Chapter Two

# LIEBIG, MARX, AND THE DEPLETION OF SOIL FERTILITY: RELEVANCE FOR TODAY'S AGRICULTURE

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During the period 1830-1870, the depletion of the natural fertility of the soil through the loss of soil nutrients was the central ecological concern of capitalist society in both Europe and North America (only comparable to concerns over the loss of forests, the growing pollution of the cities, and the Malthusian specter of overpopulation). This period saw the growth of guano imperialism as nations scoured the globe for natural fertilizers; the emergence of modern soil science; the gradual introduction of synthetic fertilizers; and the formation of radical proposals for the development of a sustainable agriculture, aimed ultimately at the elimination of the antagonism between town and country.

The central figure in this crisis of soil fertility was the German chemist Justus von Liebig. But the wider social implications were most penetratingly examined by Karl Marx. The views of Liebig and Marx on soil fertility were to be taken up by later thinkers, including Karl Kautsky and V.I. Lenin within the Marxist tradition. Still, by the mid-twentieth century the problem seemed to have abated due to the development of a massive fertilizer industry and the intensive application of synthetic fertilizers.

Today, a growing understanding of the ecological damage inflicted by the reliance on synthetic chemical inputs, the scale of which vastly increased following the Second World War, has generated new interest in a sustainable agriculture in which soil nutrient cycling plays a central role. The need to devise an ecologically sound relationship of people to the soil is being rediscovered.[1] What follows is a brief outline of the evolution of this issue over the last hundred and fifty years.

## LIEBIG AND THE NINETEENTH CENTURY CRISIS OF THE SOIL

In the 1820s and 1830s in Britain, and shortly afterwards in the other developing capitalist economies of Europe and North America, concern over the "worn-out soil" led to a phenomenal increase in the demand for fertilizer. The value of bone imports to Britain increased from £14,400 in 1823 to £254,600 in 1837. The first boat carrying Peruvian guano (the accumulated dung of sea birds) arrived in Liverpool in 1835; by 1841 1,700 tons were imported, and by 1847 some 220,000 tons arrived. So desperate were European farmers in this period that they raided the Napoleonic battlefields (Waterloo, Austerlitz) for bones to spread over their fields.[2]

The rise of modern soil science was closely correlated with this demand for increased soil fertility to support capitalist agriculture. In 1837 the British Association for the Advancement of Science solicited a work on the relationship between agriculture and chemistry from Liebig. The result was his *Organic Chemistry in its Applications to Agriculture and Physiology* (1840), which provided the first convincing explanation of the role of soil nutrients, such as nitrogen, phosphorous, and potassium, in the growth of plants. In England Liebig's ideas influenced the wealthy landowner and agronomist J. B. Lawes, who had begun experiments on fertilizers on his property in Rothamsted, outside London in 1837. In 1842 Lawes introduced the first artificial fertilizer, after inventing a means of making phosphate soluble, and in 1843 he built a factory for the production of his new "superphosphates."

Nevertheless, this technology was slow to diffuse outside of Britain. The first factories for the production of superphosphates were introduced in Germany only in 1855; in the United States only after the Civil War; and in





France only after the Franco-Prussian War. Moreover, the results obtained from the application of a single nutrient (such as phosphate) to the soil, although initially producing dramatic results, tended to diminish rapidly after that, since overall soil fertility is always limited by the nutrient in least abundance (Liebig's Law of the Minimum).

Hence, Liebig's discoveries at first only intensified the sense of crisis within capitalist agriculture, making farmers more aware of the depletion of soil minerals and the paucity of fertilizers. This contradiction was experienced with particular acuity in the United States—especially among farmers in upstate New York and in the Southeastern plantation economy. Blocked from easy, economical access to guano (which was high in both nitrogen and phosphates) by the British monopoly on Peruvian guano supplies, the United States undertook—first unofficially and then as part of a deliberate state policy—the imperial annexation of any islands thought to be rich in this natural fertilizer. Under the authority of what became the Guano Island Act, passed by Congress in 1856, U.S. capitalists seized ninety-four islands, rocks, and keys around the globe between 1856 and 1903, sixty-six of which were officially recognized by the Department of State as U.S. appurtenances. Nine of these guano islands remain U.S. possessions today. Yet guano imperialism was unsuccessful in providing the United States with the quantity and quality of natural fertilizer it needed.[3]

Meanwhile, Peruvian guano supplies had begun to run out in the 1860s and had to be replaced by Chilean nitrates. Although the potassium salts discovered in Europe gave ready access to that mineral, and both natural and artificial supplies of phosphates made that nutrient more available, the limiting factor continued to be fertilizer nitrogen (a synthetic nitrogen fertilizer was not developed until 1913).

