

Organically Produced Foods: Nutritive Content

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Introduction

This bibliography focuses specifically on the nutritive value of organically produced foods: vitamin and mineral content, as well as related chemical constituents. With the exception of a handful of references to publications that deal with the general relationship of soil qualities and crop composition, each document cited contains at least some information about nutrients found in food as related to organic production. Most items deal with research results; several are overviews of literature or research, or are opinion pieces. Many compare organic foods with those conventionally produced.

Several non-English articles appear in this bibliography. The literature and research reflect the fact that important work pertaining to the nutritional qualities of organically/biologically grown crops is being conducted internationally. The language of an article, if not English, is noted in the citation.

There is a great deal of literature related to other aspects of organically produced foods. For instance, there are many documents pertaining to the appearance and sensory attributes of organic foods, to consumer reactions and perceptions, and to pesticide residue and food contamination issues. These subjects are not addressed here unless dealt with in relation to nutritive content. We hope to compile bibliographies on related topics in the near future. See "Publications" on our web site, <http://www.nal.usda.gov/afsic/>, for updates on this and other publications.

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The case for organics

Scientific studies and reports

Effect of Agricultural Methods on Nutritional Quality: A Comparison of Organic with Conventional Crops, Virginia Worthington MS, ScD, CNS, Johns Hopkins University, Baltimore, 1998, *Alternative Therapies*, Volume 4, 1998, pages 58-69 -- Virginia Worthington reviewed available research comparing the nutritional value of organically grown and conventionally grown produce. She concluded that organic produce is nutritionally superior. She compared the composition of vegetables grown simultaneously under different farming conditions, conducting 41 studies with 1,240 comparisons of 35 vitamins and minerals. Organically grown produce was higher in most minerals and vitamins and lower in potentially harmful nitrates, which result from nitrogen fertilizers. The greatest differences among all vegetables tested were in magnesium (organic was 29% higher), vitamin C (27% higher), and iron (21% higher). In fact, organic food had higher amounts of all minerals tested, although the difference was not always statistically significant because of small sample numbers. Organic crops had 15% fewer nitrates than conventionally grown foods and lesser amounts of toxic heavy metals. Worthington also investigated the effect of routine consumption of organically grown fruits and vegetables on the nutritional adequacy of the overall diet. Using the USDA recommendation of five servings of fruits and vegetables a day, she determined that consuming organically grown produce might make the difference between a deficient and an adequate diet. See **Is Organically Grown Food More Nutritious?** Virginia Worthington, 1998 -- condensed version of "Effect of Agricultural Methods on Nutritional Quality: A Comparison of Organic with Conventional Crops":
<http://www.mindfully.org/Food/Organic-More-Nutritious-WorthingtonNov01.htm>

Nutrition and Biodynamics: Evidence for the Nutritional Superiority of Organic Crops, Virginia Worthington MS, ScD, CNS, Johns Hopkins University, Baltimore, July/August, 1999, *Biodynamics* v.224
<http://www.mindfully.org/Food/Organic-Crops-Superior-WorthingtonJul99.htm>

Nutritional Quality of Organic Versus Conventional Fruits, Vegetables, and Grains, Virginia Worthington, M.S., Sc.D., C.N.S., 2001, *Journal of Alternative and Complementary Medicine* Volume 7, Number 2, pp. 161–173. Abstract:
<http://haly.ingentaselect.com/vl=1370482/cl=23/nw=1/rpsv/catchword/mal/10755535/v7n2/s7/p161>
[Full report](#) (Acrobat file, 176 kb)

Pesticide residues in conventional, IPM-grown and organic foods: Insights from three U.S. data sets, by Brian P. Baker, Charles M. Benbrook, Edward Groth III, and Karen Lutz Benbrook, May 2002, *Food Additives and Contaminants*, Volume 19, No. 5, pages 427-446 -- Consumers who buy organic fruits and vegetables are exposed to just one-third as many residues as they'd eat in conventionally-grown foods, and the residues are usually lower as well, according to a new scientific study -- the first detailed analysis of pesticide residue data in foods grown organically and conventionally. The authors analyzed test data on pesticide residues in organic and non-organic foods from three independent sources covering more than 94,000 food samples from more than 20 different crops; 1,291 of those samples were organically grown. USDA data showed that 73% of conventionally grown foods had at least one pesticide residue, while only 23% of organically grown samples of the same crops had any

residues. Conventionally-grown crops were six times as likely as organic to contain multiple pesticide residues. California data found residues in 31% of conventionally grown foods and only 6.5% of organic samples, and found multiple residues nine times as often in conventional samples. Consumers Union tests found residues in 79% of conventionally grown samples and 27% of organically grown samples, with multiple residues 10 times as common in the former. The levels of residues found in organic samples were also consistently lower than levels of the same pesticides found in conventional samples, in all three sets of data. When residues of persistent, long-banned organochlorine insecticides such as DDT were excluded from the analysis of the USDA data, the fraction of organic samples with residues dropped from 23 to 13%. Most residues in organic foods are unavoidable results of environmental contamination by past pesticide use or by spray "drift" from adjacent non-organic farms. See [Summary "Study Finds Far Less Pesticide Residue on Organic Produce"](#), New York Times, May 8, 2002:

<http://www.nytimes.com/2002/05/08/science/08PEST.html?ex=1065240000&en=70dacc40e18ace2b&ei=5070>

Why Food Safety Will Continue Driving Growth in Demand for Organic Food, Charles M. Benbrook -- Remarks prepared for the 2003 EcoFarm Conference, Monterey, California, on January 24, 2003. Message from Dr Benbrook to the Sustainable Agriculture Network Discussion Group, 27 Jan 2003: "I presented a paper last week at the EcoFarm conference at Asilomar. It was on pesticide residues in organic vs. conventional food. It includes new data from 1999-2000 Calif. DPR testing [U.S. Department of Pesticide Regulation], as well as 2001-2002 British testing (they found the same basic pattern of residues as U.S. testing programs). It argues that on the food safety-pesticide front, the scientific case is now rock solid that consuming organic food is a reliable way to markedly reduce pesticide dietary exposures, and hence risk; and second, that recent toxicological and epidemiological studies strongly support the conclusion that for pregnant women, infants, and children, current levels of exposure in the diet cannot be defended as safe. This is the basic conclusion reached by the [U.S.] EPA in its cumulative risk assessment of the OPs [organophosphorus pesticides], and why further regulatory actions on high-risk OPs are needed." [Full report](#) (Acrobat file, 220 kb)

Organic Diets Linked to Lower Pesticide Levels in Children, 7 March 2003: Organic food reduces pesticide residues in children A study of two to five-year olds in the US has found that consumption of organic food can have a significant effect on children's pesticide exposure. Scientists at the University of Washington investigated 43 children from the Seattle area who either ate mostly conventionally grown or organic fresh fruit and vegetables and fruit juices. The children eating primarily organic diets had only one-sixth the level of organophosphorus pesticide metabolite concentrations compared with those eating conventional diets. Other possible sources of pesticides were found not to have an impact on the study's results. Dosage estimates showed that consuming organic produce reduced the children's exposure levels from above to below the U.S. Environmental Protection Agency's safety levels, shifting their exposures from "uncertain risk" to "negligible risk". Other studies back up the researchers' claims. A 2001 study found that of 110 urban and suburban children, all but one of the children had measurable levels of organophosphorus pesticide metabolites in their urine. The one exception was a child who ate only organic food.

<http://www.edie.net/news/Archive/6735.cfm>

Organophosphorus Pesticide Exposure of Urban and Suburban Preschool Children with Organic and Conventional Diets, Cynthia L. Curl, Richard A. Fenske, Kai Elgethun,

Environmental Health Perspectives v.111, n.3, March 2003 -- Abstract:

<http://ehpnet1.niehs.nih.gov/docs/2003/5754/abstract.pdf>

Full report:

<http://www.mindfully.org/Pesticide/2003/Children-Organic-Conventional-Mar03.htm>

(EPA and USDA reports show that by the time the average child is one year old, the infant will have received the acceptable lifetime dose of eight pesticides from just 20 commonly eaten foods. The Environmental Working Group (non profit research institute) reports that children may receive 35% of their lifetime dose of carcinogenic pesticides by the age of 5. A USDA study (April 94) tested 6,000 produce items (12 kinds of produce) and pesticide residues (49 different pesticides) were found on 61% of the samples. All items were prepared for human consumption (washed, peeled or cored) before being tested.)

Food Safety and Quality as affected by Organic Farming, Food and Agriculture Organisation (FAO), Report of the 22nd regional Conference for Europe, Portugal, 24 to 28 July 2000: "With respect to chemicals, organic agriculture differs from conventional agriculture as it refrains from using synthetic agricultural inputs, such as synthetic pesticides, herbicides, fertilisers, fungicides, veterinary drugs (e.g. antibiotics, growth hormones), synthetic preservatives and additives, and irradiation. Thus, potential hazards posed by synthetic input residues are prevented, to the extent possible. This underlies consumer expectations that organic foods are healthier. It has been demonstrated that organically produced foods have lower levels of pesticide and veterinary drug residues and, in many cases, lower nitrate contents. Animal feeding practices followed in organic livestock production, also lead to a reduction in contamination of food products of animal origin."

