



ON FERTILE GROUND? OBJECTIONS TO BIODYNAMICS

While acknowledging the quality of many biodynamic wines, **Jesús Barquín** and **Douglass Smith** dismiss the movement as a mix of good intentions, quasi-religious hocus-pocus, good salesmanship, and scientific illiteracy

Biodynamics has been kicking around the vineyards for several years now and is a subject ever more present in popular wine publications. The practice is suggested as an innovative, arguably superior alternative to simple organic agriculture. And in fact, biodynamics is, by its very nature, organic. But we miss a more critical treatment of the pseudoscience that makes up the balance of the biodynamic doctrine. In this article we will investigate some of the issues that, from a more sober perspective, force us to reject the theory and methodology that differentiate biodynamic from organic agriculture.

Stephen Jay Gould distinguished two basic ways we may approach the natural world: the Franciscan, charmed by the beauty and complexity of natural phenomena; and the Galilean, impassioned by the ability of human intelligence to comprehend the hidden mechanisms working behind the appearances. There is a similar spiritual duality in the more prosaic world of wine: those who approach wine as something literally alive, which is the

direct result of some force of nature, and those of us who consider it “the fruit of the vine,” yes; but also, and above all, “the work of man.” The followers of biodynamics, in their cosmogony of viti- and viniculture, are of the former type. Each vine, each harvest, even each barrel, is an organ or aspect of a universal living thing, constituted first by the vineyard and, at its most grand, by the planets, stars, and indeed the entire cosmos.

In approaching this material, one is moving through faith-infused terrain: of people who, against all evidence, believe in the memory of water; in the disequilibrium of bodily humors as a cause of cancer; in scattering the ashes of weeds and insects to frighten such pests off the land. They, or at least some of their more conspicuous spokesmen, believe that it was the Greeks’ desire to reason about natural things that broke the harmony between man and the stars. These believers will not agree with those of us who, to put it in Virgilian terms, think that the happiest moments are those where we understand the true causes of things.

Photograph © Arthur Morris / CORBIS



This article originally appeared in Issue 12 of *The World of Fine Wine* magazine. The article may not be sold, altered in any way, or circulated without this statement.

Every issue of *The World of Fine Wine* features coverage of the world’s finest wines in their historical and cultural context, along with news, reviews, interviews and comprehensive international auction results. For further information, and to subscribe to *The World of Fine Wine*, please visit www.finenwinemag.com or call +44 (0)20 8950 9117.

Some benefits ...

Nowadays it seems as if there is no such thing as a nuanced opinion, as though it were only an excuse for weakness. This is “with us or against us” time. If you are not a teetotaler, one supposes you are a drunk. If you delight in full-bodied Australian Shiraz, you can’t also be passionate about delicate Burgundy. If you believe that numerical scales are useful in ranking wine, you are considered to be in the thrall of some nefarious guru. There are dozens of such imaginary demons, even in the small world of wine.

Biodynamics presents us with a number of agricultural practices that are organic in nature, sustainable, and respectful of the environment. All of this is quite reasonable, and we happily concede it. Forthwith, some benefits:

1. Modern agriculture is in a spiral of problematic chemical treatments from which it will be difficult to escape. This also leads to problems of overproduction. Public funds in developed countries are sometimes used to destroy harvests or create artificial demand in order to raise prices. Biodynamics exists, in part, as an answer to all this, and it could have an indirectly favorable effect on a global scale. Since biodynamic practices are, *inter alia*, organic, they will contribute to reducing demand for artificial fertilizers, pesticides, herbicides, and so on. They will reduce crop yields and hence problems of overproduction. It remains to be seen what limits nature puts on the ecological practices of agriculture—an issue about which we are not entirely optimistic—but be that as it may, biodynamics should be looked on with sympathy for tackling such problems where they exist.

2. Biodynamic practices are famously labor-intensive. They force a more hands-on presence in the vineyard and avoid the use of mechanical methods or treatments. In doing so, they may lead an otherwise absent or careless viticulturalist to become more physically and mentally present among the vines. And a motivated caretaker may become aware of the existence, or extent, of problems well before one who is not so particularly in tune. So, although the particular belief systems and practices espoused by the followers of biodynamics may not in themselves hold up to scrutiny, they may add value by motivating and inculcating a philosophical closeness to soil and vine that otherwise would be overlooked or underappreciated.