The decline in natural soil fertility due to the disruption of the soil nutrient cycle accompanying capitalist agriculture, the growing knowledge of the need for specific soil nutrients, and limitations in the supply of both natural and synthetic fertilizers that would compensate for the loss of natural fertility, all contributed, therefore, to a widespread sense of a crisis in soil fertility.

In the United States this was further complicated by geographical factors. In upstate New York, which by 1800 had displaced New England as a center for wheat cultivation, the relative exhaustion of the soil was brought into

sharp relief by steadily increasing competition from new farmlands to the West in the decades following the opening of the Erie Canal in 1825. Meanwhile the slave plantations of the Southeast experienced dramatic declines in fertility, particularly on lands devoted to the production of tobacco.

In New York farmers responded to the crisis by promoting a more rational agriculture through the creation of agricultural societies. In 1832 the New York Agricultural Society was formed. Two years later Jesse Buel, an Albany newspaper editor, started the *Cultivator*, which sought to promote the kind of improved farming already being introduced in Britain, concentrating on issues such as manures, draining wet soils, and crop rotation. With the publication in 1840 of Liebig's *Agricultural Chemistry* (as his *Organic Chemistry in its Applications to Agriculture and Physiology* is commonly known), New York agriculturists turned to the new soil science as a savior. In 1850 the Scottish agricultural chemist, Professor James F.W. Johnston, whom Marx was to call "the English Liebig," traveled to North America, and in his influential work *Notes on North America* documented the loss of natural soil fertility, demonstrating in particular the depleted condition of the soil in New York as compared to the more fertile farmlands to the West.[4]

Many of these issues were reflected in the work of U.S. economist Henry Carey, who throughout the 1850s laid stress on the fact that long distance trade arising from the separation of town and country was a major factor in the net loss of soil nutrients and the growing crisis in agriculture—a point later developed further by Liebig and Marx. "[A]s the whole energies of the country," Carey wrote of the United States in his *Principles of Social Science* (1858), "are given to the enlargement of the trader's power, it is no matter of surprise that its people are everywhere seen employed in 'robbing the earth of its capital stock.' "[5]

These concerns of North American agriculturists were transmitted in turn to Liebig, mainly through the work of Carey. In his *Letters on Modern Agriculture* (1859), Liebig argued that the "empirical agriculture" of the trader gave rise to a "spoliation system" in which the "conditions of the reproduction" of the soil were violated. Soil nutrients were "carried away in produce year after year, rotation after rotation." Both the open system of exploitation of American farming and the so-called "high farming" of





European agriculture were thus forms of "robbery." "Rational agriculture," in contrast, would give "back to the fields the conditions of their fertility."[6]

Liebig looked forward to an eventual increase in the availability of fertilizers, both through discoveries of natural sources and the production of synthetic fertilizers. Yet he nonetheless generated what soil science historian Jean Boulaine has called a "great campaign to economize fertilizer use and to recycle nutritive elements on European farms." In this sense he was a "precursor of today's ecologists."[7] In his *Letters on the Subject of the Utilization of the Municipal Sewage Addressed to the Lord Mayor of London* (1865) Liebig argued—based on the condition of the Thames—that the two problems of the pollution of the cities with human and animal excrement and the depletion of the natural fertility of the soil were connected, and that organic recycling that would return nutrients to the soil was an indispensable part of a rational urban-agricultural system.[8]

## MARX AND SUSTAINABLE AGRICULTURE

Marx relied heavily on the works of Liebig, Johnston, and Carey in his critique of capitalist agriculture. However, the root source for Marx's critique in this area was James Anderson, a Scottish agronomist, practicing farmer, and political economist who was a contemporary of Adam Smith.

