DDT field study test beds at Spirit of the Earth Farm on Kauai, Hawaii. ©Marie Mauger

Safe Food From Contaminated Soil?
Biodynamic Agricultural Method Shows Successful Field Research

Marie Mauger

Many farmers and consumers are unaware that persistent organochlorine pesticides (POPs), such as DDT, are active in our soils and still a health issue many years after their sale in the United States was banned.[1] The situation remains critical because most agricultural ground has been exposed to POPs at some time, cropping and treatment histories are notoriously inaccurate, and there is a long breakdown time for toxins in untreated soil – about eighty years for DDT. In addition, POPs continue to be released into the environment, sometimes accidentally by U.S. producers or transported by weather or in produce from countries where pesticides are used without restriction.[2]

It is important to address this serious challenge because of the damaging effects these hidden pesticides can have on humans as well as the environment. More than forty years ago, Rachel Carson, in her landmark book *Silent Spring,* warned of the dire consequences of biologically harmful chemicals. Today, DDT and its metabolites are still found in virtually every breast milk sample that is tested. Cancer, decreased fertility, stillbirths, neurological abnormalities, liver damage, and impaired immune function are all linked to DDT. We need a safe, sustainable, inexpensive, and effective method to (1) reduce pesticide concentration in soils, and (2) help prevent pesticide uptake in crops. The following results of a one-year study indicate that biodynamics meets all these criteria.

Soil tests on my farm in Hawaii in 1999 indicated high levels of DDT contamination. I set up a duplicable field study to investigate pesticide exchange between soil and food, in particular beets (which take up pesticides readily) and green beans (which take up pesticides less readily).[3] After a year of field research (2005–2006), the measured results showed that the biodynamic agricultural method of Rudolf Steiner successfully reduced both pesticide accumulation in beets and persistent pesticide concentration in the soil more than other agricultural methods that were used. None of the beans in any of the plots showed detectable DDT uptake.

Research method

Like many other organic methods, biodynamics uses compost, cover crops, crop rotation, companion planting, and appropriate soil cultivation. What makes biodynamic protocols unique is the use of nine specially prepared compost and soil amendments, which are made from common herbs and natural materials such as chamomile, dandelion, cow manure, and quartz crystal dust. These act as a catalyst to ignite life-giving, formative forces of nature in the soil and, therefore, also in plants. In addition, biodynamic farmers often work with a planting calendar based on the planetary movements and rhythmic cycles of the earth. Each farm also strives toward the ideal of producing all inputs on the farm itself.

My research consisted of a field test of sixteen identical ten foot by ten foot plots set up with four different agricultural treatments and four replicates of each treatment. The treatments were called Biodynamics, Biodynamics plus High-Lignin[4] Compost, High-Lignin Compost, and Control. At the onset of the study, all sixteen plots were planted with a buckwheat cover crop twice in succession. The buckwheat was plowed under after each growth and, because of heavy rain, finally left to decompose for five weeks before planting. All plots received Organic Materials Review Institute (OMRI)-listed chicken pellets as a soil amendment at planting time.

Special biodynamic treatments were applied from the beginning, but only in two of the treatments – the four Biodynamic replicates and the four Biodynamic plus High-Lignin replicates.[5] In other words, biodynamic compost and practices were applied in one of the treatments. Biody-

Test bed, showing beans to left and beets to right. ©Marie Mauger

namic compost and practices plus high-lignin compost were used in another treatment. High-lignin compost only was used in the third treatment and the control plots were left untreated.

Soil samples were taken from each replicate plot to determine NPK (nitrogen, phosphorus, potassium), organic matter, and organochlorine pesticide residues both before planting (to provide a baseline) and after harvest (to determine any effects from the treatments). Crop samples were also taken at harvest from each plot and tested for pesticide residues (see Table 1).[6]

Field test results

The results of the test study are encouraging for those who plan to use biodynamics, whether to clean up the soil or provide safe, nutritious food. Consistent results were noted from plot to plot[7] as were measurable differences between the specially treated plots (particularly the biodynamic plots) and the control plots. These findings suggest that the biodynamic treatments used may play a significant role in reducing both pesticide residue in soils and pesticide uptake in vulnerable plants.

