Saving the Planet with Pesticides and Plastic:
The Environmental Triumph of High-Yield Fanning

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Is High-Yield Farming Sustainable?

MYTHMAKERS SAY:

"Pesticides often leave the most resistant pests behind .... Then ... the resistant pests multiply ... soon, enormous quantities of pesticides are sprayed on the crops to kill just as many pests as were there when the process began. Only now the pests are stronger. And all the while, the quantity of pesticides to which we ourselves are exposed continues to increase."

Vice President Al Gore, Earth in the Balance, p. 52

"The second cause of slower food production growth is environmental degradation, which is damaging agriculture more than ever before."

Lester Brown, State of the World 1993, Worldwatch Institute

REALITY SAYS:

"The Food and Agricultural Organization reported Sunday that the percentage of people in the developing nations who are hungry fell to 20 percent from 36 percent between 1961-63 and 1988-90."

Paul Overberg, Gannett News Service, quoted from the Binghampton, N.Y., Press and Sun-Bulletin, September 21, 1992

"... [Public and private research institutions, commercial R&D enterprises and especially the various international agricultural (research) centers ... are moving forward in concerted efforts to extend, redirect and fine-tune the original Green Revolution thrust. With the added impetus of biotechnology and other new scientific tools, we see clear indications that many of the problems and constraints of the 1960s and 1970s have been surmounted."
Don Plucknett. As senior science advisor to the Consultative Group on International Agricultural Research, the key international network for agricultural research, Dr. Plucknett may have the world's best overview of agricultural research potential.

Dr. Plucknett until recently was inclined to say that we didn't know where our next farm research breakthrough was coming from. But in recent years, he has reviewed statistics from the UN's Food and Agricultural Organization for the world and for individual countries around the globe. He also reviewed historic-even archeological-evidence of yields in past centuries (4).

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Plucknett says that yield takeoff marks a transition point when a farmer stops expanding his fields and starts getting more from the land he is already using by benefiting from scientific advice on how to boost yields, Plucknett believes once a country's farmers begin "yield takeoff," the potential for production keeps going upward.
Dr. Waggoner says we’ve been looking at agriculture through the wrong lens. We've assumed that crop yields are governed by the law of diminishing returns. But he points out that high-yield agriculture has been cheerfully violating the "law" of diminishing returns for decades-and is still getting away with it!

Diminishing returns would mean that after a certain level, more fertilizer wouldn't produce more yield. Better seeds wouldn't raise yields much higher. Instead, we find that more nitrogen, for example, can add just as much yield at higher levels as at low ones-assuming such constraints as moisture and trace minerals are dealt with. Artificial insemination keeps adding more milk per cow, as long as we keep improving the cow's nutrition, comfort, and health care. Improved seeds keep pushing yields higher.

Waggoner thinks what is happening is that farmers are removing limitations on crop yield rather than moving out on a diminishing returns curve. Let us review the past surges in farm yields:

-Mankind's first and most obvious crop yield limitation was weeds. We learned to do clean fallow, then plow and hoe, and now no-till and conservation tillage with herbicides has made a giant leap toward sustainability.

-Adding nitrogen (at first with animal manure) removed a constraint on the plants' nutrient requirements.

-Adding phosphate as well as nitrogen removed another nutrition constraint, and yields surged again.

-Later we learned that the plants need up to 26 trace minerals as well, and removing the constraint of mineral deficiencies raised yields again.

-Breeding shorter stalks on wheat and rice plants removed two constraints: It allowed more of the plants' energy to go into the grain heads; and the plants could support the heavier grain heads produced by heavy fertilization with out failing over.

-Using supplemental irrigation on rain-fed land can produce still another yield surge in dry years, without even requiring much additional water or water delivery cost.

-Blocking insect and disease attacks with pesticides and pest-resistant breeding removes another yield constraint.