3. Many wines made by biodynamic wineries are of high quality. We drink wines from such producers frequently, and with some pleasure. Knowing that a producer of a certain wine is a follower of biodynamic agriculture is no motive for skepticism about what we are going to find in the bottle. This is no surprise, since although the cosmo-dynamic techniques may in themselves be worthless, they have the evident virtue of doing no harm and, at any rate, go along with a tendency toward special care and coddling in all phases of winemaking. And we expect that it will remain so—at least until the notion becomes popularized and wily bargain-priced biodynamics entrepreneurs proliferate.

These points alone, however, are not sufficient to justify a decision in favor of this doctrine. From here on we will focus on the criticism of those aspects of biodynamics that appear to us wrong, and even dreadfully wrong. The objections we will put

forward are methodological, and they spring from our attempt to confront nature through the filter of reason.

... and tall tales

Organic practices may all be well and good, but the defenders of biodynamic viticulture do not take themselves to be practicing merely what amounts to another version of ecological or organic agriculture. Instead, they distinguish themselves by a belief system that goes beyond treatment of the field and vine; it is a cosmogony—a vitalist vision of the interstellar universe as an enormous living thing. The religious, or quasi-religious, character of such a belief system is obvious. It also puts forward treatments of an esoteric character. These have nothing to do with the methods of organic agriculture, and there are grave doubts about their effectiveness; to be charitable, they remain to be proven, since we will not take them on faith and good salesmanship. It is not sufficient that such techniques appear generally innocuous, even though this may be of some relief.

Biodynamics began with a series of eight lectures on agriculture in June 1924 by the Austrian occult philosopher Rudolf Steiner. Space prevents a detailed résumé of Steiner’s odd foundational beliefs and fruitless attempts at founding a crank “Spiritual Science,” however it is at least worth mentioning his antipathy for scientific investigations of the “orthodox” variety. In their place, he put faith in a homegrown investigative technique that appears to have involved little more than intuitive meditation and guesswork. In his agricultural lectures, these methods provided him startling revelations such as that “the ethereal moves with the help of sulphur along paths of oxygen.” And that “the spirituality which—once again with the help of sulphur—is working thus in nitrogen, is that which we are wont to describe as the astral.”¹ And so on. We can only suggest firsthand acquaintance with the founding document of biodynamics to get the unadulterated flavor of the thing.

Since the terrain of spiritual belief is particularly slippery and tends to change character with the winds, it will be best to focus on the key esoteric methods that recur in present-day biodynamics.

1. The influence of the moon

Many biodynamic treatments are supposed to be done in accordance with lunar phases or positions. This appears to be an issue in which biodynamics can be helped by scientific results. For example, we know the effect that the moon has on ocean tides, as explained by the force of gravity. However, physical models of the forces involved do not show any significant effect upon living things from the position of the moon relative to earth and sun. The force of the moon’s gravity on an adult human is less than a hundredth of a gram distributed across the whole body, and is overwhelmed by the normal gravitational stresses of motion and orientation.

Just as importantly, statistical analyses show no conclusive lunar effects. Every so often we hear of some article documenting a supposed effect of lunar phases on humans—for example, with respect to traffic accidents, the prices on stock markets, or crises with the mentally ill. At times these appear to be studies done with some rigor, to the extent that we cannot reject them out of hand. However, it is more probative to consider meta-analyses of such data, which are analyses based on the aggregation and combination of data published in a wide range of separately

None of the peer-reviewed published work on biodynamics has tested what may be its most controversial aspects: the lunar and astrological methodology and use of esoterica like “geo-acupuncture.” One supposes even its sometime academic believers are aware that planetary or lunar alignments are irrelevant

conducted studies. They work to overwhelm any statistical anomalies that may randomly skew a study carried out over a smaller sample size. It is quite clear that such meta-analyses rule out any influence of lunar phases on living things, beyond the gross effects of ocean tides and somewhat brighter nights. Further (for this is an issue that tends to come up frequently), a number of long-term studies have failed to turn up any correlation between birth rates and lunar phase.²

2. Terrestrial homeopathy

Biodynamics makes use of dilutions of different prepared ingredients: silica, manure, ash, etc. These are introduced into water, often diluted into nonexistence, and then “dynamized” by stirring for long periods of time. The practice is based on the hoary old homeopathic notion that water has a memory of what has been put into it. Dynamization involves stirring the water-filled vessel so as to produce a vortex in the solution. In this way, it is supposed that the water molecules acquire some occult properties, and memory, of the infinitesimally present ingredient. This odd idea that water can have a memory, and that certain ingredients have quasi-magical hidden properties, is one of the bases of homeopathy. Needless to say, from the point of view of scientific chemistry, such theories have no basis in fact and are little more than the sort of alchemy thoroughly discredited ages ago.