All four replicate groups, including the control treatments, demonstrated reduced pesticide concentrations in the soil. All treatments also showed pesticide accumulation in the beets. For each treatment, the average reduction of pesticides in the soil was as follows: Biodynamic, 81%; Biodynamic/Lignin, 72%; Lignin, 57%; and Control, 53%. For each treatment, the average uptake of DDT in the beets was as follows: Biodynamic, 0.0002 ppm; Biody-

Table 1. DDT in Beets and Soils: Results and Relationships (2005–2006)

Identification	Beets total DDT, ppm	Soil total DDT, ppm	Soil total DDT, ppm	Soil/Beet uptake ratio	Soil % organic matter	Soil % organic matter
Biodynamic	**2006**	**2005**	**2006**		**2005**	**2006**
#4 BD	0.0003	0.16	0.047		5.5	6.4
#8 BD	<0.0001	0.22	0.055		5.5	6.9
#12 BD	0.0003	0.14	<0.001		5.6	6.7
#16 BD	0.0003	0.26	0.051		4.9	5.7
Average	**0.0002**	**0.20**	**0.038**	**0.005**	**5.3**	**6.4 (+1.2)**
			Pesticides diminished (-81%)			
Biodyn + Lignin	**2006**	**2005**	**2006**		**2005**	**2006**
#3 BD + LIG	0.002	0.21	0.047		5.5	6.4
#7 BD + LIG	0.0006	0.19	0.051		5.2	6.7
#11 BD + LIG	0.0003	0.13	0.043		3.8	5.8
#15 BD + LIG	0.0006	0.16	0.039		4.0	6.5
Average	**0.001**	**0.17**	**0.048**	**0.021**	**4.6**	**6.4 (+1.4)**
			Pesticides diminished (-72%)			
Lignin	**2006**	**2005**	**2006**		**2005**	**2006**
#2 LIG	0.003	0.18	0.098		4.2	7.1
#6 LIG	0.002	0.23	0.097		5.0	5.3
#10 LIG	0.001	0.29	0.086		3.8	6.5
#14 LIG	0.0006	0.19	0.094		5.7	6.5
Average	**0.002**	**0.22**	**0.094**	**0.021**	**4.7**	**6.4 (+1.4)**
			Pesticides diminished (-57%)			
Control	**2006**	**2005**	**2006**		**2005**	**2006**
#1 CONTROL	0.003	0.14	0.13		4.4	6.9
#5 CONTROL	0.003	0.16	0.082		6.0	6.4
#9 CONTROL	0.006	0.37	0.098		5.0	5.0
#13 CONTROL	0.0004	0.055	0.074		5.8	6.5
Average	**0.004**	**0.18**	**0.096**	**0.042 (projected: 0.10)**	**5.3**	**6.2 (+1.1)**
			Pesticides diminished (-53%)			

namic/Lignin, 0.001 ppm; Lignin, 0.002 ppm; and Control, 0.004 ppm.

These outstanding conclusions match other reports suggesting that the method of Rudolf Steiner can reduce if not eliminate the harmful effects of pesticides within two to three years. Biodynamic grower Nicolas Joly, for example, reported that in Australia, DDT-saturated land that had been shut down to cultivation was reauthorized for planting after three years of biodynamics.[8] The speed of recovery using these methods is significant, considering the decades-long half-life of DDT in untreated soil or soil treated by conventional methods alone.