Confidence in the sustainability of yield-enhancing technologies continues to be increased by new developments on almost a daily basis. One good example is the USDA’s newest pest-resistant soybean for hot climates. The new soybean resists nematodes, leaf-eating insects, and stem canker, all of which have taken a heavier toll in hot climates than in regions with cold winters. Its yields, as a result of the pest resistance, match com belt levels (45 bushels per acre) and double the yields of current Southern commercial varieties (21 bushels) (6).

Waggoner asserts that science and technology should enable the developing countries to raise their crop yields fully as much as the rich countries already have, by removing their yield constraints over the long term. He concludes that I 0 billion people should need no more land for food production than they use today, assuming the world continues to support agricultural research and permit freer trade in farm products (7).

REALITY DATA:

"Data from China's National Network of Chemical Fertilizer Experiments (during 1981-83) revealed ... 74 percent of China's cultivated land was deficient in phosphate, . . . about 40 percent was severely deficient in P, and about 23 percent was deficient in potash.... This scenario of imbalance is, outside of the large alluvial plains and deltas, typical of most developing countries, and is one of the reasons for stagnating yields, poor quality crops, increasing incidences of diseases, and soil degradation.... With few exceptions, organic manures alone will not support the yield increases in crop production that are required. . . "

World Bank staff members Richard Grimshaw, Christopher Perry, and James Smyle "Technical Considerations for Sustainable Agriculture: Agriculture and Environmental Challenges"

Excerpted from Hudson Briefing Paper, Number 190, May 1996
Farming to Sustain the Environment

by Dennis Avery and Alex Avery

The Main Sustainability Issues

The single greatest challenge for global agricultural sustainability is to save the world's remaining wild lands and natural areas from being plowed for food. The world depends on the integrity of local ecosystems, climates, and water cycles. Crucial in maintaining that integrity is the global conservation of forests and other wild lands, as well as their wild plant and animal species. Most of this conservation responsibility falls on agriculture's shoulders, since agriculture dominates world land use decisions.

The second biggest challenge is to ensure adequate funding for agricultural research at this critical moment of world population growth and rising affluence. We must be able to triple the productivity of the world's agriculture over the short span of fifty years to meet the needs of a larger and richer world population. Current levels of productivity and knowledge cannot sustainably do the job.

The third major sustainability issue is soil erosion. The ancient enemy, erosion is still a significant problem in key parts of the globe, especially the tropics. Obtaining the knowledge and capital to implement established solutions more broadly, and developing new techniques and practices for regions where current solutions will not work, must be a global concern. The current solutions include no-till, mulch cropping, and other soil conservation practices, along with farming the best and safest farmland to its fullest potential—wherever it is found.

Monocropping, pesticide use, and finite resource depletion dominate much of the sustainability debate. Environmental quality issues, such as salinization, soil compaction, depletion of soil organic matter, surface water nitrification, and many others follow behind these major concerns. Some of these problems pose direct threats to future production; others affect future production only indirectly or slightly.

Sustainability Through Agricultural Research

Agricultural research is the most important sustainability component under humanity's direct control. Adequate research funding is urgent now for two reasons: (1) it can take years or even decades to develop new research thrusts and bring research findings into practice and (2) the next half-century is the most critical period—when the wildlife will be saved or lost to the production of food.

Cures for Soil Erosion

Soil erosion has always been the Achilles heel of agriculture. In relative terms, though, we've been doing pretty well against soil erosion for 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.

What are some of the other strategies for addressing this sustainability problem? The most basic soil-conserving strategies are contour plowing and strip cropping. In contour plowing, the farmer plows his field along the contour of the slope so that the furrows act like mini-terraces, slowing the water and, to a certain extent, catching the soil before it leaves the field. Strip cropping involves planting two or more different crops in "strips." As one crop is harvested, the other crop is still growing and the slope is never totally bare. The steeper the slope, the narrower the strips need to be. If possible, the strips are situated along the slope contour.

These strategies, however, only mitigate the soil erosion problems which plowing creates.

Mulch crops and cover crops are strategies for limiting soil losses in fields. As the name implies, a crop is planted that acts as a mulch or cover for the soil when there isn't another crop growing, thus protecting it from wind and erosion. (Cover crops are
especially effective when combined with no-till farming systems.