Homeopathy was founded in a series of papers by Samuel Hahnemann in early 19th-century Germany as a proposed treatment for human disease. However, results of meta-analysis done on homeopathic treatments of human disease are conclusive, and they permit us to discount any effect of these methods beyond that of a mere placebo.³ Given that the practices are ineffective for humans, what real likelihood is there that they would be effective for plants?

3. Other alchemical preparations

In addition to the diluted and dynamized homeopathic preparations discussed above, biodynamics counsels the use of myriad other special preparations that are meant to be added to the soil or sprayed on plants. These involve the burial of a cow’s intestine filled with chamomile, of a sheep’s skull filled with oak bark, of a cow’s horn filled with manure (ideally on the autumnal equinox), and the burning of insect or weed pests into ash in order to “warn away” other insects or weeds. Such practices could perhaps best be described as “viticulural voodoo” (to put Matt Kramer’s famous phrase to other use).

To repeat, these preparations are not based on any sort of scientific research or careful trial and error. Instead, they stem from the singular meditations of Rudolf Steiner. For example, Horn Manure (or Preparation 500) originates directly from Steiner’s lecture number 4. But a search for any serious

justification for the practice comes up wanting. At the crucial point where he discusses the importance of the cow’s horn, we find passages such as the following:

*The cow has horns in order to send into itself the astral-ethereal formative powers, which, pressing inward, are meant to penetrate right into the digestive organism. [...] Thus in the horn you have something well adapted by its inherent nature, to ray back the living and astral properties into the inner life.*⁴

Needless to say, this sort of talk does not inspire confidence, and it is perhaps worth mentioning a certain irony in passing. The use of animal horns as manure was one of the materials outlawed by Duke Philip the Bold in 1395, when he famously attacked Gamay as a substitute for the more distinguished Pinot Noir.⁵

In any event, to the Demeter certification bodies, these and the homeopathic preparations are central to biodynamic practice: A farm can be labeled biodynamic simply by virtue of being organic and using the required preparations in sufficient quantity.⁶

4. Astrology

In his book *Wine from Sky to Earth* (1999), Nicolas Joly spends nearly a score of pages on astrological topics. Monty Waldin, in his thorough treatment of biodynamic viticulture, also lends support to such practices on a number of occasions. He even suggests tasting wines during different astrological periods, “to see if it tastes floral during a flower period, and more earthy during an earth moon.”⁷

Joly, Chapoutier, and other biodynamic winemakers also claim to make use of “astronomy,” so-called, rather than “astrology.”⁸ They distinguish the two by noting that astrology has not revised the positions of the constellations relative to the Earth and planets for two millennia, which means that the dates usually correlated with zodiacal signs are inaccurate by approximately a month. The true astral influences upon terrestrial phenomena respond, according to them, to the revised positions of the zodiacal constellations. This revision may be astronomically correct; however, the astrological effects they claim are hardly creditable to the practice of scientific astronomy, and there are no other proposed forces that could produce such effects. In any event, the revisions serve only to put lipstick on the theoretical pig. The issue for any honest theory of astrology is not simply one of digging out the right star-charts—those have been available for centuries. The issue, instead, must be one of overcoming the overwhelming weight of evidence, both theoretical and empirical, contradicting the supposed astrological effects. Problems with astrology are as deep, extensive, and long-standing as anywhere in pseudoscience.⁹

5. Cosmic energy and standing stones

According to some of the followers of biodynamics, there are esoteric rhythms, cosmic forces, and mysterious energy meridians that influence living things, even plants. Biodynamic methods of cultivation, the products they employ, the stones in the fields, and so on, work to channel this cosmic energy so that the vine and earth “vibrate in harmony with the universe,” as we are told. It’s quite an expressive image, but we need to know what cosmic energy we are talking about. Is it based on any reality that goes beyond poetic wordplay? There is no evidence that such esoteric forces exist; and those who defend them as real should be responsible for coming up with the evidence. Until such is forthcoming, we must assume that there exist no sorts of energy different from those already well studied in physics; hence, that careful placement of “standing stones” in locations “determined by a specialist with the aid of a pendulum” in order to practice a form of “geo-acupuncture” are simply agriculturally worthless.¹⁰

