NATURE'S TOXIC TOOLS:

The Organic Myth of Pesticide-Free Farming

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Organic pesticides are the most heavily used agricultural pesticides in the U.S., according to the most recent data on U.S. pesticide use. (See Figure 1.)

Figure 1. Ten Most Used Pesticides (1997)

Rank	Active Ingredient	Millions Lbs/Year
1	**Oil (I)**	**102**
2	**Sulfur (F)**	**78**
3	Atrazine (H)	75
4	Metolachlor (H)	67
5	Metam Sodium (O)	60
6	Sulfuric Acid (O)	48
7	2,4-D (H)	41
8	1,3-D (O)	35
9	Glyphosate (H)	35
10	Methyl Bromide (O)	33

F = Fungicide, H = Herbicide, I = Insecticide, O = Other
From NCFAP, http://www.ncfap.org/ncfap/index.html

Data from the National Center for Food and Agricultural Policy in Washington, DC show that two pesticides approved for use on organic crops are the most heavily used pesticides in the United States.[1] Oil, an organic insecticide, was the single most used pesticide in the United States in 1997, with farmers using 102 million pounds on 22 different crops that range from almonds and walnuts to cotton and strawberries. Sulfur, an organic fungicide, was the second most used pesticide on U.S. farms in 1997; growers used 78 million pounds of sulfur on 49 different crops, ranging from alfalfa and avocados to mint and watermelons.

In fact, these two organic-approved pesticides alone accounted for over 23% of all U.S. agricultural pesticide use in 1997, with oil accounting for 56% of all insecticides and sulfur accounting for 59% of all fungicides. (See Figure 2)

1997 United States Pesticide Use

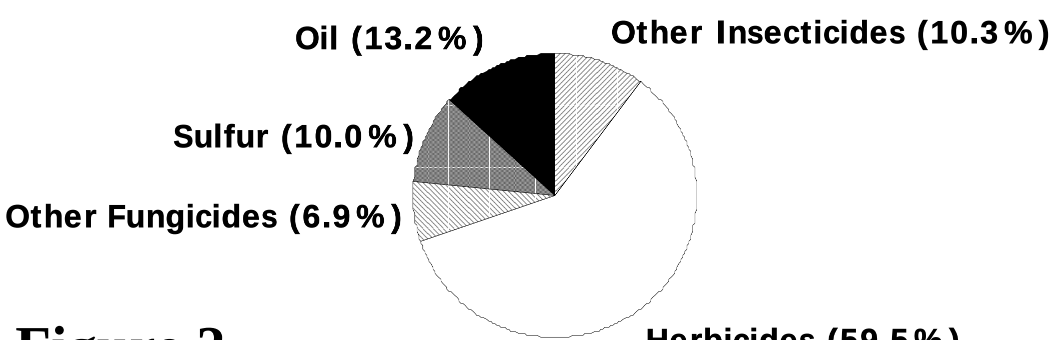


Figure 2

[1] National Center for Food and Agricultural Policy, National Pesticide Use Database, http://www.ncfap.org/ncfap/index.html (2001).

These statistics raise important questions. With organic farming still representing less than 3 percent of total U.S. food production, what will happen to overall pesticide use if and when organic farming expands to supply a larger percentage of U.S. food? How heavily are pesticides being used on organic farms in the United States? What is the total pesticide use of organic farming in the United States? What are the environmental consequences, if any, from the use of these and other organic pesticides? Are these greater or less than the environmental impacts from synthetic pesticides? Are there any potential human health risks from organic pesticide use?

Organic Does Not Mean "Pesticide-Free"

First, it is important to address the common misperception that organic farming is "pesticide-free." Organic farmers are allowed to use a number of toxic chemical pesticides, and many organic crops are routinely sprayed with pesticides.

The fundamental difference between organic and synthetic pesticides is not their toxicity, but their origin—whether they are extracted from natural plants, insects, or mineral ores or are chemically synthesized. In fact, some organic pesticides have mammalian toxicities that are far higher than many synthetic pesticides.[2] (Note: the "warning label" text on the cover of this report is taken from the label of a neem-based organic insecticide) While organic farmers promote their use of non-chemical pest control strategies, such as crop rotation and beneficial insects, they still use chemical pesticides when pests threaten their crops.