<http://www.fao.org/docrep/meeting/X4983e.htm>

Studies comparing the health effects of organic and non-organic feed on animals have found clear positive health effects of organic feed:

- Experiment 1: reduced sperm motility in bulls transferred from organically to non-organically grown fodder. Motility was restored when organic fodder was resumed. Experiment 2: greater number of eggs (nine versus three and six) and higher fertilisation rate (100 per cent versus 29 and 26 per cent) in rabbits fed organically versus non-organically fertilised feed. (Aehnelt & Hahn, 1978). Aehnelt E and Hahn J, 1978, 'Animal fertility: a possibility for biological quality assay of fodder and feeds', *Biodynamics* 25, p 36–47
- Almost all fertility and growth criteria tested, including total number of perinatal young, number of living perinatal young, live weight at birth, and number and weight of young at day 90, showed significantly better results for the organically fed rabbits than the non-organically fed rabbits. Edelmüller I, 1984, 'Untersuchungen zur Qualitätserfassung von Produkten aus unterschiedlichen Anbausystemen (biologisch-dynamisch bzw. konventionell) mittels Fütterungsversuchen an Kaninchen', dissertation, University of Vienna, Austria
- The use of organically grown feeds led to higher pregnancy rates, more embryos, larger litters and better health of rabbits over three generations, in spite of the fact that the feed pellets for the two groups were shown to be identical in terms of known essential and harmful ingredients. The fertility rate of rabbits declined over three generations in rabbits fed non-organically grown feed. Staiger D, 1988, 'The nutritional

value of foods from conventional and biodynamic agriculture', IFOAM Bulletin No. 4, p 9–12

- Better weight gain after coccidial illness and fewer incidents of illness in chickens fed organically grown feed; significantly higher egg weight, yolk weight and body weight at 32 weeks in organically fed chickens compared with birds fed chemically fertilised feed. Plochberger K, 1989, 'Feeding experiments. A criterion for quality estimation of biologically and conventionally produced foods', Agriculture, Ecosystems and Environment 27, p 419–428
- Fewer stillbirths and perinatal deaths in first litters in rats fed organically grown feed versus non-organically grown feed over a period of three generations. The rats fed organic food had a greater capacity to compensate weight loss during and after lactation and gained more weight. Velimirov A, Plochberger K, Huspeka U and Schott W, 1992, 'The influence of biologically and conventionally cultivated food on the fertility of rats', Biol Agric Hort 6, p 325–337

"In Pfeiffer's experiments the number of mortalities among 80 mice fed organic grains was about half of that among 80 mice fed mineral-fertilized grain (about 9% vs. 17%). Both groups preferred the organically grown wheat (90% of the time). Chickens on organic grain began laying earlier, and at faster rates. They laid twice as many fertile eggs, and the eggs kept better." (Pfeiffer, E.E. Soil Fertility: Renewal, and Preservation. New York: Trans. F. Heckel. Anthroposophic Press, 1938.) -- From **Nutritional Characteristics of Organic, Freshly Stone-ground, Sourdough & Conventional Breads**, Judy Campbell, B.Sc., Mechtild Hauser, and Stuart Hill, B.Sc., Ph.D., P.Ag., Ecological Agriculture Projects, McGill University (Macdonald Campus), Canada, EAP Publication - 35
http://eap.mcgill.ca/Publications/eap_foot.htm

Long-Term Field Experiment in Sweden: Effects of Organic and Inorganic Fertilizers on Soil Fertility and Crop Quality, Artur Granstedt and Lars Kjellenberg, Proceedings of an International Conference in Boston, Tufts University, Agricultural Production and Nutrition, Massachusetts March 19-21, 1997. An agricultural field experiment began in Järna, Sweden, in 1958 that lasted until 1990 -- 32 years. It included eight different fertilizer treatments, each with a four-year crop rotation without repetitions: summer wheat, clover/grass mix, potatoes, beets. The focus was primarily on aspects of crop quality, and the fertilizer application rates for the various treatments were adjusted to bring about comparable yields. Two "daughter experiments" were run in parallel during 1971-1976 and 1971-1979. The experiments compared two systems, biodynamic farming and conventional farming. Compared with the conventional treatments, the crude protein content of potatoes and wheat was lower in the organic treatments, but protein quality was higher (i.e. relatively pure protein and essential amino acids, lower amount of free amino acids). Resistance to decomposition and store quality for potatoes were higher in the organic treatments, and in wheat starch quality seemed to be higher. The organic treatments resulted in a higher soil fertility capacity and in crops with higher quality protein, a higher starch content, and a greater ability to tolerate stressful conditions and long-term storage than the inorganic treatments. The organic crops developed a structure that, studied through a picture formation method (Crystallization with CuCl₂), shows a higher organizational level which is evident in terms of both soil and crop formation as a result of the long-term effects of organic manure compared with conventional NPK-fertilizer.
<http://www.jdb.se/sbfi/publ/boston/boston7.html>