In 1777 Anderson published *An Enquiry into the Nature of the Corn Laws* in which he introduced what was to become known as the Malthusian/Ricardian theory of rent. In Marx's view, Anderson's original model was far superior to the variant later offered by the classical economists Thomas Malthus and David Ricardo since it placed strong emphasis on the possibility of continuing agricultural improvement. Rent, Anderson argued, was a charge for the use of the more fertile soil. The least fertile soils in cultivation generated an income that simply covered the costs of production, while the more fertile soils received a "certain premium for an exclusive privilege to cultivate them; which will be greater or smaller according to the more or less fertility of the soil. It is this premium which constitutes what we now call *rent*; a medium by means of which the expence of cultivating soils of very different degrees of fertility may be reduced to a perfect equality."[9]

For Malthus and Ricardo the source of this differential fertility came to be seen almost entirely in terms of conditions of natural productivity independent of human beings. As Ricardo wrote, rent could be defined as "that portion of the produce of the earth, which is paid to the landlord for the use of the original and indestructible powers of the soil."[10] Moreover, they argued—with the presumed backing of natural law—that lands that were naturally the most fertile were the first to be brought into production, and that rising rent on these lands and diminishing agricultural productivity overall were the result of bringing lands of more and more marginal fertility into cultivation, in response to increasing population pressures.[11]

In contrast, Anderson had earlier insisted that continual improvement of the soil, through manuring, draining, and irrigating, was possible and that the productivity of the least fertile land could rise to a point that brought it much closer to that of the most fertile land; but also that the converse was true, and human beings could degrade the soil. It was such changes in relative productivity of the soil, according to Anderson, that accounted for differential rent—and not conditions of absolute fertility, as in the later arguments of Malthus and Ricardo.[12]

Where general fertility problems did arise in agriculture, this was, for Anderson, a consequence of the failure to adopt rational and sustainable agricultural practices. The fact that the land in England was owned by landed proprietors and farmed by capitalist tenant farmers, he argued, posed obstacles to rational agriculture, since the farmer tended to avoid all improvements, the full return for which would not be received during the duration of the lease.[13]

In *A Calm Investigation of the Circumstances that have Led to the Present Scarcity of Grain in Britain* (1801), Anderson contended that the division between town and country had led to the loss of natural sources of fertilizer. "Every person who has but heard of agriculture," he wrote, "knows that animal manure, when applied to the soil tends to add to its fertility; of course he must be sensible that every circumstance that tends to deprive the soil of that manure ought to be accounted an uneconomical waste highly deserving of blame." It was possible, he asserted, by the judicious application of animal and human wastes to sustain the "soil for ever after, without the addition of any extraneous manures." Yet London, with its gargantuan waste of such





natural sources of fertility, "which is daily carried to the Thames, in its passage to which it subjects the people in the lower part of the city to the most offensive effluvia," was an indication of how far society had moved from a sustainable agricultural economy.[14] Armed with this critical analysis, and a historical perspective, Anderson strenuously attacked the Malthusian view that the crisis of agriculture and society could be traced to rising human population and its pressures on a limited supply of land.[15]

Marx's critique of capitalist agriculture drew upon both Anderson's original formulation of the classical rent theory and Liebig's soil chemistry in order to combat the influence of the Malthusian-Ricardian natural law doctrines of overpopulation and diminishing agricultural productivity. In the 1840s and 1850s Marx stressed the potential for "improvement" in agriculture if rationally organized through such means as the application of synthetic fertilizers.[16] Even in these early decades, however, he insisted that soil fertility was a historical issue, and that fertility could both improve and decline. The irrationality of capitalist agriculture, he argued, was bound up with the whole antagonism of town and country out of which bourgeois society had arisen.

But by the 1860s, based on his reading of such thinkers as Liebig, Johnston, and Carey, and in response to the soil fertility crisis, Marx began to focus directly on the soil nutrient cycle and its relation to the exploitative character of capitalist agriculture. Thus, in the first volume of *Capital* he wrote:

> Capitalist production ... disturbs the metabolic interaction between man and the earth, i.e. it prevents the return to the soil of its constituent elements consumed by man in the form of food and clothing; hence it hinders the operation of the eternal natural condition for the fertility of the soil.... All progress in capitalist agriculture is a progress in the art, not only of robbing the worker, but of robbing the soil; all progress in increasing the fertility of the soil for a given time is a progress towards ruining the more long-lasting sources of that fertility.... Capitalist production, therefore, only develops the techniques and degree of combination of the social process of production by simultaneously undermining the original sources of all wealth—the soil and the worker.[17]

This argument was developed systematically in Marx's analysis of capitalist ground rent in the third volume of *Capital*, where Marx also observed that, "In London ... they can do nothing better with the excrement produced by

4.5 million people than pollute the Thames with it, at monstrous expense."[18] Such considerations on capitalist agriculture and the recycling of organic wastes led Marx to a concept of ecological sustainability—a notion that he thought of very limited practical relevance to capitalist society, but vital for a society of associated producers.[19] The "conscious and rational treatment of the land as permanent communal property," he wrote, is "the inalienable condition for the existence and reproduction of the chain of human generations."[20] Further:

> From the standpoint of a higher socio-economic formation, the private property of particular individuals in the earth will appear just as absurd as the private property of one man in other men. Even an entire society, a nation, or all simultaneously existing societies taken together, are not owners of the earth, they are simply its possessors, its beneficiaries, and have to bequeath it in an improved state to succeeding generations, as *boni patres familias* [good heads of the household].[21]



Subsequent thinkers in the Marxist tradition, such as Kautsky and Lenin, were to be deeply affected by the arguments of Liebig and Marx on agricultural sustainability and the necessity of recycling organic wastes, and argued for the return of nutrients to the soil as a necessary part of a revolutionary transformation of society—despite the increased availability of fertilizers in their time. In *The Agrarian Question* (1899), Kautsky insisted that:

> Supplementary fertilisers . . . allow the reduction in soil fertility to be avoided, but the necessity of using them in larger and larger amounts simply adds a further burden to agriculture—not one unavoidably imposed on nature, but a direct result of current social organization. By overcoming the antithesis between town and country, or at least between the densely populated cities and the desolated open country, the materials removed from the soil would be able to flow back in full. Supplementary fertilisers would then, at most, have the task of enriching the soil, not staving off its impoverishment. Advances in cultivation would signify an increase in the amount of soluble nutrients in the soil without the need to add artificial fertilisers.[22]

Similarly, Lenin observed in *The Agrarian Question and the "Critics of Marx"* (1901) that,

> The possibility of substituting artificial for natural manures and the fact that this is already being done (partly) do not in the least refute the irrationality of wasting natural fertilisers and thereby polluting the rivers and the air in suburban and factory districts. Even at the present time there are sewage farms in the vicinity of large cities which utilise city refuse with enormous benefit to agriculture; but by this system only an infinitesimal part of the refuse is utilized.[23]



## RELEVANCE FOR TODAY

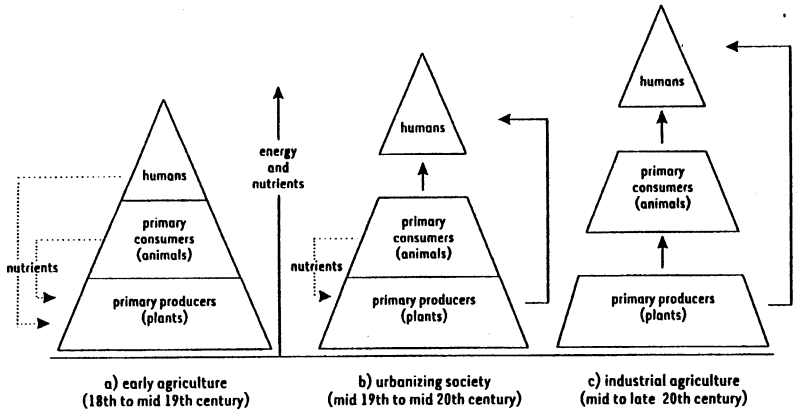
The trends that were of concern to Anderson, Liebig, Marx, Kautsky, and Lenin only intensified as capitalism developed in the twentieth century. As mechanization and low prices for farm products forced people off the farms, workers concentrated first in cities and then in suburban communities. The continued development of employment opportunities in the urban industrial sector and then in the urban-suburban service and government sectors later in the century provided job outlets for the former farm families. (On the other hand, urbanization in most third world countries has taken place without commensurate increases in employment in the cities.) As an ever-higher percentage of the population lived off the farm, the break in the cycling of nutrients was even more complete than in the nineteenth century. This break in the return flow of nutrients to the land is illustrated in Figure 1.

As soils became depleted of nutrients and organic matter they became less fertile and there was much concern about what to do with "worn out" soils. At the same time that nutrients were depleted from farmland, sewage containing those nutrients fouled many lakes and rivers, while coastal cities dumped sewage into the ocean. Although sewage treatment systems installed since the 1970s have decreased the problem of water pollution in the United States, a new problem was created—how to get rid of the sludge that is produced. Currently sewage sludge is buried in landfills, incinerated, or applied to farmland, each of which has significant environmental consequences.