The results of research

A quick glance through the research literature provides a small stack of papers published on biodynamic farming. Indeed, Monty Waldin, Jamie Goode, and other contemporary supporters of biodynamics spend time discussing the research.¹¹ They seem satisfied that biodynamics has come out well in these studies. More care, however, needs to be taken to see precisely what it is that the research reveals.

To start with, what are we looking to measure? There is agreement that the aim is to achieve healthier soils, and thereby healthier plants. It is uncontroversial, for example, that organic farming practices provide greater soil biodiversity and fertility than do conventional farming practices. To repeat, farms certified biodynamic must at least be organic. Therefore, the Holy Grail for biodynamics supporters would be to establish that the additional biodynamic methods produced soils even healthier than those found in farms that were simply organic. But a thorough search through the cream of this research crop yields little. We can enumerate the problems.

First, there are studies that have not been published in peer-reviewed journals.¹² Any non-peer-reviewed study lacks credibility and should not be cited as scientifically defensible.

Second, there are studies that blithely contrast biodynamic agriculture with conventional. Repeating again, biodynamic agriculture is organic; hence, for that reason alone, we would expect it to do better than conventional. The issue is whether the biodynamic practices add anything. And this is a question not settled by these studies. Nevertheless, many studies, particularly those by John Reganold, are exhumed with some frequency, apparently to help establish the effectiveness of biodynamic practices.¹³ Of course, they do nothing of the sort.

Third, there are studies that exhibit poor experimental design. One of the most famous and cited papers is by a Swiss group, published in the journal *Science*. It deals with a 21-year study of biodynamic, organic, and conventional farms.¹⁴ This appears to be the sort of detailed, long-baseline work we are after. But buried in the supporting material, only available online, is the methodology behind the study. There we find that the biodynamic and organic farms began with composts prepared differently. Certain chemicals were added to the organic fields that were not

added to the biodynamic ones. And these were only the “main differences.” What were the others? We aren’t told.

In order to do a proper comparison of biodynamics and organic agriculture, all the background conditions, including such things as the state of the compost, would have to be identical in every controllable way except for the addition of the biodynamic “preparations.” Where they are not, no principled answer is possible as to the precise effects of the biodynamic methods at issue, since the results discovered in the experiment may simply be due to differences in the original composts or in the chemical additions to the organic plots.

Fourth, there are studies that tell us there are chemical differences between biodynamically and organically treated composts—but without any supporting argument for why the former is of any higher quality than the latter.¹⁵ Indeed, since biodynamically treated compost does contain the additional “preparations,” we should expect that it would be at least somewhat chemically different from its organic counterpart. But so what?

Fifth, there are studies that establish that the biodynamically treated composts have, in fact, no advantage over their organically treated counterparts.¹⁶ These experiments give the lie to any claim that biodynamically produced chemical changes in compost must be of some benefit. Indeed, the lead author of these studies, Lynne Carpenter-Boggs, apparently a believer in biodynamics herself, put it thus: “No differences were found between soils fertilized with biodynamic vs nonbiodynamic compost.” It could hardly be clearer.

Professor John Reganold is Carpenter-Boggs’s thesis adviser at Washington State University and arguably one of the leading researchers into biodynamics. He is also apparently a believer in the practice and a sometime biodynamics consultant to the California wine industry. But he himself has recently said that studies done on biodynamics “didn’t distinguish biodynamic from organic.”¹⁷

The year 2005 was important for viticulture. It saw publication from Reganold’s lab of the first peer-reviewed comparison of biodynamic and organic practices with wine grapes in particular. The results were conclusive. No differences were found in soil quality “for any of the physical, chemical, or biological parameters tested.” For the vines, “Analysis of leaves showed no differences [...] There were no differences in yield, cluster count, cluster weight, and berry weight.” Although, unsurprisingly, the team was able to discover some differences, “there is little evidence the biodynamic preparations contribute to grape quality. The differences observed were small and of doubtful practical significance.”¹⁸ One has a certain feeling that this is not the result they were looking for.

