Humanity has worried about the sustainability of its farming ever since the first Middle Eastern farmer found out — the hard way — that farming without fertilizers depletes soil nutrients. The sustainability concern was reinforced when the famous Hanging Gardens of Babylon were ruined by salinization, and as the soils of the Mediterranean Basin were seriously degraded by poor farming methods and overgrazing in ancient times.

Recently, sustainability concerns have taken on a new urgency as population growth has forced the world to look farther into the future and evaluate sustainability on a larger scale and over a much longer time frame. Sustainability has thus become a mantra in farm policy circles. It is the latest buzzword, the focus of entire conferences. It has become ubiquitous in agricultural research grants. Environmentalists have discovered that the specter of “unsustainability” is a powerful weapon in their attacks on mainstream farming practices. But the basic exercise of examining the sustainability of our agricultural systems is valid, and I’m proud to be addressing this question with you.

First, what exactly is “sustainability?” What are its measures? How far from sustainability are we? If current farming practices are not sustainable, what needs changing for agriculture to become more or fully sustainable? Without a clear definition of this concept, constructive debate and comparisons will be impossible — and positive change may be impossible as well.

Most of us can agree on a broad definition of agricultural sustainability:

*Sustainable farming is the ability to produce adequate food from farming practices that can be continued well into the future without compromising the underlying resource base.*

Beyond this loose definition, however, there is considerable debate as to what comprises sustainable agricultural practice and policy.

I approach this topic from a global perspective, because that is the only valid perspective for the globalized world of the 21st century. But before we can address specific issues of agricultural sustainability and, more particularly weed management, we must look at the demands which agriculture must meet.

**Sustaining and Sustainable** Any discussion of agricultural sustainability must begin with the needs that agriculture must meet. To be sustainable, an agriculture must first be sustaining. Agriculture’s fundamental purpose is supplying virtually all our food and fiber. There is no visible, practicable substitute for *production agriculture* in this role.

We must also realize the scale of agriculture needed to meet current and future demand. Agriculture already uses a third of the earth’s land area. Feeding and clothing a projected world peak population of 10 billion will require a near tripling of the world’s agricultural output. (see *World Food Demand: 2050* of this paper)

This is the context for our discussion of agricultural sustainability.

**Population Growth** Instead of the continuing, exponential population growth forecast by Malthus, and later by Paul Ehrlich and Lester Brown among others, it appears that we are seeing a one-time surge. This is first the result of a reduction in death rates in the early 20th century, followed later by a reduction in fertility rates as economic and social stability reduce the need for large families.

Currently, the world’s global population is about six billion people. With the current rate of population growth of 1.5 percent, another 90 million consumers are added each year. That’s the equivalent of an additional Mexico added to world food demand each year. Or another New York city added each month. While this rapid current population growth has led many to predict malthusian disasters in the past and no doubt coming years, there is good reason for optimism.

The good news is that this rate of growth will not be long lived. Like a train, population growth has momentum. It changes pace slowly. During the rapid growth of the 70s, it appeared as though the world was headed for 15 or 20 billion people. However, what
was not realized at that time was that the brakes were already being set on population growth, partly as a result of the Green Revolution of the 1960s.

Societal and economic forces have led to a dramatic decline in fertility rates in most areas of the world, save for portions of Africa and some Muslim countries.

The most realistic projections of population growth now predict a peak world population of well under 10 billion. Some place the peak at below 8 billion. While this may at first seem unrealistic, consider that only a few years ago the World Bank and United Nations each predicted a peak of 12-15 billion. For 20 years, both the World Bank and UN have had to continually pare down their population predictions. They now predict between 9-10 billion. However, other groups, such as the Winrock Foundation, using the same numbers predict between 7.5 and 8.5 billion. Roughly a 50 percent increase over current levels.

However, the same forces which are lowering national fertility rates throughout the world, are also increasing the demand for better diets. The first thing that poor people do when they get more income is to bid for better diets. First, they want more rice and wheat. Then, they buy more cooking oil. Then, they buy more eggs, milk and, finally, more meat, fruits, and vegetables. Nearly half of the world’s population lives in Asia. And as Asia continues to grow, both in population and economically, we can look to Japan as a model to see what to expect from the region.

As recently as the late 1950s, Japan was a food aid recipient. Today, Japan is the world’s largest food importer. Since 1965, Japanese consumers have reduced their rice calories by 37 percent while they have increased their dairy consumption by 123 percent and their meat calories by 220 percent. In all, the average Japanese consumer now eats about 55 grams of animal protein per day. For comparison, Australians eat about 75 grams per day. These farm products take three to five times as many farming resources to produce as a calorie of cereals – but there is an innate human hunger for them.

Meat demand in Asia has been skyrocketing alongside the rise in personal incomes:

- Chinese meat demand has more than doubled over the last decade, increasing at a rate of 10 percent per year. China ate 7 million tons more meat in 1998 than it did the year before – thereby permanently adding more than 20 million tons to world annual feed grain demand.
- India’s consumers have been adding 1-2 million tons of milk and dairy products to their national diet each year, despite feed shortages, high prices and poor quality.
- Indonesia expanded its broiler flock by 25 percent (and 150 million birds) in 1995 alone!

And despite these recent trends, Asians still consume less than 20 grams of animal protein per day. By 2030, it is likely that the world will have to supply at least Japan’s current 55 grams of animal protein per day for 4 billion Asians. That’s nearly a 400 percent increase in the region’s total meat consumption!

