quality of fish is declining, as measured by their average trophic level—their status on the food chain.[7] If trends continue, and fish populations from higher trophic levels continue to be overfished or collapse, we may be moving toward oceans of jellyfish or other sea life low on the food chain and with little economic value.

Wealthy nations like the U.S. and Japan eat a disproportionate amount of the ocean's primary productivity by consuming more fish per capita, as well as fish from higher trophic levels. Poorer fish-dependent countries like the Philippines, where people get more than 40 percent of their animal protein from fish, are left with fewer and less desirable fish. As a result, the average Japanese has a fisheries Footprint of 2.0 global acres per person, compared to the average Filipino fisheries Footprint of 0.7 global acres.

Energy Footprint

The global food system is responsible for a sizeable portion of the world's fossil fuel consumption and corresponding carbon dioxide emissions. Estimates vary depending on how the food system is defined or bounded—we use 10 percent as a conservative placeholder for calculating the global food energy Footprint until more detailed studies are undertaken.[8] This 10 percent includes the energy used in food production, for inputs like fertilizers, pesticides, and irrigation, and in post-production.

Post-production, which accounts for 80-90 percent of the food system's fossil fuel use, includes processing, packaging, transportation, storage, and retail.[9] An increasingly globalized food supply means a hefty transport Footprint. Since 1961, the value of the global food trade has tripled and the tonnage of food shipped between nations has quadrupled, while human population has only doubled.[10] An average food item in the U.S. travels 1500 miles—up to 25 percent farther than in 1980—with 90 percent of all fresh vegetables grown in the San Joaquin Valley of California.[11]

The food system's thirst for fossil fuel energy leads to stunning imbalances: the energy required to produce, process, package, and distribute a can of corn is six times the food energy contained in that corn.[12] The packaging alone uses more than twice the energy of production; driving the corn home from the store and preparing it also uses more energy than production. Canned corn is quite typical in its energy intensity; on average, it takes an estimated 7 units of fossil energy to produce 1 unit of food energy in the U.S.[13]

Other Food System Impacts—Beyond the Ecological Footprint

As we have seen, the global food Footprint represents a significant portion of the Earth's total biomass production, yet even this is a conservative underestimate of the true area required for food production. Several other factors could be included, as described below, but because comprehensive datasets are not yet available, we only estimate how these factors might swell the Footprint even further.

Unsustainable yields. Footprint accounts currently do not reflect the environmental damage associated with industrial yields, such as soil degradation from intensive agricultural practices, water eutrophication, salinization from irrigation, or pesticide toxicity.

Climate change. Besides the CO_2 from its fossil fuel use, agricultural production adds to the atmospheric carbon stock through forest clearing and the release of soil carbon through cultivation. Food production also contributes to global warming through the release of methane from livestock, rice cultivation, and the burning of agricultural residues. Yet agriculture has the potential to act beneficially as a carbon sink, through farming practices like conservation tillage that build up organic carbon in soil rather than release it to the atmosphere.

Fresh water. The shortage of fresh water is one of the most immediate and potentially devastating environmental challenges facing humanity. Agriculture depletes water stocks and compromises water quality through increasing loads of organic and inorganic pollutants. Despite its significance, current Ecological Footprint accounts leave out the consumption of water due to a lack of adequate data documenting the impact of a given unit of water, which varies widely depending on soil composition, watershed hydrology, seasonal availability, withdrawal methods, and water quality.[14]

Footprint accounts also do not incorporate human activities that cause irreversible damage to the environment, such as aquifer depletion or the bioaccumulation of persistent toxins from pesticides.

Future Scenarios

We can calculate today's food Footprint. But what will the world look like in 30 years? That depends on the choices we make today.