There are many benefits to using cover crops. In addition to
the soil savings, many cover crops are legumes which add nitrogen to the soil. Soil organic matter is enhanced from the increase in plant residues. The cover also suppresses weeds, reducing weed control costs. The residues can insulate the soil and the young plants of the next crop from cold snaps. Some cover crops can actually yield a grain harvest before the next crop is planted. For the southern United States, where half of the rainfall and a good portion of the solar radiation occurs in the cool season, cover crops can be very effective.

Cover crops have been used for many years, but their use has increased significantly in recent years, in large part because of the development of herbicides that allow farmers to fully kill the cover crop so that it won't compete with the primary crop. Herbicides have also made no-till and conservation tillage possible.

Tillage means plowing or cultivating the soil. Conservation tillage is formally defined as any tillage system which leaves at least 30 percent of the soil covered by crop residue. Conservation tillage controls weeds with a combination of limited tillage and herbicides. No-till also leaves at least a 30 percent residue cover on the soil, but goes further than conservation tillage. No-till disturbs less than ten percent of the surface area in planting. As the name implies, there is no plowing, diskng, or cultivating, and no-till keeps a grass cover on the soil in the winter. No-till relies completely on herbicides to control weeds.

Conservation tillage and no-till cut soil erosion an additional 65-95 percent over traditional tillage practices.(1) Using these appropriate strategies, farmers should now be able to create soil faster than it is lost through erosion on the best land, and be truly sustainable for this precious resource. However, the benefits of these tillage systems go far beyond reduced soil erosion.

Innovative solutions such as no-till are only the most recent developments of a constantly changing body of research and technology that enhance the sustainability of our agriculture. We should encourage the spread and further development of these established technologies and assist in the creation of new systems that can be used more broadly or address unique problems.

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### Alternative to Monocropping

The sustainability charge against monocropping is that planting large tracts of relatively identical plants makes us more vulnerable to catastrophic disease outbreaks and to overall disease spread and damage. This is a valid concern. In 1970, there was a devastating outbreak of a fungal disease in corn due to an overdependence on a single cell line for hybrid corn seed production. This cell line eliminated the need to remove the corn pollen tassels (time-consuming hand work that kept many high school kids employed in the summers but increased the cost of seed production). Almost 80 percent of hybrid corn was produced using this cell line because of the cost savings.

Many growers lost 100 percent of their crop to the disease and the country paid a heavy price for overdependence on a narrow genetic line. Estimates of crop losses totaled more than $1 billion. But farmers, breeders, and seed companies learned a hard and valuable lesson on the dangers of genetic uniformity and have applied that knowledge since. As an example, in today's corn breeding, careful and deliberate shuffling of the genetic base, multiple pollen sterility factors, and hand detasseling are all used to maintain genetic diversity and reduce the chance of another catastrophe. Competition between the seed companies also plays a real part in maintaining genetic diversity.

Nor should we in the United States forget one of the biggest culprits in continuous monocropping—the federal government. The structure of the federal farm subsidy programs has done more to limit crop rotation and cropping diversity than any other factor.

The federal government subsidy programs have required farmers to maintain a base level of production every year in their commodity in order to continue to receive subsidy payments. Production of crops without attractive price supports has been severely discouraged. Unfortunately, the need to maintain a payment base in their commodity has acted as a powerful disincentive to practice crop rotation and diversification.

If the government switched to a policy that did not shackle the farmer to specific crops, the amount of diversity in the fields...
would increase dramatically. In addition to rotating more mainstream crops, farmers would also grow more of such immediately available and highly useful alternative crops as canola, sunflower, meadowfoam, and kenaf. (Farmers would still be limited to whatever crops grow best in their regions.)

-The Case for Pesticides

The use of agricultural pesticides has long been one of the most hotly debated issues in environmental and agricultural circles. The claim is that they are unsustainable due to their impact on the environment, wildlife, human health, and the development of resistance in the pests. But a careful and thorough look at these issues fails to support the claims. In fact, there is tremendous evidence that the judicious use of chemicals greatly enhances farming's sustainability.