Two developments set the stage for a second break in the cycling of nutrients. First, the availability of inexpensive nitrogen fertilizers following the Second World War helped put in motion a number of changes. The production of nitrogen fertilizers uses the same process as the production of explosives, and the end of war production freed up a large capacity to make nitrogen fertilizers. (It is also important to note a further agrichemical connection to the military-industrial complex: many of the pesticides used

in agriculture were originally developed for military purposes as defoliants and nerve agents.) With the widespread availability of nitrogen fertilizers, there was no longer a need to rely on legume crops, which convert atmospheric nitrogen into a form that plants can use, to supply non-legumes with sufficient fertility. The legume clover and alfalfa hay crops had previously been fed to ruminant animals such as beef and dairy cows and sheep. Once there was no need to grow those crops to supply nitrogen for non-legume crops (wheat, corn, barley, tomatoes), farms could more easily specialize as either crop or livestock operations.

Figure 1.
**CHANGES IN THE SPATIAL RELATIONSHIPS OF PLANTS, ANIMALS, AND HUMANS**




Second, as concentration accelerated in agricultural production, processing, and marketing, corporations began to encourage production of animals near the few large processing facilities that they operated. They selected locations that offered certain advantages such as lax environmental laws, negligible threat of union activity, and low wages. The large processors were also increasingly marketing their products under brand names and, to have a uniform and predictable product, needed to control as much of the entire process as possible—either by producing the animals on their own corporate farms or under production contracts where the farmer might not even own the animals and had to follow strict instructions from their corporate



employer. Thus animal production became concentrated in certain regions: beef feedlots in the southern Great Plains, poultry in Arkansas and on the Delmarva Peninsula (composed of parts of Delaware, Maryland, and Virginia) and hog production in certain parts of the Midwest and in North Carolina.

These two developments in the second half of the twentieth century have led to a new phenomenon that mirrors the separation of people from the farmland which so concerned Marx and others—the separation of agricultural animals from the cropland that produces their feeds (Figure 1c). The large-scale U.S. poultry and hog megafarms (aptly called factory farms) are owned almost exclusively by corporate integrators or by individual farmers under production contracts for corporations such as Tyson and Perdue. And beef feedlots with tens of thousands of animals are not uncommon. More than a third of cattle marketed in the United States come from just seventy feedlots, while 97 percent of U.S. poultry sales are controlled by operations that generate in excess of 100,000 broilers per year.[24] Even on dairy farms that produce a lot of their own feed, it is common to import about half of the animals' needs. This breakdown of the physical connection between the animals and the land producing their feeds has worsened the depletion of nutrients and organic matter from soils producing crops. Crop farms must use large amounts of synthetic fertilizers to compensate for the loss of vast quantities of nutrients as their products are sold.

In addition, as pointed out by Anderson and Marx, those renting land to produce crops have no economic incentive to make improvements for which they will not receive compensation during the life of the rental agreement. Fully 48 percent of all U.S. agricultural land in 1994 was rented from others.[25] In some sectors rental is especially common, with 60 percent of the land devoted to cash grain and 75 percent of all cotton land rented.[26] Land rental is also more common on larger farms, with 58 percent of the land operated by farms with annual gross receipts of $250,000 or more under rental agreements.[27] The great extent of rented land is another factor that increases the trend toward farm specialization and short-term approaches to maintaining soil fertility that rely on synthetic fertilizers rather than environmentally sound, long-term soil and crop management strategies.

## ENVIRONMENTAL CONSEQUENCES

The lack of nutrient cycling resulting from the physical separation first of people and then of animals from cropland created the need to use ever higher levels of synthetic nutrients. And while the crop farms have too few nutrients, these very same nutrients accumulate in cities and on the large-scale animal factory farms. Because of the long distances involved, these accumulated nutrients are not returned to the major crop growing areas because the energy and financial costs are extremely high.

There are a number of severe environmental consequences of the developments described above:

(1) Large amounts of non-renewable energy sources are needed to produce, ship, and apply the fertilizers. Production of nitrogen fertilizer is very energy intensive. Of all the energy used to produce an acre of corn in the United States cornbelt—including fuel, wear and tear on machinery, seeds, and pesticides—nitrogen fertilizer accounts for the largest amount (double the next largest category), approximately 40 percent.[28]

(2) Another adverse consequence arises because the fertilizers used are soluble and are thus prone to cause groundwater and surface water contamination. In addition, the high concentrations of livestock produce more nutrients than the surrounding soils can safely absorb. A direct health hazard results as the groundwater many use for drinking is contaminated with high levels of nitrates. Excess nutrients from agricultural production are also implicated in the deterioration of estuaries such as the Chesapeake Bay, and marine environments such as the Gulf of Mexico's dead zone to the west of the Mississippi River's mouth, as well as many fresh water lakes.