FIGURE 6

WORLD ECOLOGICAL FOOTPRINT PROJECTION

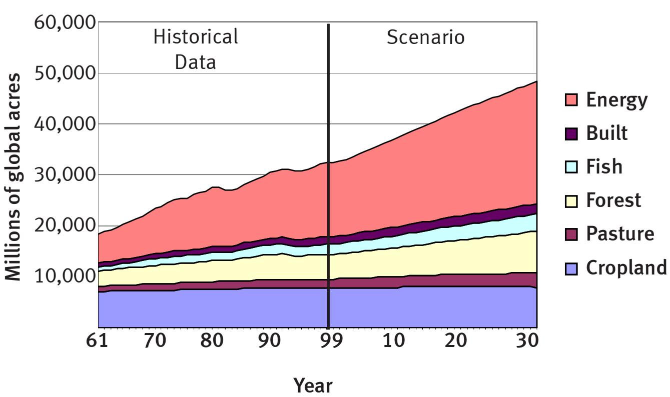
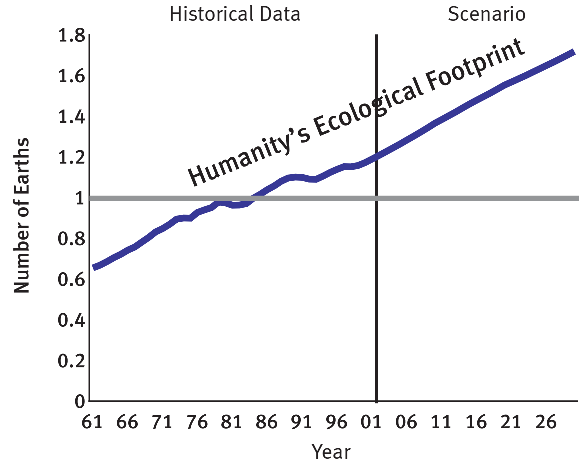


FIGURE 7

WORLD ECOLOGICAL FOOTPRINT VS. WORLD BIOCAPACITY



Using UN estimates of world population, natural resource consumption, and CO_2 emissions over the next 30 years, we can project the global Ecological Footprint forward to 2030.[15] Even though these UN estimates assume slowed population growth and more resource-efficient technologies, the world's Footprint will grow from today's level of 20 percent above the Earth's biological capacity to a level 70 percent above it. This means the world population in 2030 will, every year, require 1.7-fold the Earth's regenerative capacity to meet its consumption requirements.[16]

This forecast also assumes that the Earth *can* sustain this growth in resource use over the next 30 years. It does not account for the possibility that the degenerated biocapacity could further hamper the biosphere's ability to regenerate.

Another recent study estimates that growing enough food for the 9 billion people expected by 2050—doubling demand—would require converting an area larger than the size of the U.S., including Alaska,[17] from its current use into cropland and pasture. By this time, additional natural habitat will already have been lost to urban and suburban development to support the increasing population.

Can we grow more food on less land? Prospects for crop yield increases comparable to those of the past 40 years are not yet clear, though there is evidence that grain production yields per person have already begun to decline.[18] Additionally, the external costs of any increases will likely be similar to or worse than the current rate of agricultural externalities. Marginal and lower productivity land, where further expansion will mostly occur, is unlikely to sustain high yields. Irrigation water is increasingly limited, fertilizer runoff is already harming ecosystems, and yields may become more susceptible to pests and disease due to monoculture production.

It is also critical to remember that predictions of increased yields do not account for unanticipated effects from long-term ecological change, such as climate change or localized events. An example is the enormous "brown cloud" of pollution over southeast Asia. The cloud reduces by 10-15 percent the sunlight that reaches the ground and thus alters the region's climate, cooling the ground while heating the atmosphere. Scientists studying the cloud have warned that acid rain from the smog threatens crops, forests, and oceans, and could cut India's future rice harvest by as much as 10 percent.[19]

2. SHRINKING OUR FOOD FOOTPRINT: A WHOLE SYSTEMS APPROACH

Environmental problems are often addressed sector by sector. But without a whole systems perspective, the solution to one problem sometimes generates a new problem.

For example, aquaculture is advanced as an efficient source of food protein that frees the Earth's remaining cropland and helps conserve wild fish stocks. But concentrated fish farming damages coastal and marine ecosystems through habitat destruction, sediment deposition, raw waste discharge, disease introduction, the use and release of drugs and antibiotics, concentration of dioxins and other toxins, introduction of non-native species, and the potential introduction of genetically modified fish. And aquaculture still requires feed inputs in the form of fishmeal or grain feeds—it takes 3 to 5 kg of other fish to produce 1 kg of farmed salmon.[20]

Although some unintended consequences are unavoidable, we can prevent many through systems thinking. The Ecological Footprint helps quantify overall limits to human activities, identifying the tradeoffs of different policy choices.

Humanity's total demand on nature can be expressed as:

Number of people

x *Amount of average consumption per person*

x *Average resource intensity of consumption*

= ***Global resource demand***[21]

This ***Global resource demand*** can be compared to ***nature's supply***, or to say it more technically, the biosphere's regeneration rate.

