RADIATION AND THE PROSPERITY OF AGRICULTURE

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Editor's Note: On July 12, 2011, we posted "On Biodynamics and Radiation" by Executive Director Robert Karp on our blog to announce that the Biodynamic Research Steering Team would procure and evaluate the available research and reports relating to the question of the possible role of the biodynamic preparations in protecting farms and food from radioactivity, and draft a synopsis. This article details the results of that effort to date. See Robert's post at **biodynamicsbda.wordpress.com** for further background on this issue. We are aware that this is a burning and sometimes controversial issue; we invite you to send other perspectives or viewpoints to rebecca@biodynamics.com.

BY THE TIME RUDOLF STEINER DELIVERED HIS LECTURES in 1924 on the *Spiritual Foundations for the Prosperity of Agriculture** (the Agriculture Course), and in those lectures spoke in his idiosyncratic way about a transmutation of atomic elements, Marie Curie had already earned her Nobel Prizes in physics (1903) and in chemistry (1911). But radiation was not yet an issue for agriculture.

Nevertheless, developments in atomic physics during Rudolf Steiner's own lifetime would eventually lead, by 1945, to weapons of mass destruction, which may well have brought an end to the war in the Pacific Theater, but then threatened to drop the curtain on the whole Theater Production Company—the world as we know it!

Until the partial test ban treaty in 1963, atmospheric fallout from our own above-ground atomic weapons testing in Nevada blanketed Idaho and central Montana and fanned out across the wheat and corn belts of the Midwest.[1]

Now the "Peaceful Atom" is proving perhaps a more insidious threat. Nuclear power plant accidents at Three Mile Island in 1979 irradiated our East Coast; again at Chernobyl in 1986, the Ukraine and northwestward over Europe; and yet again at Fukushima Daiichi in 2011, central Japan and eastward over the Pacific. A plume of radioactive isotopes drifting in ocean currents will soon span over that same Pacific Theater to our own West Coast.[2]

To round out the story of radiation threats to agriculture, an EPA-allowable level of radionuclides may be spread on fields in the form of phosphogypsum, a waste product of phosphate fertilizer production in which these naturally occurring elements are concentrated during the processing of phosphate ore.[3] Agricultural fields are often treated as waste disposal sites by industry. It is also the case that heavy metal-containing industrial wastes may be incorporated into modern fertilizer formulas.[4] All the more reason for working with the farm individuality and without outside inputs from the agricultural suppliers.

BARREL COMPOST

In the Winter 2004/5 issue of *Biodynamics*, Nik Kramer told the story of the origin of Maria Thun's barrel compost (BC) formulation, born out of concern for atmospheric fallout from above-ground nuclear weapons testing in the 1950s. Disturbing levels of the radioactive nuclear fission product strontium-90 were being found in animal bones and mothers' milk. Scientists showed that plants grown on calcium-rich soils took up much less of the strontium fallout than did plants grown on sandy soils. Calcium competes with strontium for uptake and assimilation in the plant—and then into our food.

Working with Dr. Ehrenfried Pfeiffer until his death in 1961, Thun began in 1958 experimenting with basalt meal and various calcium-bearing substances that had passed through life processes. It was found that plants grown in Thun's sandy soil after treatment with eggshells and basalt meal apparently showed no trace of strontium-90. For application of this material—rich in calcium dynamics—in a potentized form practical for farmers to apply, Thun then tried making "horn preparations." But she had settled by 1970 on the rhythmically shoveled BC "cow-pat" preparation we know today.

Atomic weapons testing had by then gone underground, and BC's intended use in the amelioration of fallout radiation was largely forgotten. When Thun finally

**Editor's Note:* This is also known as *Spiritual Foundations for the Renewal of Agriculture*, as translated by Catherine E. Creeger and Malcolm Gardner. Author Barry Lia argues that the German word *Gedeihen* means prosperity,which connotes the larger social-economic reform intention of the Koberwitz impulse.

published her BC formula in 1972, little mention was made of its original intention. Today we know BC for its "coincidental" value in building soil fertility and tilth.

Then, after clouds of radioactive fallout from the Chernobyl reactor meltdown drifted over the Ukraine and northern Europe in 1986, there were anecdotal reports on blogs and even some popular internet news[5] of gaps in the fallout map where biodynamic farms were located. Kramer claims that only biodynamic farms sprayed with BC turned out to be clean. It is alleged that one scientist showed Thun his astonishing results indicating reduced soil and plant contamination on her property, but that he regrettably burned his records "for fear of his name being attached to the research." Unfortunately, we have little evidence or research to stand on.

The authors have compiled a summary of the available evidence for such claims, largely in German, on behalf of the Biodynamic Association's Biodynamic Research Steering Team.[6] The issues fall into two categories: 1) soil contamination by radioactive *fallout* and 2) plant *uptake* of radionuclides from contaminated soil.