The most heavily used pesticide on organic farms is the toxin from the soil bacteria *Bacillus thuringiensis*, commonly referred to as Bt. However, because Bt sprays are a formulation of living bacteria, they cannot be measured in pounds per acre of active chemical ingredient as are other organic and synthetic pesticides.

Copper, an organic fungicide, is the 18th most used pesticide in the United States. Over 13 million pounds of copper were applied to 54 crops in 1997. Copper, oil, and sulfur combined accounted for a full 25% of U.S. pesticide use.

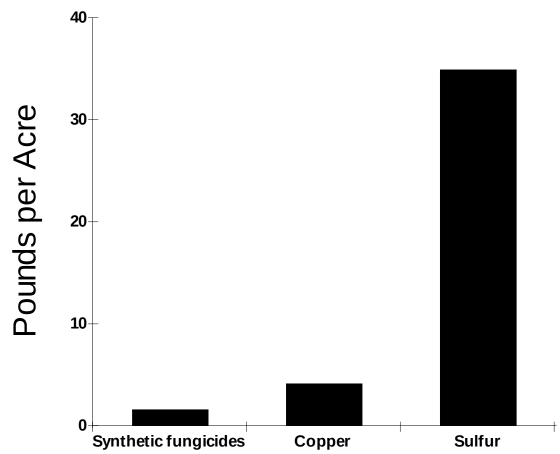
There are quite a number of additional organic pesticides, including insecticidal botanical extracts such as pyrethrum, neem, sabadilla, and rotenone, as well as insecticidal soaps and sprays such as kaolin. Surprisingly, government regulators and authorities have no statistics at all on the use of any organic pesticide other than oil, sulfur, Bt, and copper, despite the fact that millions of pounds of these other organic pesticides are used every year in the United States.

[2] Nicotine, one of the more toxic organic insecticides, has a rat LD50 (lethal dose in 50% of animals tested) of 55mg/kg. The newest synthetic insecticide, imidacloprid, has a rat LD50 of 425mg/kg, making imidacloprid nearly 10 times less toxic than nicotine. Rotenone has an LD50 of 60-1500 mg/kg and is more acutely toxic than Malathion or Sevin. Cats are highly susceptible to pyrethrum. From: http://www.agnr.umd.edu/users/ipmnet/4-2art1.htm and http://ipmworld.umn.edu/chapters/bloomq.htm (2001).

This lack of government oversight is somewhat puzzling because many organic pesticides are used more intensively per acre than non-organic pesticides. This is due to the lower effectiveness of organic pesticides compared to their synthetic counterparts.

Fungicides effectively illustrate this. The primary organic fungicides are sulfur and copper. Both products are mined from natural mineral ores. Both are toxic to a broad range of organisms and are long-term soil and environmental contaminants. Both are applied at significantly higher rates of active ingredient than synthetic fungicides. (See Figure 3) According to the NCFAP data, 13.7 million pounds of copper was used to treat 3.3 million acres of crops in 1997 at an average rate of over 4 pounds per acre. Nearly 78 million pounds of sulfur was used on 2.2 million acres applied at an average of over 34 pounds per acre. In contrast, only 40 million pounds of synthetic fungicides were used to treat over 25 million acres at an average rate of only 1.58 lbs. per acre. (See Table 1.) This is less than half the average rate for copper and less than 5 percent the average rate for sulfur.

Figure 3. Fungicide Use Rates—Synthetic vs. Organic



What If the United States Went All Organic?

Obviously, a switch to organic farming by a large number of U.S. farmers—the recommendation of several prominent environmental groups—would result in a massive increase in U.S. fungicide use and significantly increased soil contamination.

We can roughly estimate the increase in fungicide use that could be expected if all U.S. agriculture converted to organic practices by replacing synthetic fungicides with copper or sulfur at the 1997 application rate (which is nominally based on these pesticide's effective rate). This is a reasonable assumption because it is unlikely that farmers whose economic survival depends on a successful harvest will sit idly by while a fungal disease ravages their crops. Farmers facing fungal diseases will use whatever fungicides are authorized for use within the organic farming mandate.