(3) Even when cities are located near farms, the industrial contaminants, as well as chemicals in many of the products that people dispose around their homes, render most urban sewage sludges unsuitable for use on farmland. Although the U.S. Environmental Protection Agency considers most sludges safe for use on farmland, there are significant scientific concerns about the adequacy of these guidelines. U.S. standards are by far the most lax of all advanced industrial countries, with permitted levels of heavy metal eight times that of Canada and most European nations.[29] And there are potential contaminants in manures too—for example, routine feeding of copper to





hogs raised in confinement to enhance their growth results in manures that have excessive copper levels. Disposal of contaminated sludges and manures causes environmental problems that may affect the future productivity of soils or the quality of air and water.

(4) The lack of good rotations on most crop farms, partially caused by the availability of inexpensive synthetic fertilizers, has resulted in a loss of soil organic matter and a decrease in the diversity of organisms in the soil. This degradation of soil quality allows the growth of large populations of disease organisms and plant parasites that would have been held in check by a diverse community of competing organisms. Also, plants that are unhealthy tend to attract more insect pests than healthier plants. The upshot of this is that greater amounts of pesticides are used in an attempt to combat the increased pest pressures resulting from soil degradation. Thus much of the pesticide poisoning of farmers and farmworkers as well as the contamination of many foods and groundwater is a result of soil degradation.

(5) The cruel conditions under which animals are raised in large-scale production facilities create conditions in which disease can easily spread, necessitating frequent use of antibiotics. In addition, the routine use of low levels of antibiotics in feeds, which function somehow as a growth stimulant, accounts for most of the 40 percent of total antibiotics that are used on animals. The constant use of medicines causes both antibiotic contamination of food and the development of antibiotic-resistant strains of bacteria, which can then become a human health hazard.

(6) Mining operations undertaken to supply nutrients have resulted in substantial environmental damage. The fate of one of the victims of guano imperialism gives some indication of what can happen. The small South Pacific island nation of Nauru was under German control from 1888 to the First World War, after which it was under the control of Australia (except for Japanese occupation during the Second World War) until independence was gained in 1968. Strip mining of the phosphate-rich deposits began around 1908 and the deposit is expected to be exhausted within a few years. According to a *New York Times* article "four-fifths of the island has been mined out, leaving behind a pitted, ghostly moonscape.... The only habitable land is a narrow coastal fringe shaded by coconut palms. Because of the mining, even the weather has deteriorated. The waves of heat that rise from

the mined-out plateau drive away rain clouds, leaving the sun-baked island plagued by constant drought."[30]

## EXPERIENCES OF THE NONCAPITALIST WORLD

The history of the noncapitalist world offers a few glimpses of other possibilities. The Soviet model, followed by most other countries in eastern Europe, offers no help on this issue because it closely copied many of the methods used in the United States, lack of attention to cycling of nutrients and care of the soil was partially offset by applications of fertilizers and pesticides. However, in China during Mao things were different. China has an extremely low amount of arable land per capita, but has had a long tradition of carefully cycling nutrients to maintain soil fertility (as noted by Liebig in the nineteenth century). Mao's emphasis on local food self-sufficiency in each region helped to reinforce these practices and, together with the encouragement of local industry, slowed down urbanization at the same time as impressive advances were made in agricultural production. But in the transition to capitalist relations that is now far advanced, nutrient cycling and careful soil management have decreased substantially, and there is a new emphasis on building fertilizer factories to supply the nutrient needs of agricultural production.[31] In Cuba, the economic crisis of the Special Period has been caused by the cancellation of favorable trade agreements with the collapse of the Soviet Union. Lack of funds to purchase fertilizers and pesticides from abroad created an interest in reducing the use of such materials, and organic production techniques have become a mainstay of Cuban agriculture with attention paid to nutrient cycling issues.[32]

