MEETING THE CHALLENGE OF SUSTAINABLE GLOBAL FOOD SUFFICIENCY

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ABSTRACT

Historically, hunters ate more meat and had better health, but farming sustained more people. Only with modern high yields has humanity provided high-quality diets and still saved room for wildlife. However, a peak population of 9 billion affluent people and their pets will demand nearly three times as much farm output by 2050, including far more meat and milk. We're already farming half the land not under glaciers or deserts. There continues to be controversy on how best to achieve the food production demanded by 21st Century population and affluence. This paper discusses, point-by-point, why technology offers the world the only viable solutions to this demand, and why science-based farming and forestry is sustainable for the future. The latest sustainability breakthrough: biotech crops that take salts out of soils, to cleanse the irrigated fields that supply 40 percent of today's food. In contrast, a Danish government committee concluded organic farming would cut Danish grain production by 62 percent, pork and poultry production by 70 percent and potato output by 80 percent. Two Nobel Peace Prize winners and a Greenpeace co-founder, amongst others, have signed a new High-Yield Declaration that highlights today's modern agriculture as the most sustainable and eco-friendly farming system the world has known.

INTRODUCTION

Getting enough food has been mankind's first and foremost concern for millions of years. Fortunately, mankind has shown enormous ingenuity in achieving food-sufficiency, from the early invention of clubs and spears through the development of agriculture, and today's pursuit of high-yield, virus-resistant crops through biotechnology.

The problem for early man was that hunting and gathering provided a healthy diet rich in meat, eggs, fish and shellfish, fruits and vegetables—but not for very many people. Game animals were elusive, their populations cycling up and down.

After millions of years to with the limitations of hunting, 10,000 years ago we finally discovered how to domesticate plants and animals, and created agriculture. Farming created, for the first time, a stable, sustainable food supply for large numbers of humans, but there was still a problem: Farming didn't provide a very good diet for humans who had evolved as hunters of meat.

"It's easy to tell from the skeletons of our ancestors whether they were agriculturists or hunter-gatherers," says Arthur de Vany, an expert on Stone Age diets at California State

University. "The agriculturists have bad teeth, bone lesions, small and under-developed skeletons, and small craniums compared to hunter- gatherers."
Experts now believe humans spent 2 million years as hunters and scavengers, eating meat-oriented diets that were about 65 percent livestock calories and 35 percent plant calories. Early farmers who ate mainly plants lacked key vitamins, minerals, and amino acids. This led to higher infant mortality, shorter life spans, more infectious diseases, and widespread iron deficiency anemia and bone mineral disorders.

The U.S. Council for Agricultural Science and Technology (CAST) reports: "where intakes of animal products are low, increases in meat (in particular), milk and eggs in the diets of toddlers and school children have resulted in marked improvement in growth, cognitive development and health."

Only in the last century, through the high-yield wonders of modern plant breeding, industrial fertilizers, and integrated pest management, has society been able to broadly support high-quality diets for large groups of people.

THE CHALLENGE OF AFFLUENCE

The world's population growth is rapidly tapering off. Births per woman in the Third World have fallen from 6.2 in 1960 to less than 3.0 today, and are still declining. Population stability is 2.1 births per woman. The First World is at 1.6 births per woman. It is now entirely reasonable to expect that the world's human population will peak at less than 9 billion people, about the year 2040, and trend slowly downward after that.

The big challenge for farming—and for wildlands conservation—in the 21st century will be the innate human hunger for high-quality protein amplified by the world's strongly rising income trend. We will need to provide high-quality diets for nearly all the expected 9 billion people instead of for just today's 1 billion affluent consumers.

There will even be a pet challenge. America has 112 million companion cats and dogs among its 270 million people. A rich, one-child China in 2050 may well have 500 million companion cats and dogs—and woe unto any politician who stands between Fluffy and her favorite food!

CAST expects world meat demand to rise about two-thirds in the next 20 years, with 90 percent of the increased consumption in the Third World. I regard this forecast as conservative. Ultimately, we must expect that Third World per capita consumption of livestock products will equal that in the First World today.

Sheep, goats, and cattle in the Third World produce more than a kilogram of human food for each kilogram of grain consumed. However, much of that Third World livestock production uses the world's limited supplies of grassland. Most of those grasslands have limited potential to produce more, due to poor rainfall or soil quality. (In the First World, it takes about three kilos of grain to produce a kilo of meat, and a bit less than one kilo of grain to produce a kilo of milk or eggs.)

There are only small amounts of additional good land that can be brought into production, in places like Brazil and Sudan. There are low-yield farming systems that can be improved through economic and societal reforms in a few places such as the Ukraine and Bangladesh. Overall, however, it is appropriate to say that good farmland is the scarcest resource in the world.