Sulfur was applied to U.S. crops at an average rate of 34.885 lbs. per acre in 1997. This rate is 22 times higher than the 1997 average synthetic fungicide use rate of 1.588 lbs. per acre. Thus, if all synthetic fungicides were replaced by sulfur, U.S. farmers would use an additional 840 million pounds of fungicide. This amounts to a 738 percent increase in

U.S. fungicide use! At this use level, sulfur would account for more pesticide use than the current ten most-used pesticides combined.

Copper was applied to U.S. crops at an average rate of 4.08 lbs. per acre in 1997, or over 2.5 times higher than the average synthetic fungicide use rate. If copper were the organic replacement for synthetic fungicides, U.S. farmers would replace 40 million pounds of synthetic fungicides with 102.8 million pounds of copper, increasing total fungicide use by 63 million pounds. This would be a 47 percent increase in overall fungicide use. At this level, copper would total 116.5 million pounds, making it the single most used pesticide in the United States.

While these calculations are imperfect comparisons due to complex arrays of crops and growing conditions, they serve to illustrate the greater use intensity of organic pesticides and the fallacy of assuming that moving to organic farming will result in reduced pesticide use. Worse, sulfur and copper have much more persistent environmental toxicity than their synthetic counterparts, which raises further questions about their increased use.[3]

What about insecticides? The only organic insecticides for which any use statistics are available are oil and Bt. Under an all-organic scenario, the use of Bt would undoubtedly increase. However, Bt is effective against a relatively narrow range of crop pests. Therefore, the use of Bt as a replacement for synthetic insecticides is limited. Millions of pounds of oil or other organic insecticides, such as pyrethrum, neem, rotenone, or sabadilla, would need to be used as replacements for the majority of synthetic insecticides.

Because of the lack of statistics, it is impossible to accurately estimate the increase in the use of these organic pesticides under an all-organic scenario. If oil were the main replacement for synthetic insecticides, overall insecticide use would skyrocket. Oil is used at rates of up to 72 pounds per acre, with the average being 49 pounds per acre. This is compared to 1-4 pounds per acre for a typical synthetic insecticide. Newer synthetic insecticides, such as imidacloprid, have average per acre use rates of less than 0.5 pounds per acre.[1]

Because organic insecticides are less effective and degrade more rapidly than their synthetic counterparts, organic insecticides would also need to be used more frequently to achieve the same level of pest control. The alternative is significantly increased crop losses to insect pests, wasting scarce agricultural resources, and increasing pressures on natural resources—especially cropland.

An additional factor that must be accounted for: the suppression of pest populations by the current overwhelming majority of non-organic farmers. If a majority of farmers in a

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[3] J. Kovach, C. Petzoldt, J. Degni, and J. Tette, "A Method to Measure the Environmental Impact of Pesticides," *New York's Food and Life Sciences Bulletin* Number 139, New York State Agricultural Experiment Station, Cornell University, Ithica, New York (1992) and available at http://www.nysaes.cornell.edu/ipmnet/ny/program_news/EIQ.html

region use effective synthetic pesticides to control pest populations, then organic farmers in the region benefit from the resulting smaller pest population. It is extremely difficult to measure this “umbrella effect,” although indirect evidence indicates that the effect is not insignificant. For example, many organic crops can only be produced economically in regions where pest populations are low. The recent proliferation of large-scale regional cotton boll weevil eradication programs—that use synthetic insecticides—has allowed the expansion of organic cotton production into areas where it was previously uneconomic.[4]

Thus, it is reasonable to conclude that overall insecticide use will increase significantly under an all-organic scenario, although it is impossible to estimate the exact scale of the increase.

Organic farming proponents will argue that the above comparisons are invalid because they fail to incorporate the multitude of non-chemical strategies available to organic farmers. They will argue that the per acre use rates of copper and sulfur are substantially lower on organic farms and that the NCFAP statistics are an invalid comparison.

It is true that organic farmers use crop rotation, disease and insect-resistant crop varieties, and soil fertility management to maximize plant health and minimize the impacts of crop pests—but the effectiveness of these strategies is quite limited. All farmers use a combination of crop rotation, disease and insect-resistant crop varieties, and soil fertility management to maximize plant health and minimize the impacts of crop pests. But all farmers also combine these strategies with judicious pesticide use to achieve an acceptable balance between crop yield, pest damage, and profitability. The biggest difference between organic farmers and their conventional counterparts is that organic farmers generally accept higher amounts of crop damage and loss before using pesticides. They do so because of the price premium for organic food and because organic pesticides are generally more expensive and less effective than their synthetic counterparts.