## WHAT CAN BE DONE?

What can be done to remedy the break in the cycling of nutrients in the advanced capitalist countries and the resulting environmental consequences? Without a major challenge to the structure of agriculture and corporate decision making, a profound change in the nature and sizes of cities and the curbing of suburban development, and a moratorium on the continued introduction of new synthetic chemical compounds until their environmental safety is proven beyond a doubt (all unlikely in the near future), there remain few options. These include encouraging the consumption of locally grown food and the recycling of clean food wastes from homes, restaurants, and markets back onto farmland. And seeking out of farmers that follow environmentally and socially sound practices at farmers markets and through the new Community Supported Agriculture farms (CSAs, where individuals and families buy shares in the production of the farm before the season starts) can help as well. A massive effort can also be undertaken to clean up sewage sludges by eliminating the contamination of sewage with potentially toxic wastes from industries as well as individual homes. This will be resisted by industry because of the large expenditures required for most to have zero discharge of toxic materials. Although such activities will not solve the problems, they will make a difference. And during the struggles, the mutual education of those interested in broader societal issues, on the one hand, and those concerned with sustainable agriculture and environmental issues, on the other, could lead to more permanent future alliances.

From a longer-term perspective, it is important to understand that neither a lack of technology nor a lack of understanding of ecological processes are standing in the way of sustainable agricultural systems today. Although there is plenty to find out, we already know how to design and implement agroecosystems that are biologically sustainable, taking into account soil nutrient cycles and other factors. But the mass of farmers cannot use this knowledge and survive under the current economic-social-political structure.

A humane and sustainable system, socialist and based on sound ecological principles, will concern itself with sustaining the earth, as Marx wrote, "as the inalienable condition for the existence and reproduction of the chain of human generations." To fail to take these more fundamental issues into account in our current struggles would be to ensure our failure not only in the cause of social justice, but also in fulfilling our obligations to the earth–understood as the ground we live on and the bio-geological processes that sustain us. One thing we can be assured of: future generations will only look at us askance if we allow ourselves to give in at any point to a system, such as the present one, run on the principle "Aprés moi le dèluge!." [33]