And sixth, none of the peer-reviewed published work we find on biodynamics has tested what may be its most controversial aspects: the lunar and astrological methodology and the use of esoterica such as “geo-acupuncture.” One supposes that this is so because even its sometime academic believers are aware that planetary or lunar alignments and the locations of “standing stones” are irrelevant to whatever function the “preparations” may have.

So a review of the supporting literature establishes that, insofar as it has been tested, biodynamics per se is simply ineffective at aiding soil—and, thereby, plant—health. Much of

what passes for research supporting the practice, at least in the popular press, is nothing of the sort; instead, it is either irrelevant to the issue or demonstrates poor experimental design.

A further caveat is in order. Much of the biodynamic literature, as with many sorts of proto- or pseudoscience, appears in obscure publications, where standards of evidence and the capability to do thorough peer review may be quite low or even nonexistent.¹⁹ Although we have attempted to focus on the cream of the research crop, it is always good to keep in mind the quality of the source publication. Going forward, one should also always be concerned with any controversial issue that is supported by only a small handful of studies, or studies all out of one laboratory or university. Any scientifically valid result will be repeatable, and ideally it should be repeated in different, unaffiliated laboratories before acceptance is warranted. Hard experience with such “discoveries” as cold fusion establishes the precedent.

What testimonials tell us

There are some who will claim there is evidence in favor of biodynamics in front of us already. Namely, there are testimonials of success from farms and wineries that employ such practices. We pick up the latest magazine articles and read of capable winemakers employing the practice with success. We hear of supposedly poor land made better, biodynamically, and we are led to suppose, perhaps, that we have all the evidence we need.

But there is a long road from anecdotal evidence and testimony to anything approaching conclusive proof. This is, after all, the same road down which myriad quack remedies went in the past several centuries. In the words of one FDA commissioner in 1941, “Our experience of more than 30 years in the enforcement of the Food and Drugs Act has demonstrated that testimonials may be obtained for practically any article labeled as a treatment for practically any disease.”²⁰ Why should this be? There are at least a couple of reasons relevant to our discussion of biodynamics.

First, living organisms are naturally good fighters of illness. Let us assume we are sick and given an ineffective cure, a red pill. In such a case we can expect most of the time that the body will guide us to health of its own accord. It is human nature to assume that the red pill was at least partly responsible. Similarly, biodynamic treatments may be heralded for “curing” or “bettering” plants that are simply bettering themselves naturally. Or, perhaps just as likely, the viticulturalist is comparing a conventionally farmed vineyard with a biodynamic alternative and is impressed by what he does not realize is simply the result of better soil biodiversity through organic farming.

Second, there is an element of randomness involved. Diseases fluctuate unpredictably; if a putative drug is taken when disease is most manifest, it is likely to be lauded for an improvement that is simply random in character. Similarly, if we take 20 plots of land and put ten under biodynamic treatment and ten under organic, we would expect, on average, for five of the biodynamic ones (50 percent) to appear marginally better than their counterparts simply by virtue of blind luck, even assuming biodynamics to be entirely ineffective. But for those five farmers, the “evidence” for the worth of biodynamic agriculture might well appear genuine enough to solicit testimonials on its behalf.

It is perhaps indisputable that many of the practitioners of viticultural biodynamics, like Alvaro Espinoza, Lalou

Bize-Leroy, and Stéphane Derenoncourt, are extremely talented winemakers in their own right. Their effectiveness as winemakers, however, goes nowhere toward proving the effectiveness of the biodynamic esoterica that they claim to practice so assiduously.

While it may appear child’s play to divine causal processes in the natural world, in fact more rigorous techniques are necessary. Anecdote and testimony are not always credible. Often what appears causal may be a mere phantom in the spectator’s mind. Teasing out these threads is hard work, often involving complex statistics and careful controls, designed to clarify the case, isolate the relevant variables, and make it repeatedly testable. So far, all credible evidence provided by those who have done such work on biodynamics points ineluctably to the conclusion that biodynamic esoterica are causally ineffective. As Carl Sagan once said, “Extraordinary claims require extraordinary evidence.” But the spokesmen of biodynamics have not provided us even *reasonable* evidence of their claims.