The prospect of significantly increased organic pesticide use raises another question: What are the social and ecological costs of producing the additional organic pesticides? Many organic insecticides are extracts of plants. Pyrethrum is extracted from the flowers of pyrethrum chrysanthemums, much of it produced in Kenya and Peru. In 1981, Levy estimated that global demand for pyrethrum flowers exceeded 25,000 tons annually, satisfied by an estimated 150 million flowers hand-harvested daily.[5] In 1995, USDA statistics indicate that Kenya produced over 100,000 tons of dry flower petals, indicating a significant increase in pyrethrum production since 1981. How much land is required to meet current pyrethrum production and how much land would be needed to increase organic pesticide production if all U.S. farmers went organic? What are the social costs of large populations of agricultural workers—most of them poor women and children in developing countries—hand-picking flowers for organic pesticide production? Is this not analogous to a sweatshop?

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[4] Personal Communication, Frank Carter, National Cotton Council, Kansas City, Kansas (2001).
[5] L.W. Levy, *Environ. Exp. Bot*. 21, 389 (1981).

Herbicides

The only category of pesticide use that would decrease under an all-organic scenario is herbicides. But this decline in herbicide use would be accompanied by lower crop yields and higher soil erosion.

Weeds are the oldest problem in agriculture. Weeds steal moisture and nutrients away from crop plants. They decrease crop yields and harbor crop pests. Until the advent of chemical herbicides, the only strategy for killing weeds was mechanical control—tilling, plowing, and hoeing to kill the weeds. But these "bare-earth" methods of weed control expose the soil to wind and rain and considerably increase soil erosion rates. Soil erosion is the biggest impediment to sustainable agriculture.

That is why in the early 1970s, innovative farmers devised what are now called "low-till" and "no-till" farming systems. Instead of plowing or tilling, herbicides are used to kill weeds. These systems leave the soil relatively undisturbed, which reduces soil erosion and decreases spring moisture loss—especially important in dry areas. The roots, stalks and other residues of the weeds are left in the upper soil layers and on the soil surface, thereby increasing the organic matter content of the soil as well as protecting the soil surface from the erosive forces of rain and wind. As a result, soil erosion on no-till and low-till fields is a small fraction of the losses seen in conventional and organic fields. Instead of losing soil, these fields are creating soil and are fully sustainable for the first time in history.[6] Moreover, the structure of the soil in no-till fields becomes more conducive to crop production: Earthworm populations skyrocket, increasing soil porosity and water holding capacity.[7]

But organic farmers refuse to use chemical herbicides to kill weeds. They are left with bare-earth weed control methods that lead to increased soil erosion and less sustainability.

The irony is that herbicides are the least toxic class of pesticide and offer the most environmental benefit. Herbicides are mostly compounds that narrowly target plant enzymes and are virtually harmless to insects and mammals. Yet the benefits from their use are enormous. An all-organic mandate would eliminate all of these benefits. It is worth noting that the only insecticide and fungicide on the Top Ten list are organic. However, four of the Top Ten pesticides are herbicides. This reflects the increasing use of herbicides, one of the major pesticide trends in the last 20 years, as farmers switch to no-till and low-till farming systems.

[6] *Farming for a Better Environment*, Soil and Water Conservation Society, Ankeny, Iowa (1995).
[7] M.J. Clapperton, J.J. Miller, F.J. Larney, and C.W. Lindwall, "Earthworm populations as affected by long-term tillage practices in southern Alberta, Canada" Proceedings of the Fifth Symposium on Earthworm Ecology, *Journal of Soil Biology and Biochemistry*, (1995).

Biocontrol and Other Organic Pest Control Strategies

There are a number of pest control strategies that organic farmers heavily rely upon. Biocontrol is one. Under an all-organic scenario, the use of these alternative pest control strategies would increase.

Biocontrol uses predatory insects or other biological agents, such as fungi or bacteria, to kill or control insect pests. Organic farmers promote biocontrol as a more natural and less environmentally damaging alternative to chemical pesticides. However, biocontrol agents have a mixed record of success and failure, along with some fairly undesirable ecological impacts. This calls into question the assumption that a shift to these methods would result in gains in environmental safety.