Closing the gap between human demand and ecological supply therefore will depend on four areas—**population, consumption, technology, and maintaining natural capital**. Sustainable agriculture offers us opportunities to simultaneously encourage progress on all four fronts.

- **Population**: A growing world population means less available biological capacity per person. One of the most cost-effective and humane opportunities for sustainability is to make safe, effective and affordable family planning widely available.

- **Consumption**: Consumers have enormous leveraging power in bringing about a more sustainable food system. The choices we make about the food we eat have a direct effect on other people and the land we live on—it is one of the most important votes we have. A sustainable food system looks beyond labels of organic versus conventional farming, or meat-eater versus vegetarian, to the whole food system. Sustainable food is grown in one's own foodshed by a local farmer; grown at a scale appropriate to the area with minimal ecological disruption and processing; grown under healthy working conditions; and typically low on the food chain.

- **Technology**: Increased efficiencies in food production, processing, and transportation, and a shift to renewable fuel sources, can substantially reduce our food Footprint while yielding the same output.

- **Maintaining natural capital**: Sustainable farming methods protect soil, water, and wildlife. There are many ways to build natural capital through farming including maintaining or even creating habitat for wildlife, using conservation tillage to restore soil carbon, reducing water pollution, and farming with natural flood cycles.[22]

Alternative food systems—both new and old—demonstrate successful models for farming and feeding people sustainably. Growing numbers of food producers and consumers are joining an active and burgeoning movement for ecological farming, food safety, and connecting the act of eating with the people who grow our food.

By following the food chain from farm to table, we can point the way toward smaller-Footprint alternatives that will transform agriculture.

3. DOWN TO EARTH EXAMPLES: FOOD FOOTPRINTS FROM FARM TO FORK

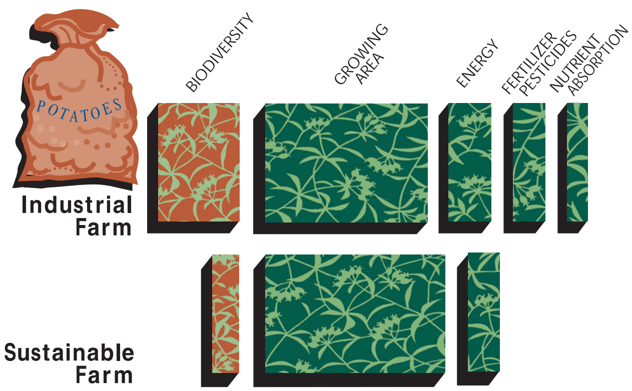
Potatoes—Industrial or Sustainable?

Industrial agriculture appears highly productive, yet it is startlingly inefficient.

The figure below compares the Footprint areas of two potato farms: one using conventional practices that rely heavily on inputs, the other working with nature to close resource loops, increase soil fertility, control pests and other disruptions, and protect biodiversity.

FIGURE 8

GROWING POTATOES
THE FOOTPRINT OF TWO DISTINCT APPROACHES



Adding up all the Ecological Footprints associated with industrial farming leads to a substantially larger Footprint per pound of potatoes. This is the case even if we assume that the industrial farm's cropland Footprint is slightly smaller, due to potentially higher yields. However, the smaller growing area is overshadowed by the area for the energy embodied in fertilizers, pesticides, and direct fuel use; the area for absorbing excess nutrient runoff; and the area needed to compensate for displaced wild species.

Growing area: Studies comparing the yields of organic and conventional farms indicate comparable or slightly lower yields in organic systems on average, but show organic systems consistently outperforming conventional systems in stressful conditions.[23]

Energy: Of the 10-20 percent of the food system's fossil fuel energy that is used by agricultural operations,[24] 40 percent is indirect energy consumption; that is, the energy it takes to produce chemical fertilizers and pesticides. Of the remaining energy, 25 percent is used directly as diesel fuel and 35 percent for other uses such as irrigation.[25] Sustainable farming substitutes organic nutrient sources for chemical fertilizers, such as cover crops and animal manure, shrinking the energy Footprint and adding valuable organic matter to the soil. Pesticides are replaced by integrated pest management techniques such as biological control, crop rotations, intercropping, and management of habitat and buffer areas. Small-scale, sustainable agriculture typically requires less energy to operate than industrial systems,[26] and fueling equipment with biodiesel or alternative fuels can further minimize energy demands.