Some antipesticide activists have asserted that agrichemicals have damaged the environment so severely as to decrease potential future production. This contention is refuted, however, by the ever-increasing yields on our fields. Every high-yield farm is a long-term testament to the viability and sustainability of today’s agricultural practices, including pesticide and fertilizer use. This assertion is supported by the University of Illinois’ Morrow plots and the Rothamstead Plots in England, both of which go back many decades, and other objective scientific studies of long-term farm productivity (2)

The point is often raised that pest damage worldwide has increased dramatically despite pesticide use. But the real question is how much extra land would have been needed to compensate for the losses.

(We must also note that organic producers also use large quantities of "organic" pesticides. Are organic pesticides exempt from the accusations of environmental impact leveled against synthetic pesticides?) Pest resistance to pesticides is also raised in discussions of pesticides and sustainability. Pests will always adapt to overcome obstacles. Our only solution to pest adaptation is constant development of new pest resistant crops, pesticides with new or altered modes of action, and prudent approaches to slowing the development of resistance in the pests. There is every reason to believe that we can continue to stay ahead of pest and disease organisms, especially in light of the potential of biotechnology- We cannot sit still on any broadly used pest controls, even organically derived pyrethrins.

The claims that agricultural pesticides wreak havoc on natural ecosystems are unrealistic for today's highly specific, low-volume, and short-lived pesticides. In addition, today's chemicals are applied very carefully so that virtually all of their impacts are within the fields where they are applied. For example, less than one percent of the herbicides applied in the United States leave the root zone of the fields. The fields are far from being pristine natural environments; we can hardly burden our farmers with the task of creating ideal wildlife habitat within their fields while still demanding they protect the real wildlands from the plow with high yields.

Concerns About the Health of Our Soil

Soil Quality: Although conservation tillage and no-till are practical solutions to soil erosion, some critics of high-yield farming have suggested new "problems" associated with modern farming systems.

One of the primary issues they have raised is soil quality. John Haberem and Anthony Rodale, of the Rodale Institute, phrased it in lurid, emotional language: "The soil provides us with life. The quality of that life depends on the quality of the soil itself... If we feed the soil, the soil will feed us. It's nature's way."(4) They see pesticides and even chemical fertilizers as contrary to this goal and contend chemical use must be reduced or eliminated.

Fertilizers-plant nutrients-are essential to maintaining and restoring soil fertility, structure, and organic matter content. Fertilizers allow plants to produce more crop and crop residues, and -crop residues are the critical factor in building the content of soil
organic matter in our fields. Long-term studies have shown that soil organic carbon and nitrogen levels are highest when we combine conservation tillage, crop rotation, and adequate fertilizer (5).

Plants absorb all nitrogen fertilizers in an inorganic form regardless of whether the nitrogen comes from organic or inorganic sources. What this means is that, from the plant's perspective, organic nitrogen fertilizers, such as manures, have no advantage over synthetic nitrogen.

What about pesticides? Are they degrading the quality of our soils and undermining agriculture's sustainability? Evidence from long-term field studies using pesticides says not. The productivity of the fields continues to increase as long as the soil structure and quality remains high, and these factors are most affected by till-age and nutrient management practices.

So far, there is little evidence that the quality of the soil is degrading past a critical point in the First World. In fact, herbicide-based low-till systems are now improving soil quality without the animal wastes or added plant manures which are so land and resource-costly.(6)

**Soil Degradation:** Soil degradation has been cited as another reason that current practices in farming are unsustainable. These problems include waterlogging, salinization, nutrient depletion, and soil compaction. Although some lands are indeed subject to these problems, these are localized, manageable problems with limited global impact.

Nutrient depletion occurs when farmers produce crops without adequate fertilization. All fields must be fertilized to replace nutrients that are removed in the harvested crops. Nutrient deficiencies are manageable simply through appropriate fertilization. Soil testing for nutrient presence and availability is relatively inexpensive.