Organically grown foods higher in cancer-fighting chemicals than conventionally grown

foods, American Chemical Society, 4 March 2003 -- Fruits and vegetables grown organically show significantly higher levels of cancer-fighting antioxidants than conventionally grown foods, a new study suggests. The research found that pesticides and herbicides actually thwart the production of phenolics -- chemicals that act as a plant's natural defense and also happen to be good for our health. The study by UC Davis researchers measured antioxidants found in corn, strawberries and a type of blackberry called a marionberry. The results showed a significant increase in antioxidants in organic and sustainably grown foods versus conventionally grown foods: corn was 58.5% higher, marionberries were about 50% higher, strawberries about 19% higher.

<http://www.sciencedaily.com/releases/2003/03/030304073059.htm>

Full study: **Comparison of the Total Phenolic and Ascorbic Acid Content of Freeze-Dried and Air-Dried Marionberry, Strawberry, and Corn Grown Using Conventional, Organic, and Sustainable Agricultural Practices**, Danny K. Asami, Yun-Jeong Hong, Diane M. Barrett, and Alyson E. Mitchell, Department of Food Science and Technology, University of California-Davis, March 3, 2003, Journal of Agricultural and Food Chemistry 51 (5), 1237 -1241.

<http://pubs.acs.org/cgi-bin/sample.cgi/jafcau/2003/51/i05/html/jf020635c.html>

Acrobat file (60kb)

<http://pubs.acs.org/journals/jafcau/sample.cgi/jafcau/2003/51/i05/pdf/jf020635c.pdf>

Fruits of Success: Organic food is not just tastier and better for the environment, it also makes better business sense, New Scientist, 18 April 2001 -- The first comprehensive study of apple-growing systems provides evidence that there are financial as well as environmental rewards for apple growers who go organic. The study compared the economic and environmental sustainability of conventional, organic and integrated apple production systems in Washington State from 1994 to 1999, analyzing differences in yields, costs, taste, soil quality, energy use and environmental impacts. Headed by soil scientist John Reganold, the research project planted Golden Delicious apples on four acres loaned by a 50-acre commercial farm in the state's Yakima Valley apple district. Each growing system was tested in four different plots, laid out in a random fashion. The three systems gave similar apple yields. The organic and integrated systems had higher soil quality and potentially lower negative environmental impact than the conventional system. The organic orchard was more energy efficient than the conventional and integrated systems, requiring less labour and less water per apple produced. The organic system produced sweeter and less tart apples, higher profitability and greater energy efficiency. The organic system ranked first in environmental and economic sustainability, the integrated system, using a combination of organic and conventional techniques, ranked second and the conventional system last.

<http://www.newscientist.com/news/news.jsp?id=ns9999642>

Comment by **Pesticide Action Network North America (PANNA)**:

http://www.panna.org/panna/resources/panups/panup_20010810.dv.html

Sustainability of three apple production systems, John P. Reganold, Jerry D. Glover, Preston K. Andrews & Herbert R. Hinman, 19 April 2001, Nature 410, 926 - 930 -- Abstract:

http://www.nature.com/cgi-taf/DynaPage.taf?file=/nature/journal/v410/n6831/abs/410926a0_r.html

Organic Food and Farming: Myth and Reality, Soil Association and Sustain, 2001 -- Counters the myths spread by the opponents of organic food and farming. Endorsed by 36 public interest groups ranging from the National Federation of Women's Institutes to WWF-UK. Myth 1: Myth Organic foods are no healthier than non-organic foods. Reality Wrong: food

produced organically contains fewer contaminants. Some scientific studies have shown that there are more nutrients in organically produced food. Useful summary of research findings, with references. (Acrobat PDF, 32 pages, 154k)

[http://www.soilassociation.org/web/sa/saweb.nsf/24ffc96e2350a4e680256ab10047def0/0f72781fb39de61880256ae4005dea9b/\\$FILE/Myth&Reality.pdf](http://www.soilassociation.org/web/sa/saweb.nsf/24ffc96e2350a4e680256ab10047def0/0f72781fb39de61880256ae4005dea9b/$FILE/Myth&Reality.pdf)