Need for more testing, certification, research, and education

I have spoken with at least fifteen farmers in my area who are growing organically or are oriented toward sustainable production. Few are aware that the former pineapple or sugarcane land they are farming is likely contaminated with varying levels of persistent pesticides. At the time of my inquiry, none had tested the soil or their produce for toxicity (possibly because testing costs from $150–$250 per sample).[9] Yet, many of these growers plant and sell crops of concern, such as ginger, turmeric, taro, sweet potatoes, beets, and carrots.

On the mainland, DDT was used extensively in citrus and apple orchards and on soybeans, cotton, and peanuts until 1972. Diana Tracy, owner and operator of Antech Lab in Oregon, is very knowledgeable about the current situation of pesticide contamination in soils. As a result of testing more than 500 soil samples for persistent pesticides, she found that from 30% to 50% had measurable residues and from 10% to 15% had measurable residues of possible concern.[10] Although the FDA considers most residue as incidental contamination, many in the food industry, including baby food manufacturers and some organic processors, require soil testing as a prerequisite for growing.

The USDA has recently acknowledged POP exposure in food as an issue, especially for children, who consume several of the most at-risk crops (carrots, squash, apples, and strawberries) at a far higher rate than the average adult.[11] However, general awareness of the menace of POPs has come slowly. Not until 2002 did we have the first detailed information about U.S. foods grown conventionally versus organically. Extensive data gathered by three U.S. studies showed that nearly three-fourths (73%) of conventionally grown foods tested had at least one pesticide residue, and these foods had multiple residues more often than the organic foods that were tested. In contrast, fewer than one-fourth (23%) of organically grown foods of the same crops had any residues, and the amount in each sample was usually lower.[12] It is important to keep in mind that many organic foods are unavoidably subject to contamination that persists in soils or travels by air or water from non-organic farms. The study also found that crops grown in certain areas had less contamination. Another 2002 publication, citing a study based on government data, stated that even when consuming a balanced diet, adults who do not stick with organics may receive up to ninety times the acceptable exposure of POPs.[13]

Although a small experiment, the preliminary study in Hawaii showed results that are likely to be of great interest to farmers and other researchers. This producer is willing to do further research with proper funding. However, why wait? The need to resolve the hazards of soil pollution is now. In addition to indications of such in this research, the benefits of biodynamics in other aspects of agriculture are well documented. At an annual materials cost of approximately $30 per acre, biodynamics is indeed an inexpensive, safe, sustainable, and effective method of restoring vitality and life to our soils and our food. In conclusion, it seems highly likely that biodynamics is the answer to any soil remediation needed.

I give particular acknowledgment and appreciation to the following:

- Hugh Courtney of the Josephine Porter Institute for providing high-quality biodynamic preparations and mentoring me in the biodynamic method since 1981. Contact number is (276)930-2463.
- Western SARE (Sustainable Agriculture Research and Education) for providing partial funding for the research. SARE is part of the United States Department of Agriculture. Contact number is (435)797-2257.
- Diana Tracy, president of Antech Lab, Corbett, Oregon, for lab work, compilation of data, and contribution in kind. Contact number is (503)695-2135.
- Ann West of Carmel, California, for introducing me to biodynamics and editing this article.

Notes

1) Often called Persistent Organic Pollutants, POPs include the "dirty dozen," twelve compounds (such as dichlorodiphenyltrichloroethane (DDT), dieldren, chlordane, and dioxins) considered most harmful by the ninety plus countries working together at the UN's 2001 Stockholm Convention to help identify and gradually eliminate such toxins. For details, see Office of International Affairs, EPA, "POPs: A Global Issue, a Global Response" [2610R], 2002. Online at <www.epa.gov/oia/toxics/pop.htm>.

2) Current customs data regarding U.S. exports of banned pesticides are considered unreliable. See Carl Smith, "Pesticide Exports

From U.S. Ports, 1997–2000." Online at <www.fasenet.org/pesticide-report97-00.pdf>.

3) The following are some of the crops considered at risk for POPs: beets, potatoes, carrots, parsnips, cucumbers, strawberries, apples, ginger, turmeric, sweet potatoes and squash. Beets are thought to be particularly vulnerable.