Soil compaction occurs when external pressure from farm implements (tractors, harvesters, etc.) causes large soil pores to collapse. This condition causes slowness of water infiltration, poor drainage, and poorly aerated soils, all of which limit root growth and nutrient uptake. Solving soil compaction involves appropriate management practices and equipment. These can include no-till and conservation tillage, deep ripping to break up hard pans where they occur under the soil surface, permanent tracks for equipment to run on, and low-pressure tires, multiple axles, and tracked equipment, which reduce the pressure on the soil and prevent compaction from reoccurring.

Salinization and waterlogging result from irrigation and over-irrigation of cropland, particularly in drier areas, and areas with poor drainage. Salinization can also be caused by poor-quality groundwater. It occurs when excess water evaporates, leaving behind salts that concentrate in the topsoil. Although salinization and waterlogging are separate phenomena, they are often linked in susceptible areas.

Prevention should be our primary goal in treating salinization and waterlogging problems, and it is often straightforward: more frequent light irrigation, higher soil moisture regimes, and conjunctive use of surface and groundwater. The overuse of water is the biggest contributor to the problem. (Flood irrigation used by traditional farmers is also one of the major culprits.) Private ownership of water rights and real-cost pricing of water resources would encourage conservation and help avoid overuse (7).

There are also after-the-fact solutions to existing salinization problems include waterlogging, salinization, nutrient depletion, and soil compaction. Although some lands are indeed subject to these problems, these are localized, manageable problems with limited global impact.
and water logging, such as leaching with water and simultaneous lowering of the water table. These, however, are more expensive than prevention.

**Fear of Resource Depletion**

Extremists have cited agriculture’s dependence on resources that can’t be replaced as evidence of the unsustainability of current approaches. This is a harshly oversimplified indictment of high-yield agriculture. Agriculture’s current nonrenewable resource dependence is relatively small and only two inputs seem to raise sustainability issues, petroleum and phosphorus.

**Petroleum:** Petroleum is currently a cheap and readily available carbon and energy source. The percent of U.S. petroleum used in farming is tiny. Agriculture currently accounts for only two percent of total U.S. energy consumption for direct energy use and the manufacturing and transport of agrochemicals and fertilizers (8). Moreover, agriculture will use whatever energy system the rest of our industries and homes use. When the United States was horse-powered, so was agriculture. When the rest of the country changes from fossil fuels to electricity, hydrogen, fusion, or whatever, agriculture will change too.

There is no sound rationale for forcing agriculture to change its energy system before the rest of the economy does so. Agriculture could, but it would ultimately hurt our sustainability in other areas. For example, if we removed a percentage of crop residues for direct energy production (for example, by burning for electricity production), the extra land we would need and the reduced levels of residues on fields (which are needed to maintain soil quality and structure) would undermine any environmental benefits. It is pure folly to use our food-producing industry for energy experimentation.

**Phosphorus:** Some individuals claim that the world is short of phosphate rock ore reserves. Phosphorus is a major plant nutrient, and virtually all of the world’s phosphorus consumption is in agricultural feeds and fertilizers. Phosphorus is less abundant than most of the other natural elements. Some argue that this resource is very limited and predict we will exhaust our minable ore reserves in a relatively short time. For example, Herring and Fantel predict we will have depleted known phosphate ore reserves in a short 100 years (9). A closer look, however, reveals several major flaws in their analysis. Their first and most minor mistake is in underestimating known phosphate ore reserves by ten percent. Their estimate is 34.3 gigatons (Gt), whereas the U.S. Bureau of Mines number is 37.8 Gt. Second, they offer ridiculous population growth estimates of between 58 billion (lowest estimate) and 82.1 billion people by 2150.

Predictions of resource depletion dates are always highly suspect, because of economics and human nature. Mining companies do not like to admit to having very large reserves of ore. As more reserves are demonstrated, the value of known reserves falls.

Reasonable estimates of phosphate ore reserves extend at least 250 years, and that does not include vast reserves of lower-grade ores that could become available with future mining technology. The United States has phosphate concentrations in 28 states, but only four large fields are currently competitive. Also, biological extraction systems are a likely prospect for producing large quantities of phosphorus from the world’s extensive deposits.