Organic Foods vs Supermarket Foods: Element Levels, by Bob L. Smith, 1993, Journal of Applied Nutrition, Vol 45-1 -- Over a two-year period, organically and conventionally grown apples, potatoes, pears, wheat, and sweet corn were purchased in the western suburbs of Chicago and analyzed for mineral content. Four to 15 samples were taken for each food group. On a per-weight basis, average levels of essential minerals were much higher in the organically grown than in the conventionally grown food. The organically grown food averaged 63% higher in calcium, 78% higher in chromium, 73% higher in iron, 118% higher in magnesium, 178% higher in molybdenum, 91% higher in phosphorus, 125% higher in potassium and 60% higher in zinc. The organically raised food averaged 29% lower in mercury than the conventionally raised food. See [Full report](#)

Effect Of Diets Based On Foods From Conventional Versus Organic Production On Intake And Excretion Of Flavonoids And Markers Of Antioxidative Defense In Humans, Lisbeth Grønder-Pedersen, Salka E. Rasmussen, Susanne Bügel, Lars V. Jørgensen, Lars O. Dragsted, Vagn Gundersen, and Brittmarie Sandström, August 2003, Journal of Agricultural and Food Chemistry, 51 (19), 5671 -5676 -- Danish scientists have substantiated a nutritional difference between organic and conventional vegetables. They found that organically grown vegetables have a higher concentration of flavonoids -- natural antioxidants. The study was a double-blinded randomised, human crossover intervention study with strict control of dietary intake. Test-persons were given organic food and conventional food in turn for periods of 3 weeks. During the test-periods blood and urine samples were collected and tested for the intake and excretion of five selected flavonoids and effect on markers of oxidative defense. The study was conducted by The Institute of Food Safety and Nutrition under The Danish Veterinary and Food Administration; The Department of Human Nutrition and Centre for Advanced Food Studies under The Royal Veterinary and Agricultural University; and Risø National Laboratory. See [Full report](#) (Acrobat file, 68 kb)

Organically Produced Foods: Nutritive Content, Mary V. Gold, Alternative Farming Systems Information Center, National Agricultural Library, Agricultural Research Service, U.S. Department of Agriculture, June 2000 -- Bibliography on the nutritive value of organically produced foods: vitamin and mineral content, as well as related chemical constituents. A few references deal with the general relationship of soil qualities and crop composition, all documents cited contain information about nutrients found in food as related to organic production. Most are research results, some are overviews of literature or research, many compare organic foods with those conventionally produced. 216 documents cited. Special Reference Briefs Series no. SRB 2000-03
http://www.nal.usda.gov/afsic/AFSIC_pubs/srb0003.htm

Research by the **Organic Advisory Service of the Organic Retailers & Growers Association of Australia** (ORGAA) compared nutrient content of organic and conventionally grown vegetables. Four vegetable varieties, tomatoes, beans, capsicums and silver beet, were grown on a certified organic farm using compost and soil regenerative techniques and were

later analysed for vitamin and mineral elements. A similar range of vegetables grown conventionally was sampled and analysed from a supermarket. Results showed significant differences in mineral levels in favour of the organic produce. Calcium levels in some produce increased by eight times, potassium by ten times, magnesium by seven times and zinc by five times. See **"Food with Attitude"**, *Permaculture International Journal* (March-May 2000, No. 74, ISSN 1037-8480), p.27.

	Beans	Tomatoes	Capsicum	Silver Beet
Calcium S	40	6.7	4.7	6
Calcium O	480	67	84	1600
Potassium S	260	200	150	450
Potassium O	1900	300	1600	2600
Magnesium S	26	10	11	69
Magnesium O	240	89	700	1700
Sodium S	<1	2.4	<1	180
Sodium O	<10	26	20	1800
Iron S	0.6	<0.5	<0.5	1.4
Iron O	<5	<5	<5	9.4
Zinc S	0.38	0.19	0.13	0.57
Zinc O	3.4	1.2	2.5	130

S-supermarket produce, O-organic/revitalized soil, mg/kg
 Australian Government Analytical Laboratory

"Organic Farming, Food Quality and Human Health", the Soil Association, Bristol, UK. Key findings: "The evidence from properly conducted scientific studies shows that on average organic food is better for you than non-organic food: It's more nutritious. On average our research found higher vitamin C, higher mineral levels and higher phytonutrients -- plant compounds which can be effective against cancer. There's also less water in organic vegetables so pound for pound you get more carrot for your carrot. Tests with people and animals eating organic show it makes a real difference to health. Alternative cancer therapies have achieved good results relying on the exclusive consumption of organic food. Animal feeding trials have shown better reproductive health, better growth, better recovery from illness."