Concluding thoughts

What we see when looking over the biodynamic landscape is a vista of starry eyes and good intentions mixed with quasi-religious hocus-pocus, good salesmanship, and plain scientific illiteracy. It is true, biodynamic practice does not appear to involve anything that would be agriculturally harmful; and, indeed, it counsels methods of organic farming that are, in themselves, beneficial. It may give lackadaisical viticulturalists a kind of quasi-religious motivation or inspiration to spend more time at work, using treatments that amount to mulching and sparse irrigation. Taken as such, it might seem the practice is worth perhaps muted applause or a disinterested shrug. In fact, however, it is the esoteric, occult aspects that give biodynamics its originality and *raison d’être*. Get rid of the esoterica, and it is not clear that any point remains for the small industry of consultants, conferences, press articles, books, or fanciful homeopathic dilutions.

There are other questionable details of biodynamics that we will leave aside, such as its passion for the arcana of ancient Egypt and its naive insistence that there are four primary forces that control everything: earth, air, fire, and water. Much of this nonsense originates from the occultist Rudolf Steiner, the aforementioned founder of biodynamics. Steiner wrote with the pretensions of being an expert on art, medicine, economy, psychology, architecture, science, philosophy, religion, history, pedagogy, and, at the end of his life, agriculture as well. He was, however, a man who had no real interest in testing his agro-cosmic theories—or in holding them up to any clear standards of evidence.

It requires profound scientific blindness to follow practices such as astrology and homeopathy, dynamizations and esoteric fields of cosmic energy many years after such practices have been shown to be scientifically barren. Such darkness calls for exposure to the open light of day. If, as perhaps will be claimed, there remains any argument in favor of these occult theories, then we should expect to see evidence for them accumulated in a rigorous and repeatable fashion. Failing that, what truly appears new and different about biodynamic practice is only so much hot air. It should be allowed to rise naturally and dissipate on the vineyard breeze. ■

Acknowledgement

The authors would like to thank Dr Linda Chalker-Scott, associate professor and extension horticulturalist, Puyallup Research and Extension Center, Washington State University, for her gracious assistance.

Notes

- 1 Steiner, 2004, pp.46–47.
- 2 E.g., Rotton et al. 1985; Abell et al. 1979; Martens et al. 1998.
- 3 Barrett, 1987; Ernst, 2002; Shang et al. 2005.
- 4 Steiner, 2004, pp.72–73.
- 5 Hanson, 2004, p.37.
- 6 Waldin, 2004, p.73.
- 7 Waldin, 2004, p.78. See also pp.83, 103.
- 8 George, 2005, p.14.
- 9 E.g., Frazier, 1986, pp.219–28; Frazier, 1991, pp.279–323; Plait 2002, pp.212–20.
- 10 Chapoutier, 2005.
- 11 Waldin, 2004, pp.8–9; Goode, 2005.
- 12 E.g., Carpenter-Boggs, 1997, and the conference papers cited in Waldin 2004, p.9.
- 13 E.g., Waldin, 2004, p.9; Reganold et al. 1993; Reganold, 1995.
- 14 Mäder, et al. 2002.
- 15 Carpenter-Boggs et al. 2000a.
- 16 Carpenter-Boggs et al. 2000b; Carpenter-Boggs et al. 2000c.
- 17 Darlington, 2003.
- 18 Reeve et al. 2005, pp.371–74.
- 19 E.g., papers in Waldin 2004, p.9.
- 20 Young, 1992, p.4.

Bibliography

- George Abell, et al. “The Moon and the Maternity Ward,” *Skeptical Inquirer* 3:4 (1979), pp.17–25.
- Stephen Barrett MD, “Homeopathy: Is It Medicine?” *Skeptical Inquirer*, Fall 1987, pp.56–62.
- Lynne Carpenter-Boggs, “Effects of Biodynamic Preparations on Compost, Crop, and Soil Quality,” Washington State University, Crop and Soil Sciences, PhD dissertation, 1997.
- Lynne Carpenter-Boggs, JP Reganold, AC Kennedy, “Effects of biodynamic preparations on compost development,” *Biological Agriculture and Horticulture: An International Journal* 17:4 (2000), pp. 313–28. [Carpenter-Boggs et al. 2000a]
- Lynne Carpenter-Boggs, JP Reganold, AC Kennedy, “Biodynamic preparations: short-term effects on crops, soils, and weed populations,” *American Journal of Alternative Agriculture* 15:3 (2000), pp. 110–18. [Carpenter-Boggs et al. 2000b]
- Lynne Carpenter-Boggs, AC Kennedy, JP Reganold, “Organic and biodynamic management: effects on soil biology,” *Soil Science Society of America Journal* 64:5 (Sept/Oct 2000), pp. 1651–59. [Carpenter-Boggs et al., 2000c]
- Linda Chalker-Scott, “The Myth of Biodynamic Agriculture” (www.puyallup.wsu.edu/%7ELinda%20Chalker-Scott/Horticultural%20Myths_files/Myths/Biodynamic%20agriculture.pdf). September, 2004.
- Michel Chapoutier, “The Influence of Geo-acupuncture on Viticulture,” Chapoutier—Research and Development. (www.chapoutier.com/chapoutier/gb/r_d/geo_acupuncture.html). Accessed December 2005.