Development economists say that the world will need at least 250 percent more farm output by 2050, and perhaps 300 percent more. Since the world is already farming 37 percent of its land area, we cannot contemplate simply extending today's crop and livestock yields to supply tomorrow's food needs. If we want to save the world's wildlands for future generations, we should be thinking how to quadruple today's yields—sustainably—on the high-quality land.

CHARGES AGAINST SCIENCE BASED AGRICULTURE

John Hopkins University academics take stance against modern agriculture

A group of academics from Johns Hopkins University recently wrote in *Environmental Health Perspectives* (May, 2002) that the world should abandon the high-yield science-based agriculture. They claim that low-input farming systems can provide enough food—if people are willing to adopt vegetarian diets. The Johns Hopkins authors self-importantly titled their article "*How Sustainable Agriculture Can Address the Environmental and Human Health Harms of Industrial Agriculture.*"

"The industrial agriculture system consumes fossil fuel, water and topsoil at unsustainable rates. It contributes to numerous forms of environmental degradation, including air and water pollution, soil depletion, diminishing biodiversity, and fish die-offs. Meat production contributes disproportionately to these problems, in part because feeding grain to livestock to produce meat—instead of feeding it directly to humans—involves a large energy loss. . . . The pesticides used heavily in industrial agriculture are associated with elevated cancer risks for workers and consumers and are coming under greater scrutiny for their links to endocrine disruption and reproductive dysfunction. In this article, we . . . discuss how these systems could be made more sustainable."

The academics ignore the reality that without the higher yields from intensive farming, the world would have had to plow at least another 16 million square miles of wildlands to produce today's food supply. That means virtually every forest tree and creature on the planet owes its existence to high-yield farmers, researchers and suppliers. The EHP paper offers no credit at all to high-yield farming for the wildlands not plowed to keep up with world population and income growth since 1950. That is a startling and even a disabling omission in their analysis.

The Soil and Water Conservation Society of America, no friend of agribusiness, has declared modern high-yield farming the most sustainable in history in large part because of its unprecedented ability to minimize farming's land requirements while sustaining soil fertility, preventing soil erosion and controlling pests through integrated pest management.

Will the world give up meat?

The Johns Hopkins authors clearly believe the world should suppress meat consumption. Horrigan et al say that meat consumption has risen hardly at all in the poorest countries. Unfortunately, however, the poorest countries, like the Congo and the Philippines, currently support a thriving trade in "bushmeat," including gorilla steaks and monkey brains.

When the first human hunters arrived in the Western Hemisphere, they quickly wiped out dozens of the species they were able to catch, including North America's versions of the elephant, camel, horse, and ground sloth. Without domestic livestock production, virtually all the Third World's animals and most of its birds will also be hunted to extinction.

Much of the increased livestock demand is occurring in such crowded countries as China, India and Indonesia, where only higher yields of crops and livestock—or imports from countries with more good farmland—can prevent massive farm land expansion and widespread loss of wild habitat and species.

From the standpoint of preserving the world's wild biodiversity, it is far better to feed people meat and milk from farms than from hunting wild animals to extinction. Domestic livestock production begins rising when incomes begin rising. The developing countries' per capita consumption of farm-raised livestock products rose 50 percent between 1973 and 1996.

Too much fossil fuel?

The Johns Hopkins authors condemn the use of fossil fuels in agriculture. However, modern farming in the United States accounts for only 2 percent of the country's petroleum use, according to the U.S. Department of Agriculture's Office of Energy. Historically, farmers use the same energy sources as non-farm industries (horses, steam, gasoline, diesel). If engineering provides a cleaner, more sustainable power source in the future, farmers will adopt it. Why begin a new energy system with the most critical use?

One of farming's major fossil fuel uses is to capture 80 million tons of nitrogen fertilizer per year from the air. All plant life needs nitrogen to grow, and as crops take the N from the soil, it must be replaced by either N captured from the air (the air is 78 percent N), from animal manure or from other organic biomasses.

The U.S. Department of Agriculture and Environmental Protection Agency both estimate that America has only about one-fourth of the organic N needed to support its current crop output. Countries like India, where the crop biomass is burned for cooking fuel and used as animal fodder, are even more seriously short of organic matter.

Vaclav Smil, author of *Enriching the Earth* (MIT Press, 2001), estimates that a worldwide organic farming mandate would require the manure from another 7–8 billion cattle to replace the elemental nitrogen high-yield farmers currently take from the air. The best-quality land could support no more than one animal unit per hectare, and low-quality land might need 15 hectare per animal unit.

The United States would need nearly one billion additional cattle to replace its current N fertilizer use—and has only 2.1 billion acres in the whole lower 48 states. The U.S. could not even feed that many cattle, let alone having land for food production, parks and national forests. (However, the extra cattle could be used as draft animals, replacing tractors and lowering farm fuel needs slightly—at the expense of shortening the growing season because of the draft animals' slower speed).