## NOTES

1. See Kozo Mayumi, "Temporary Emancipation form the Land," *Ecological Economics*, vol. 4, no. 1 (October 1991), 35–56; Fred Magdoff, Les Lanyon and Bill Liebhardt, "Nutrient Cycling, Transformation and Flows: Implications for a More Sustainable Agriculture," *Advances in Agronomy*, vol. 60 (1997), 1–73; Gary Gardner, *Recycling Organic Waste: From Urban Pollutant to Farm Resource* (Washington, D.C.: Worldwatch, 1997).
2. Jean Boulaine, "Early Soil Science and Trends in the Early Literature," in Peter McDonald, ed., *The Literature of Soil Science* (Ithaca: Cornell University Press, 1994), 24; Daniel Hillel, *Out of the Earth* (Berkeley: University of California Press, 1991), 131–32.
3. J.M. Skaggs, *The Great Guano Rush* (New York: St. Martin's Press, 1994).
4. Margaret W. Rossiter, *The Emergence of Agricultural Science: Justus Liebig and the Americans, 1840–80* (New Haven: Yale University Press, 1975), 3–9; Karl Marx and Friedrich Engels, *Collected Works*, vol. 38, 476; James F.W. Johnston, *Notes on North America*, vol. 1 (London: William Blackwood and Sons, 1851), 356–65; Marx, *Capital*, vol. 3 (New York: Vintage, 1981), 808.
5. Henry Carey, *Principles of Social Science* (Philadelphia: J.B. Lippincott, 1867), vol. 2, 215, and *The Slave Trade Domestic and Foreign* (New York: Augustus M. Kelley, 1967), 199.
6. Justus von Liebig, *Letters on Modern Agriculture* (London: Walton and Mabery, 1859), 171–83, 220. Liebig's criticism of the "spoliation system" was made even more explicit in the revised 1862 edition of his *Agricultural Chemistry*, which influenced Marx. See William H. Brock, *Justus von Liebig: The Chemical Gatekeeper* (Cambridge: Cambridge University Press, 1997), 175–79.
7. Boulaine, "Early Soil Science," 25.
8. Brock, *Justus von Liebig*, 250–72.
9. James Anderson, *Observations on the Means of Exciting a Spirit of National Industry* (Edinburgh: T. Cadell, 1777), 376, *Enquiry into the nature of the Corn Laws; with a View to the New Corn Bill Proposed for Scotland* (Edinburgh: Mrs. Mundell, 1777), 45–50; J.R. McCulloch, *The Literature of Political Economy* (London: Longman, Brown, Green, and Longmans), 68–70.
10. David Ricardo, *Principles of Political Economy and Taxation* (Cambridge: Cambridge University Press, 1951), 67. Ricardo did not deny altogether the possibility of improvement in agriculture but gave it a very limited role. "Improvements in agriculture," he wrote, were "of two kinds: those which increase the productive powers of the land, and those which enable us, by improving our machinery to produce with less labour." The former type of improvement was mainly associated with "more skillful rotation of crops, or better choice of manure." *Ibid.*, 80. It seems to have been a key assumption of the Ricardian rent theory that such improvements could have only a limited impact on fertility, and could in general be abstracted from altogether.
11. Karl Marx, *Theories of Surplus Value*, part 2 (Moscow: Progress Publishers, 1968), 114–17, 121–25.
12. Ibid., 241–44; James Anderson, *A Calm Investigation of the Circumstances that have Led to the Present Scarcity of Grain in Britain: Suggesting the Means of Alleviating the Evil and Preventing the Recurrence of Such a Calamity in the Future* (London: John Cumming, 1801), 5.
13. James Anderson, *Essays Relating to Agriculture and Rural Affairs*, vol. 3 (London: John Bell, 1796), 97–135; Karl Marx, *Capital*, vol. 3 (New York: Vintage, 1981), 757.
14. Anderson, *A Calm Investigation*, 73–75.
15. Ibid., 12, 56–64.
16. Karl Marx, *Grundrisse* (New York: Vintage, 1973), 527.
17. Karl Marx, *Capital*, vol. 1 (New York: Vintage, 1976), 637–38. Marx's argument was similar to that of Liebig in *The Natural Laws of Husbandry* (New York: D. Appleton and Co., 1863), 180 (this was the English translation of vol. 2 of the 1862 edition of Liebig's *Agricultural Chemistry*.)
18. Marx, *Capital*, vol. 3, 195.
19. On the relation of Marx's concept of sustainability to his vision of communist society see John Bellamy Foster, "The Crisis of the Earth," *Organization & Environment*, vol. 10, no. 3 (September 1997), 278–95.
20. Marx, *Capital*, vol. 3, 948–49.
21. Ibid., 911.
22. Karl Kautsky, *The Agrarian Question* (Winchester, MA: Zwan, 1988), vol. 2, 214–15.
23. V.I. Lenin, *Collected Works*, vol. 5 (Moscow: Progress Publishers, 1961), 155–56.
24. Gardner, *Recycling Organic Waste*, 43.
25. Judith Sommer, David Banker, Robert Green, Judith Kalbacher, Neal Peterson, and Theresa Sun, *Strucutal and Financial Characteristics of U.S. Farms, 1994*, (Agriculture Information Bulletin No. 735, Economic Research Service, U.S. Department of Agriculture), 79.
26. Ibid., 87.
27. Ibid., 84–85.
28. Pimentel, D., and G.H. Heichel. "Energy efficiency and sustainability of farming systems." In R. Lal and F.J. Pierce (eds.) *Soil management for sustainability* (Ankeny, Iowa: Soil and Water Conservation Society, 1991), 113–123.

29. Gardner, *Recycling Organic Waste*, 34.
30. New York Times, December 10, 1995, 3.
31. See Bill Hinton's chapter in this book for a discussion of the burning of crop residues in China.
32. See Peter Rosset's chapter in this book.
33. "*Aprés moi le dèluge!* is the watchword of every capitalist and of every capitalist nation. Capital therefore takes no account of the health and length of life of the worker, unless society forces it to do so." Karl Marx, *Capital*, vol. 1 (New York: Vintage, 1976), 381.



Chapter Three

# CONCENTRATION OF OWNERSHIP AND CONTROL IN AGRICULTURE

WILLIAM D. HEFFERNAN

## THE EVOLVING FOOD SYSTEM OF THE UNITED STATES

Native Americans and the European settlers who subsequently occupied the territory of the United States developed an agricultural and food production system that was largely self-sufficient. Most families produced, processed, and consumed their own food. Families made many of the tools and produced most of the seed they needed, and raised their own animal power. Few items were purchased for food production and processing, but there was very little surplus food or fiber to sell. The family controlled its food system from seed to plate—the ultimate integrated food system. The purpose of colonies, however, was to send raw materials, including food and fiber products, back to the mother country. The industrial revolution and the development of industrial cities, first in England and then in the United States, required that farmers produce a larger and larger surplus of food for the growing urban market. Government policy encouraged farmers to produce an ever greater excess of food and fiber and to do so with less and less labor. Thus agriculture evolved from a subsistence agriculture to a commercial agriculture in which the role of the farm family was to produce for the market.