Biocontrol agents are extremely unpredictable. Sometimes they achieve significant pest control, other times they don't. The list of factors contributing to success or failure is long, complicated, and specific for each biocontrol agent. Weather, crop abundance, pest population dynamics and a host of other factors contribute to the unpredictability of biocontrol agents.

In addition to their uneven performance, biocontrol agents are expensive compared to chemical pesticides. Biocontrol agents are usually targeted to just one pest, so biological control strategies need to be implemented for each pest in an area. In contrast, one chemical pesticide can suppress a half a dozen crop pests.

Biocontrol agents also come with their own unique set of ecologic hazards.[8] While the scientific and regulatory community is still searching for the first negative ecological impacts from genetically engineered crops, biocontrol insects have proven to be major factors in the declines of several native insect and plant species.[9] These ecological hazards would increase considerably if all U.S. farmers were actively releasing large populations of a wide variety of biocontrol agents.

Conclusion

A major U.S. shift to organic agriculture would mean more pesticide use, not less; more toxicity, not less; and higher pressures on agricultural and other natural resources without any apparent offsetting benefits.

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[8] C.E. Turner, in Proceedings of the Sixth International Symposium on Biological Control Weeds, University of British Columbia, Vancouver, BC, 19 to 25 August 1984; E.S. Delfosse, Ed. (Agriculture Canada, Ottawa, 1985). Pp. 203-225; F.G. Howarth, Annu. Rev. Entomol. 36:485 (1991).

[9] S.M. Louda, D. Kendall, J. Connor, D. Simberloff, Ecological Effects of an Insect Introduced for the Biological Control of Weeds, *Science* 277:1088-90 (1997); D.R. Strong, Fear No Weevil, Science 277:1058-59 (1997); G.H. Boettner, J.S. Elkinton, C.J. Boet, Effects of a Biological Control Introduction on Three Nontarget Native Species of Saturniid Moths, *Conservation Biology* 14:1998-1806 (2000)

Table 1. Synthetic Fungicide Use Rates (1997)

Active Ingredient (AI)	Acres Treated	Lbs. AI Applied	Rate (Lbs. AI/Acre)
Azoxystrobin	965,767.00	228,614.00	0.237
Benomyl	1,094,727.00	675,498.00	0.617
Captan	637,694.00	3,992,780.00	6.260
Chlorothalonil	3,170,470.00	11,916,714.00	3.758
Cymoxanil	238,895.00	45,886.00	0.192
DCNA	80,883.00	188,683.00	2.330
Dimethomorph	243,388.00	51,536.00	0.212
Dodine	72,560.00	151,538.00	2.088
Etridiazole	544,124.00	91,669.00	0.168
Fenarimol	658,813.00	46,272.00	0.070
Fenbuconazole	112,033.00	32,818.00	0.290
Ferbam	57,234.00	317,127.00	5.540
Flutolanil	20,800.00	24,960.00	1.210
Fosetyl-AL	304,962.00	904,718.00	2.960
Iprodione	863,681.00	689,648.00	0.798
Mancozeb	2,570,046.00	9,585,779.00	3.729
Maneb	961,185.00	3,039,932.00	3.162
Mefenoxam	470.00	210,100.00	0.446
Metalaxyl	1,788,418.00	659,996.00	0.369
Metiram	199,364.00	1,385,329.00	6.948
Myclobutanil	1,108,391.00	174,482.00	0.157
Oxytetracycline	72,547.00	33,536.00	0.462
PCNB	1,031,738.00	819,086.00	0.793
Propamocarb	157,731.00	173,885.00	1.102
Propiconazole	3,178,929.00	493,997.00	0.155
Streptomycin	134,213.00	50,433.00	0.375
Tebuconazole	1,984,955.00	478,569.00	0.241
Thiophanate Methyl	666,220.00	453,793.00	0.681
Thiram	33,764.00	179,809.00	5.320
Triadimefon	298,592.00	53,097.00	0.177
Triflumizole	466,051.00	92,481.00	0.198
Triforine	43,277.00	23,625.00	0.545
Triphenyltin Hyd	959,907.00	660,971.00	0.688
Vinclozolin	158,575.00	121,960.00	0.769
Ziram	333,775.00	1,992,554.00	5.970
Total	**25,214,179.00**	**40,041,875**	
Average Application Rate based on acreage			**1.588**