Thus, the world’s biggest food gap is opening in the region least able to meet that demand — the densely populated nations of Asia. That region will have eight or nine times as many people per acre of cropland as North America. Any discussion of sustainability must account for this land and population disparity and the obvious need for agricultural trade.

Saving Wildlife and Wildlands  The leading threat to wildlife is the potential loss of habitat to low-yield farming. Agriculture dominates the world’s land use; already, 1/3 of the earth’s land surface is in agriculture and 1/3 is in forest as “left over” from farming. Only by investing in sound, yield-increasing technology and practices will we prevent the loss of the remaining wildlands and creatures.

Wildlands are also urgently needed as a reservoir of genes and biodiversity for use in biotechnology—necessary to enhance and ensure the sustainability of our agricultural systems. Our crop and livestock breeders must keep pace with the increasing pressures on agricultural resources. As pests and disease organisms continue to adapt, farmers will need new crop and livestock genetics to minimize the damage they cause.

Fortunately, genetic engineering techniques will enhance our capacity to continue the rising yield and productivity trends which have protected wildlife habitats from conversion to agriculture over the past four decades.

Since the world’s agricultural output must nearly triple in the years ahead, no farming system can protect the environment and wildlife unless it achieves far higher yields than today’s farms. To the extent we fall short of raising yields to meet human demands, we will lose more wildlife habitat and wild species to the plow.
The Critical Sustainability Role of Weed Management

Soil erosion has always been the Achilles heel of agriculture and humanities greatest agricultural sustainability concern. Many outside and even inside agriculture have forgotten that the true origin of plowing was for weed control. For 10,000 years, humanity’s only weed control method was tillage. And as you all well know, weeds compete for nutrients and water and sharply reduce yields. The problem is that plowing and fallow expose the soil to wind and water erosion. Until now, the price we had to pay for weed control was gradual loss of our soil resource, and a very real long-term sustainability problem.

In relative terms, though, we’ve done pretty well against soil erosion over the last 50 years. We’ve doubled total world farm output by tripling the yields on the best land. When we triple the yields on an acre of land, we can get the same food tonnage even though we open only one-third as much soil to wind and water. In that sense, fertilizer should be considered a powerful soil conservation weapon. In as much as weed management has helped to foster yield increases, even through tillage, it too has contributed to agricultural sustainability.

But weed management has now spawned a weed management solution with benefits far beyond weed control—conservation and no-till farming methods. Conservation tillage and no-till cut soil erosion an additional 65-95% over traditional tillage practices. Using these methods, we are creating soil faster than it is lost through erosion on the best farmland, thus becoming truly sustainable for this precious resource. And the benefits of these tillage systems go far beyond reduced soil erosion:

- Diversity and abundance of soil organisms is increased, and insect problems are decreased due to higher numbers of predatory arthropods such as ground beetles and centipedes.
- Less soil compaction results from fewer passes with farm machinery and improved soil structure which is better able to resist compaction forces.
- Higher average yields are achieved.
- Fuel use is reduced.

We’re now using conservation tillage on hundreds of millions of acres around the globe, including even in such underdeveloped places as Africa.

With the advent of herbicide-resistant crop varieties, these systems are becoming even more widely adopted. Yet some now argue that the negative environmental impacts of herbicide use outweigh the benefits. Although herbicides do appear as environmental pollutants, mostly as traces in ground and surface waters, there have been no documented human health or ecological impacts from these minute traces. Yet the sustainability and wildlife conservation benefits of these chemicals are undeniable.

Greenpeace, the World Wildlife Fund, and Friends of the Earth have offered no practical alternatives to no-till and conservation tillage which give so many immediate benefits. They have merely criticisms and unworkable solutions. There is no hope that the world will suddenly go from 6 billion to the 2 or 3 billion population which they say is “acceptable.” They offer vegetarianism as another solution, when the world’s most vegetarian cultures, China and India, are moving as fast as they can afford to away from vegetarianism. Sixty percent of Indian consumers say they will eat meat when they can afford it. That is why McDonald’s is now selling mutton burgers in New Dehli.

By far no-till and conservation tillage will not be the end in advances in weed control on our farmland. New cropping techniques such as high-density planting and crops which quickly develop a weed-shading canopy are being developed or are already a part of the modern farm. These help cut costs and reduce chemical usage.

Biotechnology offers the future possibility of crops which eliminate weed competition by producing weed-killing chemicals, also called allelopathy. However, the ecological and health implications of such an
approach would need to be extensively tested. Here too, environmental organizations have taken the narrow view and condemned our most promising sustainability tool.

CONCLUSION
The world faces an enormous challenge as we head into the 21st century. Global population growth and dietary changes will inevitably lead to at least a doubling of world food demand, and likely a tripling of world food demand.

Yet already we take so much from nature. The path to true sustainability is through no other door than continued increases in agricultural productivity and efficiency. Make no mistake that this means effective and continued weed management. The term “acceptable losses” is narrowed considerably in this context.

Weed management is no longer about increasing farmer income—but about wildlife conservation. It is our job to communicate this to the general public and policy makers.

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He represented the Center at the 1996 United Nations World Food Summit in Rome and was co-author of Farming to Sustain the Environment, a recent Hudson Institute briefing paper, which addresses issues of agricultural sustainability from a practical and global perspective.