Even the tiny amount of petroleum that farmers use in producing pesticides pays important public health dividends, which the Johns Hopkins authors ignore. Pesticides reduce the amount of natural toxins produced by fungi in our fields. They also permit lower prices for fruits and vegetables, our most important weapon against cancer. This is especially important for poor families unable can't afford the high organic price tag.

On the other hand, the world has no looming shortage of fossil fuels. It has perhaps 200 years worth of probable petroleum and orimulsion reserves. (Huge deposits of orimulsion, which can be burned in power plants, lie unused in Venezuela.) There are centuries worth of coal for clean-burn technologies.

Unsustainable soil erosion?

The Johns Hopkins authors complain that modern farming allows topsoil to erode unsustainably. In reality, modern farming has reduced soil erosion to the lowest rates in agriculture's history. It is primarily the world's peasant and organic farmers who suffer the high rates of soil erosion. The peasant farmers today get yields one-tenth or one-hundredth as high as the modern farmers, so they must extend their fields onto steep slopes. Monsoon climates where erosion risks are ten times higher than in Iowa.

High-yield farmers increasingly use some form of conservation tillage, which eliminates plowing, cuts water runoff and soil erosion by up to 95 percent, retains up to twice as much water in the soils, and encourages far more soil microbes and earthworms. Conservation tillage is now being used on hundreds of millions of acres in North America, South America, Australia and—most recently—in Asia.

Dr. Stanley Trimble of UCLA recently performed 'soil archeology' on one of the worst Dust Bowl soil erosion sites, the Coon Creek watershed in Wisconsin. In the 1970s and again in the 1990s, he re-did an old 1938 Soil Conservation Service soil survey. Trimble concluded that, thanks primarily to chemical fertilizers and conservation farming systems, the Coon Creek watershed currently has only 6 percent as much erosion as it suffered during the Dust Bowl days. Its topsoil is now fully sustainable.

Loss of biodiversity?

Horrigan et al complain that high-yield farming destroys biodiversity. Again, they ignore the wild species protected by the 16 million square miles of wildlands not plowed. Their charge may be based on the fact that lots of small farmers, all over the world, have shifted from traditional low-yield seeds to high-yield Green Revolution-type seeds. Some activists demand that we keep virtually all the Third World's half of the planet's arable land as a gene museum—thereby sacrificing millions of wild species to preserve "man-made biodiversity."

Alternatively, the Johns Hopkins authors may be referring to the fact that low-yield fields often contain somewhat more weed and insect species than high-yield fields. However, all farming is an intrusion on nature. Even an organic field has probably lost 98 percent of its wild biodiversity.

Too much water pollution?

Horrigan et al complain that modern "industrial farming" entails too much water pollution. The biggest water pollutants from farming are runoff water and soil particles. However, the modern farmer permits less water runoff and soil loss per ton of food production than any farmers in all history. This is partly because yields are higher per acre, partly due to conservation tillage systems that hold moisture in the soil, and partly because they farm the best land extensively and do not have to extend farming onto fragile soils.

Modern farming does, however, permit some traces of pesticides in some of our water. The most commonly found water pollutant in the United States is an herbicide called atrazine, widely used to control weeds in conservation tillage. (Atrazine is the chemical that rescued Al Gore's home state of Tennessee from the awful soil erosion that Mr. Gore reports seeing during his youth.

Based on the EPA's own recently revised safety rating of atrazine, to get above the no-effect levels in the rat tests a person would have to consume 150,000 gallons of atrazine-contaminated water per day for 70 years—meaning that, for about 9 months of the year, the consumer would have to provide her own atrazine.

Soil depletion

Horrigan et al even accuse modern farmers of soil depletion! Are the farmers who use soil tests to make sure they restore all the nitrogen, potash, phosphate and each of 26 trace minerals that growing plants take out of their soils really committing soil depletion?

African farmers use virtually no fertilizer on their food crops, and in many cases their bush-fallow periods have been cut from 15–20 years to two or three years because of their urgent need to produce more food for their still rising populations. Africa is now locked in a downward spiral of declining soil fertility, declining yields, and declining soil organic content.

The International Food Policy Research Institute predicts that, unless their agriculture becomes more productive, sub-Saharan Africa will likely double its number of malnourished children (to 49 million) by 2020 and the reality could be even more disastrous. Is this the "sustainable" farming that the John Hopkins team recommends?

The environmental case for confinement meat production

Indicting modern confinement meat production for water pollution is the most ludicrous element in the Johns Hopkins authors' paper, though it is a popular theme with activists and the media. In the first place, feeding birds and animals in confinement saves millions of hectares of land that would otherwise be used for barren hog and poultry lots. Secondly, the confinement feeders save the creatures' wastes and apply them to growing crops as

organic fertilizer. Otherwise, they would wash into the nearest stream with every storm event—as the wastes from outdoor livestock and poultry producers do.