Nutrient pollution: Nitrogen fertilizers damage aquatic ecosystems through nutrient loading and contribute to changes in atmospheric composition. An Ecological Footprint study in the Kävlinge watershed in Sweden estimated that an extra 10 percent of the drainage basin area would need to be set aside as wetlands to neutralize the pollution load from agriculture.[27] Organic fertilizers and reduced tillage can substantially reduce nutrient losses and increase nutrient use efficiency.

Biodiversity: Industrial agriculture has devastated both crop and wild biodiversity. Expansive monocultures and forest clearing have eliminated wildlife habitat, with high-tech seeds threatening many native crop varieties. Native pollinators are also at risk, even as they become increasingly responsible for stabilizing food supplies as domesticated honeybee populations decline.[28] Sustainable farms work to preserve biodiversity by protecting wildlife habitat, avoiding toxic pesticide applications, and preserving soil and water quality.

TOMATOES—FROM THE FIELD OR THE GREENHOUSE?

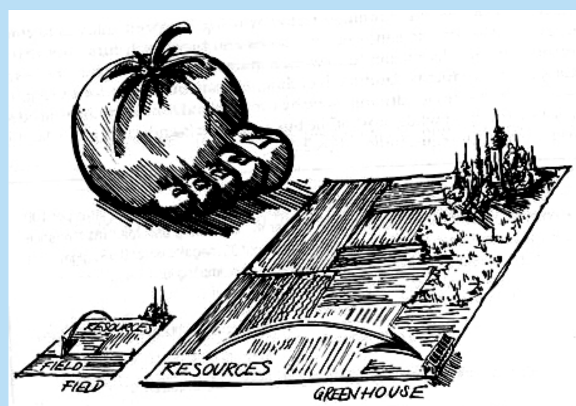


Illustration Courtesy M. Wackernagel and W. Rees, 1996. *Our Ecological Footprint.* New Society Publishers, Gabriola Island, BC.

Hydroponic greenhouse agriculture is advanced as a new and particularly productive approach to high-output farming. However, an Ecological Footprint study in British Columbia compared the resource inputs required to grow 1000 tons of tomatoes in hydroponic greenhouses with inputs needed for conventional open field operations.[29] The hydroponic approach required 14 to 21 times more Footprint area than conventional farming to produce the same quantity—yet another example of the energy dependency and fragility of high-output agriculture.

Meat or Potatoes?

An animal-based diet generally requires more land, energy, and water resources than a plant-based diet. To put it in Footprint terms: crop-based food requires an average 0.9 global acres per gigacalorie of food, compared to 3.6 global acres per gigacalorie of animal-based food. Other impacts not captured in Footprint accounts include overgrazing, animal wastes from concentrated animal feeding operations (CAFOs), and food safety and animal welfare concerns.

In contrast, sustainable grazing can support biodiversity and grassland productivity while providing food from a resource that humans can't directly consume. Wild game also offers a potentially sustainable source of meat. In other words, there are no hard and fast rules—in Sweden eating reindeer meat will likely have a smaller food Footprint than eating a tofu meal imported from the U.S., made from industrially produced soybeans.

Long-distance Imports or Home-grown?

In a study of three local food projects in Iowa, with farmers selling directly to restaurants, hospitals, and other institutions, food traveled an average of 45 miles, compared with an estimated 1550 food miles from conventional national sources.[30]

A study in England compared two versions of the same traditional Sunday meal, one with imported ingredients, one with locally grown ingredients, and found that the imported meal would produce 650 times the amount of CO_2 as the local meal, due to food transport.[31]

	Eating from a supermarket in Chicago (via a major distribution terminal)	**Eating locally in San Francisco** (bought at the farmers market)
Apples	1,555 miles	105 miles
Tomatoes	1,369 miles	117 miles
Grapes	2,143 miles	151 miles
Beans	766 miles	101 miles
Peaches	1,674 miles	184 miles
Winter Squash	781 miles	98 miles
Greens	889 miles	99 miles
Lettuce	2,055 miles	102 miles

Data from a San Francisco farmers market that calculated the average number of food miles traveled by its produce and compared those distances with produce in a Chicago terminal market, where brokers and wholesalers buy produce that has typically traveled long distances to sell to grocery stores and restaurants.[32]

Local and regional food systems, including Community Supported Agriculture, farmers markets, and urban agriculture, reduce the distance from farmer to consumer, with potential for dramatic Footprint savings.

4. THE ROAD AHEAD

Can Sustainable Agriculture Feed the World?