**Conclusion**

Calling alternative agriculture "sustainable" does not make it sustainable. Alternative agriculture may rely less on chemical inputs, this is not a prerequisite for sustainability. It could actually make farming less sustainable by increasing land requirements. Today’s modern, high-yield farming practices are the most sustainable we’ve ever had (11). They will continue to change and improve in efficiency, safety, and sensitivity to the environment in direct proportion to our investments in agricultural research and technology.
Notes for "Farming to Sustain the Environment"


4. Rodale Institute press release, Sustainable Agriculture Network (SANET) on the Internet, August 8, 1995. sanet-mg@ces.ncsu.edu or scottrodn@aol.com


6. Conclusion, op. cit., IO.


Preserving Genetic Diversity with Gene Banks

The agricultural research institutions of the world are in a crash program to save the old landrace varieties of plants, along with their wild relatives, by collecting their seeds and preserving them in gene banks. The world really is in danger of losing these old landrace varieties of crop plants as they are being displaced in the fields by higher-yielding modern seeds.

The "Green" solution to this risk of gene loss would be to eliminate the new varieties. Essentially, they would turn the whole Third World into a gene museum, without the productive power to feed humans or protect wildlife from encroachment. Nor does having a primitive rice plant in a Burmese farmer's field make its genes available, say, to a rice breeder trying to defeat the brown planthopper in Indonesia.

The International Board on Plant Genetic Resources (IBPGR) is part of the Consultative Group on International Agricultural Research (CGIAR) whose researchers launched the Green Revolution. (The Green Revolution was probably founded by the Rockefeller and Ford Foundations when they established a plant breeding program in Mexico in the 1940s; it later became the International Maize and Wheat Improvement Center, now a key part of CGIAR.)

CGIAR encourages and coordinates national and multinational gene preservation efforts all over the world. These gene banks now have more than 500,000 plant "accessions" representing hundreds of plant species and thousands of varieties. The board has working relationships with more than 120 countries and 600 research institutes.

The International Rice Research Institute (IRRI) rice collection alone has 4,100 seed samples of landrace rice from Asia, and another 6,000 from Africa. The CIP potato collection has more than 5,000 accessions of domesticated potatoes, plus 1,500 from wild potatoes, covering 90% of the variation in about 100 wild species.

One payoff has been the discovery of resistance to the bean weevil. A search of all the field bean varieties in the world's gene banks...
failed to turn up such resistance. Now, bean varieties that can protect themselves from this voracious pest are being bred for the whole world. The world should also invest judiciously in some additional "gene farming," to preserve more of the old farmer-developed landrace strains of seeds, livestock, and poultry. This gene farming has become controversial, unfortunately, because some non-government organizations are demanding that First World governments make subsidy payments so the Third World's farmers will keep on farming with the traditional low-yield genetics. (It may be that the non-government organizations see themselves collecting the First World payments and becoming heroes to traditional Third World farmers.)

The world cannot afford to turn the whole Third World into a gene museum. The Third World has more than half of the world's arable land! But a few designated gene farmers should get payments for preserving the old genes.

QUAD-TRAC-It's not a lunar lander, but the latest effort to provide farmers with a cost-effective way to prevent soil compaction. It is pulling a tool that breaks up compacted subsoil layers.
Analyzing even the successes of IPM points out how complex it is, as the following example shows.

**The Case of Pakistan's Mangoes and Indonesia's Rice**

Mangoes in Pakistan are attacked by four major groups of insects: mealybugs, fruit flies, scale insects, and leafhoppers. During the 1980s, the International Institute of Biological Control worked with the mango growers, who were spraying about five times per year and still not getting good insect control.

Research showed that the mealybugs laid their eggs in the soil at the base of the trees, and moved up to the leaves in the spring. Ladybird beetles preyed on them, but the ladybirds didn't build up their populations until late in the season. Research offered two inexpensive solutions.