The birds and animals also suffer less from weather extremes. Hogs, for example, can't sweat in the summer, or grow fur for the winter. Indoor hogs are far more comfortable, and reflect this in feed conversion ratios about 20 percent higher than outdoor animals. High feed conversion rates mean less land must be planted to crops to nourish them.

North Carolina's Black River, which drains the most intensive hog production region in America, is still rated an "outstanding resource water" by the state. The nutrient "spikes" found in North Carolina streams are not associated with hog farms but with its urban sewage treatment plants. (Current sewage treatment methods take out only about half of the N from human wastes.)

Quarterly reports from North Carolina's Department of Water Quality consistently show that 99 percent of the state's hog farms have no discharges to surface waters at all. The total gallon discharge is miniscule.

No wonder a U.S. Federal judge recently dismissed a lawsuit against a large hog-feeding firm (brought by the Waterkeeper's Alliance, Bobby Kennedy Jr.'s pet project)—and required the plaintiffs to pay the hog firms' legal costs!

The small farmer diversion

The Johns Hopkins authors assert that "sustainable" farms are small and diversified. This reflects either idealized nostalgia or ignorance. The size of the farm has nothing to do with sustainability or environmental value.

Farmers have been migrating to the cities for centuries to get better pay and working conditions. The proportion of farmers in the United States and Europe has dropped from more than 80 percent in the early 19th century to well under 10 percent today. Asia is repeating the same pattern as it creates urban jobs that offer higher incomes and more comfortable working conditions than stoop labor in the rice paddies.

It is doubtful that enough of the First World's people would now accept the hard work, harsh weather exposure, and low pay of small, labor-intensive farms to supply its food. Britain's Cooperative Wholesale Association says most of its hired organic farm workers leave within a few weeks.

Modern farmers get incomes as high as city workers by increasing their output. They farm more acres, and/or more animals and/or get higher yields. Often, high-yield farmers buy land that would otherwise be sold to developers.

High-yield farmers have an outstanding record of good stewardship and good environmental husbandry. When Auburn and North Carolina State University assessed the hog industry in North Carolina, they found 95 percent of the farms fulfilling their environmental responsibilities. The erring 5 percent were almost all small farms, with older farm operators who had little interest in making new investments in manure handling

and animal comfort. This "careless 5 percent" is characteristic of the farming community, and has been for generations.

Dangerous pesticide residues?

Horrigan et al strongly imply that pesticide residues cause human cancer. The evidence to support this assertion is lacking. There is evidence that high-dose rat tests can cause tumors in rats, but this often occurs at exposures as much as 100,000 times the expected human exposure. (Almost no substance causes cancer at low doses.)

Even so, the Director of the U.S. Center for Toxicological research noted in 1991 that the most dangerous thing we do to the rats is to give them all they can eat. When the Center re-tested one of the most potent carcinogens, and restricted the feed supply by 20 percent, the tumor rate dropped from 90 percent to 3 percent.

A U.S. National Research Council report, *Carcinogens and Anticarcinogens in the Human Diet* (1996) notes that synthetic pesticides are no more toxic than the natural pesticides found in our foods—and we eat 10,000 times more of the natural pesticides than the synthetic ones.

The limonene in orange juice and the hydrazines in mushrooms are carcinogens—but the NRC report concludes that both the natural and man-made pesticides are present in such low doses that they present 'no appreciable health hazard." That is as close as good scientists ever come to saying, "Don't worry." The American Cancer Society concurs.

The WHO estimates 220,000 deaths, worldwide, per year from pesticides. But they also estimate that more than 90 percent of these deaths are suicides. Most of the rest are accidental poisonings, occurring because someone drinks from the wrong container. These deaths have nothing to do with consumer food risks.

The British Food Standards Authority recently announced that there's no need to wash or peel produce because of pesticide residues—though they still recommend washing and peeling to avoid such dangerous bacteria such as Salmonella and E. Coli O157:H7.

VIEWS OF ALTERNATIVE AGRICULTURE

The Swiss experiment

A Swiss organic research institute just reported in *Science* that organic farming is "practical," since their 21-year side-by-side tests showed the organic crops yielded "only" 20 percent less than the conventional crops.

However, twenty percent is a substantial yield penalty. Worldwide, a 20 percent increase in cropland requirements would force the plow-down of another 1.2 million square miles of wildlife habitat—equaling one-fourth of Europe's land area.

Moreover, the Swiss organic results are actually much worse than reported: Their wheat averaged only 4 tons per hectare, compared to the Swiss national average of 6–7 tons per