Unfortunately, no form of agriculture—conventional or sustainable—can feed the world if we bank on continuous expansion of human demands. Feeding an ever-increasing population with its ever-increasing consumption habits cannot last, even with the most sustainable practices.

Yet sustainable agriculture is the ***best*** chance we have to feed the world. Today's industrial food system not only occupies an exorbitant amount of the biosphere's regenerative capacity, it also degrades the productivity of ecosystems, both natural and farmed, which are the very basis of our food supply. Ecological Footprint accounts, by identifying the ecological constraints of food and other human demands, underline why planning for resource and food security are essential strategies for a socially just and ecologically healthy world.

The Burden on People

The apparent bounty of industrial agriculture that surrounds the shopper in upscale supermarkets fails many. Economic pressure and environmental degradation force small-scale farmers off the land. Pesticides threaten the health of farm workers and consumers everywhere. While obesity and diabetes have emerged as public health crises in the U.S., 800 million other people in the world go hungry every day. Even in the U.S., the world's number one food exporter, 36 million people, or 1 in 9 Americans, experience food insecurity and hunger.[33]

The concentration of economic control over agriculture poses a formidable challenge to the sustainability of the global food system. Two companies control 70-80 percent of the world's grain trade.[34] Four companies control 84 percent of American cereal production.[35] Five companies account for almost one-quarter of the global seed market.[36] Corporations, by definition, are only responsible for their own bottom-line, not for the wellbeing of people or the public good. In addition, the enormous externalities associated with the food system—from soil erosion, pollution, and exploitation of cheap labor to threats to consumer health—are subsidies to these corporations and are clearly not in the public interest. Large corporations have also benefited disproportionately from new technologies such as those advanced within the "Green Revolution" and the modern era of biotechnology.

"TOO BAD WE NEED THIS NASTY STUFF...??" THE ROLE OF TECHNOLOGY IN AGRICULTURE

Are pesticides, irradiation, and genetically modified seeds just a sad necessity for feeding the world? On the contrary, these technologies represent short-term bandages to systemic problems in agriculture, and pose unknown—and often unresearched—risks to ecosystem integrity and human health.

Alternatives are possible. When the Soviet Union collapsed, Cuba was forced to transform its export-based, highly industrialized agricultural system, implementing sustainable agriculture on a massive scale. Without chemical fertilizers, pesticides, and fuel, the country invested in alternative farming techniques like polycropping, biofertilizers, biological pest control, and widespread urban farming. Out of a severe crisis blossomed a model of sustainable agriculture.

We have the opportunity to make the transition without a harsh crisis such as waiting for water or fossil fuel supplies to run dry. And there are no technical barriers to moving to a sustainable food system. Research and practice have demonstrated the productivity of organic, small-scale agriculture. What is needed is *investment* in the transition to sustainable food production.

While agricultural output has increased over the last decades, distribution has become more unequal. For much of the world's population, food is harder to purchase. Costly production inputs and middlemen have squeezed millions of the world's farmers, who spend more to farm yet receive less income. It is a sad irony when those who grow the world's food can't afford food for themselves or their families.

But food has become cheaper for wealthy people. For instance, while Americans spent 25 percent of their disposable income on food in 1930, they spent 13.8 percent in 1970, and 11.6 percent in 1990, a smaller percentage than in many other countries.[37] But this apparent cheapness does not include hidden costs. If the price of this food factored in the true cost of fossil fuel consumption, soil and water degradation, farm worker injuries and exposure to toxic chemicals, and health problems from eating overly processed products from aggressive use of agro-chemicals, and exposure to toxic residues, industrial agriculture could not compete with sustainable food systems. In fact, 40 percent of income from industrial agriculture in the U.S. comes from government subsidies: price supports, tax credits, and product promotion.

Opportunities for Sustainable Food Systems

There is nothing inevitable about unsustainable food systems. They are the product of past choices, social forces, and special interests. Alternatives abound for every dimension of the current food system. Making them a reality depends on overcoming special interests, providing recognition and financial support, and restructuring the current incentive system that subsidizes and encourages unsustainable behavior. Transforming agriculture will require an economy that corrects today's price distortions and perverse incentives; phases out our addiction to fossil fuels; supports local economies; and pays farmers and farm workers a fair share of every food dollar.

This is no different from catalyzing any systemic change towards sustainability. A recent report on advancing sustainable consumption and production explains how effective action builds on:

- Recognizing the interdependence of initiatives to raise public awareness;
- Galvanizing citizen and consumer constituencies;
- Advancing policy proposals;
- Mounting market-based initiatives by institutional consumers and investors; and
- Accelerating technological innovation.