4) A cellulose-like substance that adds strength and stiffness to cell walls. The high-lignin compost was included in this study because there is a reported relationship between lignin, white rot fungus, and the breakdown of benzene rings in DDT removal. See Steven D. Aust and John T. Benson, "The Fungus Among Us: Use of White Rot Fungi to Biodegrade Environmental Pollutants," *Environmental Health Perspectives* 101(3), August 1993, 232-233. Online at <www.ncbi.nlm.nih.gov/entrez/query>.

5) The biodynamic protocol for the specified plots included the following:
   - Cover-crop application: Biodynamic Prepared 500 (horn manure) applied to cover crop;
   - Plow-under application: Pfeiffer Field Spray applied to cover crop at time of plow down;
   - At-planting application: Biodynamic compost amended to soil before planting beets and beans;
   - At-planting application: Biodynamic Prepared 500 applied to beets and beans;
   - Application during growth cycle: Biodynamic Preparation 508 (horsetail) applied to beets and beans;
   - *STELLA NATURA* 2005, 2006 were the calendars used to guide the planting of beets and beans.

   Note: I generally apply the Biodynamic Preparation 501 (horn silica) in the second year. In future research, I will apply it for all experiments.

6) Because there was no significant change in NPK levels, they were not included in Table 1.

7) Quality control at Antech Lab (testing facility for this study) follows general good laboratory practices, including duplicate samples and spiked matrix samples (at least 10% of total). Recovery of spikes must be at least +/- 20% to be acceptable, with most duplicates and spikes better than +/- 10%.

8) Nicolas Joly, "Is Biodynamic Wine-growing a Myth or a Reality?" Clos de la Coulée de Serrant, Pamphlet, 2003. Online at <www.coulee-de-serrant.com/mytheourealiteangl.htm>.

9) In the past, most organic certification requirements included soil pesticide residue testing. However, the USDA's "Final Rule with request for comments..." (CFR part 205 of the National Organic Program, implemented October 2002), does not include routine testing for certified growers, unless there is specific reason to suspect contamination or crop bioaccumulation issues.

10) Antech Lab tested soils for Oregon Tilth (organic certifying agent), from 1988 to 2003, as well as Hawaii Organic Farmers Association (HOFA) and Kauai Organic Growers' Association (KOGA). Sixty-five percent of the soils tested were from Oregon, twenty percent from the continental United States, and fifteen percent from outside the United States.

11) For more information, see U.S. Food and Drug Administration, *Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed.* August 2000. Online at <www.cfsan.fda.gov/~lrd/fdaact.html>.

    Also see <www.ams.usda.gov/science/pdp/> to find out more about the Pesticide Data Program (PDP), a national pesticide residue database, cooperating with state agriculture departments and other federal agencies, with an emphasis on U.S. products highly consumed by infants and children.

12) Brian P. Baker, Charles M. Benbrook, Edward Groth III, and Karen Lutz Benbrook, "Pesticide Residues in Conventional, IPM-grown, and Organic Foods: Insights From Three U.S. Data Sets," *Food Additives and Contaminants* 19(5), May 2002, 427–446.

    For a summary of this study, see the Eco-Gardeners' Webring site, "The Case for Organics: Scientific Studies and Reports," online at <journeytoforever.org/garden_organiccase.html>.

13) Andre Picard, "Pesticides Banned Many Years Ago Still in Some Foods," *Globe and Mail* (Toronto), October 15, 2002, p. A10. Online at <www.theglobeandmail.com>. The study was conducted by the San Francisco-based Pesticide Action Network and published in the *Journal of Epidemiology and Community Health* (Oct 2002).

Marie Mauger offers a 28-day intensive training in biodynamic farming at Spirit of the Earth Farm (or Uhane Aina) on Kauai. Contact Marie at <mariemauger@yahoo.com> or PO Box 416, Anahola, HI 96703.