<http://www.soilassociation.org/sa/saweb.nsf/9f788a2d1160a9e580256a71002a3d2b/de88ae6e5aa94aed80256abd00378489>

Executive Summary:

<http://www.soilassociation.org/web/sa/saweb.nsf/848d689047cb466780256a6b00298980/80256ad80055454980256a9d004983d4!OpenDocument>

Key findings:

<http://www.soilassociation.org.uk/web/sa/saweb.nsf/848d689047cb466780256a6b00298980/80256ad80055454980256a9d005707d8!OpenDocument>

Organic food might reduce heart attacks, New Scientist, 14 March 2002 -- Salicylic acid is a chemical signal in plants infected by pathogens and it is responsible for the anti-inflammatory

action of aspirin. People who take aspirin have a reduced risk of developing hardening of the arteries and bowel cancer. Dietary salicylic acid may help to prevent these conditions. The study determined the contents of salicylic acid in organic and non-organic vegetable soups purchased from supermarkets. The organic soups had a significantly higher content of salicylic acid, suggesting that the vegetables and plants used to prepare them contained greater amounts of the phenolic acid than the corresponding non-organic ingredients. Consumption of organic foods may result in a greater intake of salicylic acid.

<http://www.newscientist.com/news/news.jsp?id=ns99992033>

Salicylic acid in soups prepared from organically and non-organically grown vegetables,

Baxter GJ, Graham AB, Lawrence JR, Wiles D, Paterson JR, Area Biochemistry Department, Dumfries and Galloway Royal Infirmary, Scotland, Dec 2001, *European Journal of Nutrition* 40(6):289-92 -- Abstract:

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11876493&dopt=Abstract)

[Retrieve&db=PubMed&list_uids=11876493&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11876493&dopt=Abstract)

Research Shows More Vitamin C In Organic Oranges Than Conventional Oranges,

American Chemical Society, June 2, 2002 -- Organically-grown oranges contain up to 30% more vitamin C than those grown conventionally, according to research by Professor Theo Clark of Truman State University. Conventional oranges are larger than organically-grown oranges, and they have a deeper orange color. Because of their size, "we were expecting twice as much vitamin C in the conventional oranges," said Clark. But to his surprise, chemical isolation combined with nuclear magnetic resonance (NMR) spectroscopy revealed that the organically-grown oranges contained 30% more vitamin C than the conventionally-grown fruits -- even though they were only about half the size.

<http://www.sciencedaily.com/releases/2002/06/020603071017.htm>

The Haughley Experiment was started on Lady Eve Balfour's farm in England in 1939 and continued for 33 years, comparing two similar sections under crops and livestock, one under organic management with no imports (a closed system), and the other the same plus chemical fertilizers and pesticides, with ongoing sample analyses of soil, crops and livestock products, totalling thousands of individual analyses. The experiment had many significant results. The many different chemical analyses revealed no consistent or significant differences between the sections, other than the usually higher water content of the chemically grown fodder. Yet the findings confirmed many reports from organic farmers in different parts of the world, that a given output of animal products -- milk, meat, eggs, etc -- required from 12-15% less input of food when the food was grown organically. For example, though the organic herbal leys (pastures) were of clearly sparser growth than the much lushier chemical section leys, the cows on the organic section gave, over a 20-year period, around 15% more milk. The organic cows also lived longer, and the organic section had far less pest and disease problems. -- See **"Towards a Sustainable Agriculture -- The Living Soil"**, by Lady Eve Balfour, address to IFOAM (International Federation of Organic Agriculture Movements) conference in Switzerland, 1977. [Full report](#)

-- See also **"The Living Soil"** by Lady Eve B. Balfour, Faber & Faber, London, 1943. Full text online at the Soil and Health Library:

<http://www.soilandhealth.org/>

Organic Crops Competitive with Conventional Systems, May 1999 -- Farm profits from organic cropping systems can equal or exceed profits from conventional rotations in the Midwestern United States, according to a study by the Henry A. Wallace Institute for Alternative

Agriculture. The report reviews past and current research on conditions that make growing organic crops profitable, as well as studies that compare organic grain and soybean production with conventional production. The Economics of Organic Grain and Soybean Production in the Midwestern United States, Rick Welsh, policy analyst, Henry A. Wallace Institute for Alternative Agriculture -- full report (Acrobat file, 301Kb):