David Darlington, “Horns of Plenty,” *San Francisco Chronicle*, San Francisco, CA, September 25, 2003, p.D-1.

Edzard Ernst, “A Systematic Review of Systematic Reviews of Homeopathy,” *British Journal of Clinical Pharmacology* 54:6 (2002), pp.577–82.

Kendrick Frazier, editor, *Science Confronts the Paranormal* (Prometheus Books, Buffalo, NY; 1986).

—, editor, *The Hundredth Monkey and Other Paradigms of the Paranormal* (Prometheus Books, Buffalo, NY; 1991).

Stuart George, “Institute of Masters of Wine biodynamic seminar,” *The World of Fine Wine* 7 (2005), pp.13–14.

Jamie Goode, “Bringing together biodynamics and science,” www.wineanorak.com. Accessed December 2005.

Stephen Jay Gould, *Bully for Brontosaurus: Reflections in Natural History* (WW Norton, New York; 1991).

Anthony Hanson, *Burgundy* (Mitchell Beazley, London; 2004).

Nicolas Joly, *Wine from Sky to Earth* (Acres USA, Austin, Texas; 1999).

Paul Mäder, A Fliessbach, D Dubois, L Gunst, P Fried, U Niggli, “Soil Fertility and Biodiversity in Organic Farming,” *Science* 296 (2002), pp. 1694–97. Supporting online material at www.sciencemag.org/cgi/data/296/5573/1694/DC1/1

R Martens, I Kelly, and DH Saklofske, “Lunar phase and birth rate: a fifty-year critical review,” *Psychological Reports* 63 (1998), pp.923–34.

Philip Plait, *Bad Astronomy* (John Wiley & Sons, New York; 2002).

Jennifer Reeve, L Carpenter-Boggs, JP Reganold, AL York, G McGourty, L McCloskey, “Soil and Winegrape Quality in Biodynamically and Organically Managed Vineyards,” *American Journal of Enology and Viticulture*, 56:4 (2005), pp.367–76.

John Reganold, AS Palmer, JC Lockhart, AN Macgregor, “Soil quality and financial performance of biodynamic and conventional farms in New Zealand,” *Science* 260:5106 (1993), pp.344–49.

John Reganold, “Soil quality and farm profitability studies of biodynamic and conventional farming systems: a review,” In HF Cook and HC Lee, eds., *Soil Management in Sustainable Agriculture* (Wye College Press, Wye, UK; 1995), pp.1–11.

James Rotton and Ivan Kelly, “Much ado about the full moon: a meta-analysis of lunar-lunacy research,” *Psychological Bulletin* 97:2 (1985), pp.286–306.

Carl Sagan, *Broca’s Brain: Reflections on the Romance of Science*. (Random House, New York; 1979).

Aijing Shang et al. “Are the clinical effects of homeopathy placebo effects? Comparative study of placebo-controlled trials of homeopathy and allopathy,” *The Lancet* 366 (2005), pp.726–32.

Rudolf Steiner, translated by George Adams, *Agriculture Course: The Birth of the Biodynamic Method* (Rudolf Steiner Press, Forest Row, UK; 2004).

Maria Thun, *Gardening for Life—The Biodynamic Way: A Practical Introduction to a New Art of Gardening, Sowing, Planting, Harvesting* (Hawthorn Press, Stroud, UK; 2000).

Monty Waldin, *Biodynamic Wines* (Mitchell Beazley, London, UK; 2004).

James Harvey Young, *American Health Quackery* (Princeton University Press, Princeton, NJ; 1992).