No single approach will work on its own, but together, lasting positive change can be achieved.[38]

The beauty of a sustainable food system is its ability to generate benefits in numerous areas: health, biodiversity, ecological restoration, energy savings, aesthetic values, and economic justice. None of these benefits alone may outweigh the apparent short-term gains of the current destructive system. But the sum of these benefits will make society far better off and help to avoid the trap of increasing production at the expense of people and the planet.

Shrinking our food Footprint also becomes a social feast. Support for sustainable food systems will let farmers become more than nameless raw material providers for a giant food manufacturing system. Sustainable agriculture gives a human face to food. We create relationships with the people who grow what we eat, as we work toward community food security and public education around our food supply.

Other countries have started to recognize this opportunity. For example, Germany's government—responding to the wishes of consumers, family farmers and environmental groups—is aiming to have at least 20 percent of its farms be organic by 2010. The government is allocating hundreds of millions of dollars in tax subsidies to help German farmers make the transition.

The United States is also exploring new models. For instance, "green payments" to farmers who follow sustainable practices could begin to level the playing field and lead to increased adoption of sustainable agriculture.

Already, the U.S. Department of Agriculture uses incentive programs for environmental protection—and there is still vast opportunity for improvements on these schemes. Agricultural support payments could be conditional upon environmental compliance. Removing subsidies for fertilizers and pesticides, or taxing them, would discourage their use.

Consumer incentives also play an important role, such as pricing and labeling food to reflect the true costs of production. A recent survey conducted by land-grant universities confirms that Americans do care where their food comes from, and are willing to pay more for locally and sustainably grown food.[39]

To put it simply: global sustainability depends on sustainable food systems. Our food system is one of the dominant pressures on the biosphere. It is also a testing ground for sustainable economies, offering powerful, much-needed lessons about how to operate a steady-state economy that maintains economic vitality, provides healthy and satisfying lives to people, and protects ecological assets. The movement toward sustainable food systems thus provides an opportunity to generate the operating manual for a sustainable world while uniting the basic need and pleasure of food with ecological and social responsibility.

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ENDNOTES

[1] For a comprehensive overview of the devastating social and ecological effects of industrial agriculture, see *Fatal Harvest: The Tragedy of Industrial Agriculture,* Andrew Kimbrell, Editor (Island Press, 2002). The link between various forms of agriculture and deforestation is described by Michael Williams in *Deforesting the Earth: From Prehistory to Global Crisis* (Chicago: University of Chicago Press, 2003).

[2] Our most recent calculations are consistent with the Ecological Footprint results published in the *Living Planet Report 2002*, World-Wide Fund for Nature International (WWF), UNEP World Conservation Monitoring Centre, Redefining Progress, and Center for Sustainability Studies (Gland, Switzerland: WWF, 2002).

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[13] Heller and Keoleian.

[14] A preliminary Footprint study examines the extent to which countries artificially augment their agricultural productivity through

irrigation (submitted by M. Wackernagel and M. O'Hara to *Ecological Economics*). Results are expressed as the percent of a country's biocapacity that is compromised by irrigation, following the premise that diverting water for agriculture means lost or compromised biological capacity somewhere else. This analysis reveals the fragility of the position of nations or regions that are heavily dependent on irrigation, and points to critical choices in arid regions concerning domestic food production, water intensive agriculture, irrigation technology, cropping techniques, urban water consumption, population growth, and wildlife conservation.

[15] A 70 percent increase in the Ecological Footprint by 2030 is a conservative forecast based on optimistic projections of key variables. Increases in agricultural yields are assumed to continue at the rate experienced over the past forty years. A number of critical factors, including salinization, limitations on irrigation potential, and expansion into marginal cropland threaten to stall additional efficiency gains. The IPCC emissions scenarios used in this forecast assume rapid development of energy efficient technologies and an equal share of fossil and non-fossil energy sources by the year 2050. Failure to achieve these conditions would markedly increase the Ecological Footprint. The forecast is also based on moderate population growth to 8.1 billion by 2030. A continuation of current population growth rates would result in a significantly higher figure. See Food and Agriculture Organization. 2000. *Agriculture: Towards 2015/2030, Technical Interim Report* (Rome, Italy) and Intergovernmental Panel on Climate Change (IPCC). 2000. *Special Report on Emissions Scenarios* (Cambridge, UK: Cambridge University Press).

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