*First*, the farmers were told to hoe around the bases of the mango trees in the winter, to expose and kill the eggs.

*Second*, the ladybirds were having to overwinter on other trees because the bark of the mangoes isn't rough enough to shelter them. Simple bands of rough sacking around the mango trunks let the ladybird beetles overwinter right on the trees and start effectively preying on the mealybugs sooner in the season.

Fruit flies were the reason for most of the insecticide use, because the maggots, laid in the mangoes, ruined the fruit. As an alternative to spraying, attractant traps were set up using imported fruit fly attractant (methyl eugenol). The traps cut fruit fly infestation rates from 35 percent to 3 percent.

Mango hoppers still needed spraying—but a study of hopper distribution on plants revealed that the growers could spray just the lower part of the trees (up to 5 meters) and still get control. This cut the amount of spray used.

Cutting the other sprays also eliminated the scale problem, because beneficial insects now controlled the scale. (They had been killed by the pesticides.)

Overall, research cut the mango growers' spray program from five applications to one, with a fourteenfold reduction in chemical costs. About 25 percent of Pakistan's mango growers currently use the IPM program (13).

The biggest success for IPM to date is against the brown planthopper in the rice fields of Indonesia. The hoppers were increasingly attacking the miracle rice varieties of the Green Revolution during the 1970s and 1980s—despite subsidized pesticides and additional varieties bred for planthopper-resistance.

Research in the 1980s indicated that cutting pesticide applications didn't reduce yields. The pesticides had been killing many beneficial insects, and the hoppers had developed enough resistance to the approved pesticides that they offset the impact of the chemicals. (Too many farmers had also focused too long on a few favor- ite rice varieties that brought high prices.)

In 1986, a Presidential Instruction banned 57 insecticide formulations from the rice fields. It also ordered that only resistant varieties be grown in affected areas and that the rice industry be trained in IPM. Most farmers now spray once a year instead of four times. The amount of pesticide used has been cut by 50 percent, while yields have risen (14).

Leonard Gianessi, a pest control expert with Resources for the Future, says the United States alone has thousands of pest species infesting 80 to 100 crops in thousands of microclimates. As we saw earlier, there are hundreds of thousands of possible combinations of pest, crop, and region for researchers to struggle with in replacing the 200 active pesticides ingredients now in use. Yet only a small and declining fraction of pesticide uses appear to threaten human or environmental health.

**Preserving Wetlands**

Amazingly, the United States is now gaining wetlands. High-yield farming and the environmental movement share the credit for this development. The environmental movement gave wetlands a far higher priority in the public mind than they had ever had before—and a priority much more in keeping with their ecological importance. High-yield farming provided the high farm productivity so that we could spare these important ecological assets.

America has recently undergone a dramatic shift in its attitude toward wetlands, as Jonathon Tolman notes in his important report...
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become nearly so positive if America were facing severe shortages of key foods—or rampant epidemics of malaria.

MYTHMAKER:

"The relatively cheap and abundant supplies of fossil fuel have been substituted for human and draft animal energy ... Per capita use of fossil energy in the U.S. is ... 14 times the level in China .... As our population continues to grow, we will inevitably experience resource shortages similar to those now being experienced by China and other nations."


MYTHMAKER STILL DOESN'T GET IT:

"The use of more land to produce food reduces the total energy inputs necessary for crop production and would lead to greater solar energy dependence and sustainability in agriculture. This of course assumes the availability of sufficient land, halving crop yields per hectare. . . ."

Pimental et al., op. cit.

Reality Comment: How does Pimental protect the wildlife if he needs twice as much land per person? He says we can only support 2 billion people on his system. Three billion people must be subtracted so we can give up the fossil fuels now used in agriculture. Who gets to choose the survivors?

Agriculture is the crucial industry for people and wildlife. It should not be the place where we casually start our energy-change experiments. Rather, it should be the place where we implement tested-and-successful strategies. Maybe we should listen to Dr. Pimental after his University (Cornell) has banned autos for its students and faculty.

Notes


7. Waggoner, op.cit.