<http://www.winrock.org/wallacecenter/documents/pspr13.pdf>

Soil Fertility and Biodiversity in Organic Farming, Paul Mäder, Andreas Fliebach, David Dubois, Lucie Gunst, Padruot Fried, Urs Niggli, Research Institute of Organic Agriculture and the Swiss Federal Research Station for Agroecology and Agriculture, May 31, 2002, *Science* 296:1694-1697 -- A 21-year Swiss study of organic and conventional farming systems provides evidence that large-scale organic farming is economically viable and environmentally sustainable over the long haul. The trial demonstrates that organic crop production is amazingly efficient -- organic farming produced more food with less energy and fewer resources. Although expenditure on fertilizers and energy was 50% lower and pesticide use was 97% lower, yields of organic crops were only 20% lower on average. Published in *Science*, May 31, 2002, the study reported that organic farming methods used 50% less energy, 97% less pesticide and 51% less fertilizer than conventional methods. The study, co-sponsored by the Swiss government, began in 1978. The researchers used 96 small plots on a site near Basel, Switzerland, growing potatoes, barley, winter wheat, beets and grass clover. Full report: <http://www.mindfully.org/Farm/Organic-Farming-Fertility-Biodiversity31may02.htm>

Soil minerals, chemicals and food

Alex Jack, a health writer in Massachusetts, and Anne-Marie Mayer, a nutrition researcher in Britain (now at Cornell), separately compared government reports on the levels of vitamins and minerals in fresh food in the 1990s and from several decades ago. Both revealed significant declines in calcium and iron in a variety of raw fruits and vegetables. Each comparison also noted declines in other nutrients, including vitamins A and C, and potassium.

Alex Jack reported on his comparison of US Department of Agriculture food composition tables from 1975 and 1997 that average calcium levels in 12 fresh vegetables have declined 27%, iron levels have dropped 37%, vitamin A levels, 21%; and vitamin C levels, 30%. "This suggests a steady deterioration in soil, air, and water quality, as well as reduced seed vitality, that is depleting minerals," he said.

Jack took his findings to the US Department of Agriculture (USDA), hoping for a reasonable explanation. After two years, he's still waiting. So is *Organic Gardening* magazine, which published an open letter, seeking an explanation from Dan Glickman, then-Secretary of Agriculture. Glickman didn't respond, but USDA employee Phyllis E. Johnson did. In her letter to *Organic Gardening*, Ms. Johnson said that the nutritional content of produce is not as important as things like appearance and big yield. -- "**Vegetables Without Vitamins**", LE Magazine, March 2001

http://www.lef.org/magazine/mag2001/mar2001_report_vegetables.html

A similar analysis comparing British nutrient data from 1930 and 1980 indicates reductions of essential minerals in both fruits and vegetables. According to the report, published in the *British Food Journal* (1997, vol 99, no. 6, pp 207-211), average calcium content has declined 19%;

iron, 22%; and potassium, 14% in the 20 vegetables compared. Author Anne-Marie Mayer said: "Agriculture which relies on NPK (chemical) fertilizers and pesticides, that adds little organic matter to the soil and that alternates between soil compaction and ploughing, could produce food depleted in minerals."

The 1999 report on the University of Wisconsin-Madison's ongoing 37-year project monitoring the effects of nitrogen fertilisers in the US concluded that agriculture's continuing overapplication of nitrogen fertilizers is causing irreparable damage to the soil. It said US farms have "a 50% applied nitrogen efficiency rate" -- only half the nitrogen applied to the soil is actually used by the crop. The other half becomes harmful nitric acid. They said three decades of such overuse of nitrogen has destroyed much of the soil's fertility, causing it to age the equivalent of 5,000 years. -- **"Acidification From Fertilizer Use Linked To Soil Aging"**: http://www.cals.wisc.edu/media/news/03_99/acid_soil.html

Paul Bergner, in **"The Healing Power of Minerals, Special Nutrients and Trace Elements"** (Prima Publishing, 1997), lists official figures from the US Department of Agriculture showing a fall in the mineral and vitamin contents of fruits and vegetables between 1914 and 1992. From 1963 to 1992, with the use of chemical fertilizers at a peak, calcium levels fell an average 30%, iron 32%, magnesium 21%, phosphorus 11%, potassium 6.5%.

World Scientists' Statement

Calling for a Moratorium on GM Crops and Ban on Patents

We the undersigned scientists call upon our Governments to:

- Impose an immediate moratorium on further environmental releases of transgenic crops, food and animal-feed products for at least 5 years.
- Ban patents on living organisms, cell lines and genes.
- Support a comprehensive, independent public enquiry into the future of agriculture and food security for all, taking account of the full range of scientific findings as well as socioeconomic and ethical implications.