As to claims of gaps in the Chernobyl fallout map over biodynamic farms, we found no available substantiation. Friedrich Sattler took hundreds of personal Geiger counter readings on his advising travels throughout Europe and could never demonstrate any difference in radioactivity between biodynamic (BD) farms and neighboring farms in a given region. Granted, he did not explicitly distinguish farms using BC, but presumably some of them must have engaged in that practice.

It is less hard to imagine differential reduction of plant uptake of radionuclides from soils suffering a uniform fallout. We are aware of two studies addressing this uptake issue in regard to BD/BC, one a greenhouse pot study published in a volume of fertilizer symposium proceedings and the other a field study published as an institute monograph. These two studies apparently comprise the scientific evidence available.

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The first is a study published in 2007 (in English) by Susanne Schroetter, Maria Thun, and Ewald Schnug of the Institute of Plant Nutrition and Soil Science, FAL, Braunschweig-Volkeffode, Germany.[7] The toxic heavy metal uranium, and traces of its radioactive decay products radium and radon, may be carried in rock phosphate-derived mineral phosphate fertilizers. The treatments in this study were as follows: potted soil with or without applied uranium contamination with U_3O_8 (U) was then treated with either mineral fertilization (control), or BD compost with application of BC spray ("Fladen A"), or BD compost with application of BC spray and the addition of BD 500 and BD 501 spray treatment ("Fladen B"). A perennial ryegrass was grown and U-uptake by shoots and roots was measured.

There was much less U-uptake for the Fladen A and the Fladen B treatments than for the control treatment, and no apparent difference between the Fladen A (i.e., BD+BC) and the Fladen B (i.e., BD+BC+500/501) treatments. Due to the greater biomass achieved by both the Fladen A and the Fladen B treated plants compared to the control treatment, the authors allow that there may be a "dilution effect" accounting to some degree for the reduced rate of uptake.

As acknowledged by the authors, previous peer-reviewed literature has reported that soil organic matter and humus/compost *per se* can reduce uptake of U and other heavy metals. The authors point out that (a) lower soil organic carbon (C_{org}) in the control treatment group means less U may be bound to soil C_{org} and more may be available for uptake by plant tissue; (b) with increasing phosphorous supplied to the control treatment by the mineral fertilizer, "U will crystallize out as autunite [$Ca(UO_2)_2PO_4$] in the tips of control plant roots or will be located within cell walls"; and (c) the use of chemical fertilizer may have resulted in acidification of the control treatment soil, which would increase the amount of free U ions available for uptake. These factors, due to *mineral* fertilization of the control plants, confound the study design.

Thus, we can say that increased organic matter may result in reduced U uptake, but this study does *not* allow us to say that biodynamic compost and preparations help in any additional way to prevent accumulation of radioactivity in food crops than might simply have resulted in a soil with good organic matter and humus/compost. A soil treatment with non-BD compost would have served as an appropriate control by which to test such an assertion. Moreover, it would have been desirable to add further treatments to the design with and without BC, in order to test for any additional reduction in uptake by BC compared with organic and with BD compost treatments.

The second study, published in 2009 by M. Diduk and A. Mudrak of the Zhytomirski National Agroecological University in the Ukraine, directly addresses our fallout issue. It was conducted on land in the secondary contamination zone about 130 kilometers from Chernobyl.[8] This soil had an average of about 1.3% humus and pH 5.0-5.5 (*acidic*). Over a four-year period, they treated six fields with organic fertilizers (non-BD composted manure) either with or without the BD preparations and with or without effective microorganisms (EM).

This is the proper design to determine specific effects of the BD or the bacterial preparations versus mere organic treatment. Unfortunately, this study *cannot* differentiate between BC *per se* and the other BD preparations, as BC was always applied along with BD compost preps and

either 500+501 or another compound prep spray ("Präparat Johanni").

The study began in 2005, and they report data for crops in 2009, ranging from oats, buckwheat, and wheat to lupines and clover. The various organic treatments (BD, non-BD, and EM) increased yields, soil pH, available phosphate and potassium, and decreased soil density. The various organic treatments also decreased levels of cesium-137 and strontium-90 uptake two- to three-fold in the leaves, grain, and straw over five years (*roots were not tested*).

There was, however, *no additional* statistically significant effect of using the BD preparations (or the other microbiological preparations) compared with the organic treatment, except in one case, growing one variety of oats under BD conditions, where they saw a tendency for more decline in radioactivity in grain and straw (but not in greenmass). The authors conclude, as we must also, that the BD/BC preps made no appreciable difference versus the organic compost treatment.

WHERE WE STAND

In summary, there is no scientific evidence in either of these studies for us to responsibly claim that there is remediation/protection from radioactive contamination by biodynamic preparations above and beyond what good organic compost and neutral pH might otherwise provide. Furthermore, there is no evidence of BC remediation/protection above and beyond BD treatment.

It must be pointed out that the negative findings in these two studies say nothing about the broader value of BC or biodynamics. In other contexts, there *are* peer-reviewed scientific studies showing *positive* findings as to the effectiveness of the biodynamic preparations for composting, soil pH regulation, and as a field spray.[9]

Regarding radiation remediation, we see that more sophisticated experimental design and statistical analysis would be required in future to test for a specific BC effect in radiation remediation and to account for the various factors involved: favorable variations in pH, differences in soil C_{org}, a "dilution effect" of greater biomass, etc., resulting from the mere *organic* action of the treatment with biodynamic compost and preparations.

Yet, even if well designed, this sort of experimental science drastically reduces the *context* in which BD and BC preparations *might* act in the first place. The fields tested in the Ukrainian study were only treated for four years and were not enclosed within a well-established biodynamic farm individuality. Pots and plots are of limited and focused value.

It would be desirable to systematically compare blocks of land, as did Sattler, in the context of well-established biodynamic farms. Ideally, several replicates of four neighboring farms might be identified in which one is managed biodynamically without BC, one biodynamically and with BC, one certified organic, and one farmed chemically. We could then assess the contamination levels of their soils and then the rate of nucleotide uptake of their crops.

We are just now about at the half-life of the strontium-90 and the cesium-137 released from the Chernobyl accident. There should still be sufficient contamination levels adequate to detect differences yet. That is, we might recreate results equivalent to the records allegedly burned by the scientist who had shown them to Thun. Then, if we *do* find differences, we might turn to focused experimental science to ferret out "mechanisms" of action.

Meanwhile, it appears that the best we can do at this point for protection against radioactive contamination in our fields is to reduce radionuclide uptake by improving soil tilth (soil organic matter, pH, etc.). This works as protection against heavy metal contamination as well. Among the benefits of applying biodynamic practices are the promotion of soil life and its enrichment with humified organic matter, as well as the facilitation of soil pH regulation, processes which do work in our favor in this regard.

And then the best we can do to reduce contamination of our fields in the first place, by both heavy metals and radioactive fallout, is to reduce the need for nuclear power and to turn away from industrial agriculture. And there is arguably no better way to do so and to bring about the prosperity of agriculture than to practice biodynamic husbandry.

NOTES

[1] http://en.wikipedia.org/wiki/File:US_fallout_exposure.png.

[2] http://www.csmonitor.com/Science/2014/0315/Fukushima-radiation-Coming-to-a-West-Coast-beach-near-you.

[3] http://www.epa.gov/radiation/tenorm/fertilizer.html.

[4] http://community.seattletimes.nwsource.com/archive/?date=19970703&slug=2547772.

[5] http://www.alternet.org/print/story/156382/does_biodynamic_farming%27s_unusual_philosophy_really_help_produce_better_food_and_drink.

[6] Available from Sarah Weber, Research Coordinator for the Biodynamic Association, at sarah@biodynamics.com. If you have questions, or can provide further information, please contact Sarah.

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[7] Schroetter S., Thun M., and Schnug E. 2007. "Effect of Biodynamic Additives on Uranium Uptake by Plants," 16th International Symposium of the International Scientific Centre of Fertilizers (CIEC), *Mineral versus Organic Fertilization, Conflict or Synergy?*, Ghent, Belgium, 16-19 September, *Proceedings*, pp. 465-471.

[8] Diduk M. and Mudrak A. 2009 "Der Einfluss mikrobiologischer (Effektive Mikroorganismen) und biodynamischer Präparate auf die Bodenfruchtbarkeit und auf die Migration von dem Radiodukleid Cäsium unter Bedingungen der Radiaktivitätsbelastung nach der Tschernobylkatastrophe," *Forschungsarbeit im Jahr* 2009, Ukrainisches Agrarpolitikministerium Zhytomirsky National Agroökologische Universität.

[9] Carpenter-Boggs et al. 2000, *Biological Agriculture & Horticulture* 17:313-328 [compost preps]; Reeve et al. 2011, *Agricultural Systems* 104:572-9 [soil pH regulation]; Giannattasio et. al. 2013, *J. Microbiology & Biotechnology* 23:644-651 [prep 500].

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Maria Linder has a PhD in Biochemistry from Harvard University. Her involvement with biodynamics stems from having Dr. Ehrenfried Pfeiffer (and his co-workers) as family friends. She worked in his laboratory during and just after college, and with Margaret Selke to support and then transition the Compost Starter from the Pfeiffer Foundation to the Josephine Porter Institute. A member of the Board of the Biodynamic Association for many years, she has been a Professor at California State University Fullerton in the Department of Chemistry and Biochemistry, and teaches nutrition and environmental biochemistry courses that include information and concepts from biodynamic agriculture.