1. We are extremely concerned over the continued release and commercialization of transgenic crops, food and animal-feed products in the face of growing scientific evidence of hazards to biodiversity, food safety, human and animal health, while neither the need nor the benefits of genetic engineering agriculture are yet proven.

1.1 New scientific evidence have convinced us of the need for an immediate moratorium on releases.

1.1.1. Herbicide resistant transgenes have spread to wild relatives by cross-pollination in both oilseed rape and sugar beet,¹ creating many species of potential superweeds. One study shows that transgenes may be up to 30 times more likely to escape than the plant's own genes²

1.1.2. Bt-toxins engineered into a wide range of transgenic plants already released into the environment may build up in the soil and have devastating impacts on pollinators and other beneficial insects³

1.1.3. Serious doubts over the safety of transgenic foods are raised by new revelations on the results of animal feeding experiments. Potatoes engineered with snowdrop lectin fed to rats caused highly significant reduction in weight of many organs, impairment of immunological responsiveness and signs suggestive of viral infection.⁴

1.1.4. Research from the Netherlands show that antibiotic resistant marker genes from genetically engineered bacteria can be transferred horizontally to indigenous bacteria at a substantial frequency of 10^{-7} in an artificial gut⁵

1.1.5. Researchers in the US found widespread horizontal transfer of a yeast genetic parasite to the mitochondrial genome of higher plants⁶, raising serious concerns over the uncontrollable horizontal spread of transgenes and marker genes from transgenic plants released into the environment.

2. The patenting of living organisms, cell lines and genes under the Trade Related Intellectual Property Rights agreement are sanctioning acts of piracy of intellectual and genetic resources from Third World nations⁷, and at the same time, increasing corporate monopoly on food production and distribution. Small farmers all over the world are being marginalized, threatening long term food security for all⁸.

3. The Governments of industrialized nations, by voting for patents on organisms, cell lines and genes, including human genes, are in danger of allowing corporations unrestricted exploitation of their citizens and natural resources through the treaties being negotiated in the WTO and other fora. Environmental standards, food safety standards and even basic human rights will be sacrificed to corporate financial imperatives⁹.

4. Governmental advisory committees lack sufficient representation from independent scientists not linked to the industry. The result is that an untried, inadequately researched technology has been rushed prematurely to the market, while existing scientific evidence of hazards are being downplayed, ignored, and even suppressed¹⁰, and little independent research on risks are being carried out.

5. The technology is driven by an outmoded, genetic determinist science that supposes organisms are determined simply by constant, unchanging genes that can be arbitrarily manipulated to serve our needs; whereas scientific findings accumulated over the past twenty years have invalidated every assumption of genetic determinism¹¹. The new genetics is compelling us to an ecological, holistic perspective, especially where genes are concerned. The genes are not constant and unchanging, but fluid and dynamic, responding to the physiology of the organism and the external environment, *and require a stable, balanced ecology to maintain stability.*

Endnotes:

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2. Bergelson, J., Purrington, c.B. and Wichmann, G. (1998). Promiscuity in transgenic plants. *Nature* 395, 25.
3. Crecchio, C. and Stotzky, G. (1998). Insecticidal activity and biodegradation of the toxin from *B. acillus thuringiensis* subsp. *kurstaki* bound to humic, acids from soil, "*Soil Biology and Biochemistry* 30", 463-70, and references therein.
4. Leake, C. and Fraser, L. (1999). Scientist in Frankenstein food alert is proved right. UK Mail on Sunday, 31 Jan.; Goodwin, B.C. (1999). Report on SOAEFD Flexible Fund Project RO818, Jan. 23, 1999.
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6. Cho, Y., Qui, Y.L., Kuhlman, P. and Palmer, J.D. (1998). Explosive invasion of plant mitochondria by a group I intron. *Proc. Natl Acad. Sci. USA* 95, 14244-9.
7. See Shiva, V. (1998). *Biopiracy: The Plunder of Nature and Knowledge*, Green Books, London; also Latin American Declaration on Transgenic Organisms, Quito, 22 Jan. 1999.
8. The Corner House (1998), *Food? Health? Hope? Genetic Engineering and World Hunger*, Briefing 10.
9. See Mander, J. and Goldsmith, E. eds. (1996). *The Case against the Global Economy and for a Turn toward the Local*, Sierra Club Books, San Francisco.
10. See note 4.
11. See Ho, M. W. (1998, 1999). *Genetic Engineering Dream or Nightmare? The Brave New World of Bad Science and Big Business*, Gateways Books and Third World Network, Bath and Penang.

Scientists involved in the Statement:

Signed (136 scientists from 27 countries):

Update on 21st October 1999

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