Appendix 3: Agricultural Use of Effluent

Behold this compost! Behold it well!
Perhaps every mite has once form'd part of a sick person— yet behold!
The grass of spring covers the prairies,
The bean bursts noiselessly through the mould in the garden,
The delicate spear of the onion pierces upward,
The apple-buds cluster together on the apple-branches,
The resurrection of the wheat appears with pale visage out of its graves.
What chemistry!
That the winds are not really infectious.
That all is clean forever and forever,
That the cool drink from the well tastes so good,
That blackberries are so flavorous and juicy.
That the fruits of the apple-orchard and the orange-orchard,
that melons, grapes, peaches, plums, will none of them poison me,
That when I recline on the grass I do not catch any disease.

Now I am terrified at the Earth, it is that calm and patient,
It grows such sweet things out of such corruptions,
It turns harmless and stainless on its axis,
with such endless succession of diseased corpses,
It distills such exquisite winds out of such infused fetor,
It gives such divine materials to men, and accepts such leavings from them at last.

"*This Compost*," Walt Whitman [edited]

Some background on fertilizer and plant growth seems in order for this discussion. Of necessity, it will be brief, but this is quite obviously a subject of great concern to anyone striving for greater self-sufficiency (or rational interdependence— a more reasonable goal), and it is of considerable interest to anyone concerned with the other major useful byproduct of the biogas process— the effluent, and its potential fertilizing value.

The modern school of agriculture is based in a narrow view of the soil/plant ecosystem which perceives it almost exclusively in very simple chemical and mechanical terms. For example, one book on plant nutrition describes plants as "…*those fixed, silent, chemical machines*…" (Epstein 1972). Such a view is not surprising, considering the tools that have been used to explore the life of plants. For example, the most common method of comparing one plant with another is to burn it and analyze the ashes. Nearly all of the tools developed for basic agricultural research similarly involve the death of the plant or the dissection and destruction of its environment to gain knowledge about the nature and function of the plant and its surrounding ecosystem.

The elements which comprise a human body are worth about $2 on the open market— but how much does this tell us about human beings and their nature and function? What does it tell us about human nutrition? Modern agriculture in this respect is very much like modern medicine, which knows a great deal about disease, but far less often appears to come to significant scientific conclusions about health.

This is not to say that the facts discovered through science are incorrect— agricultural science has made tremendous progress in the last one hundred years. However, no true scientist would believe that humanity's progress in knowledge has ended, or that any of today's cherished theories will not be regarded by future scientists very much as today's scientists look upon yesterday's theories. What will we know in another century? In two? Can you really believe that people in two centuries will have the same view of the world that you do?

i. NPK

The modern method of agriculture generally compares all materials used for soil amendments (fertilizers and composts) based on their chemical analysis, and particularly on their relative amounts of the nutrient elements N, P, and K (nitrogen, phosphorus, and potassium). This is because the quantity of these three nutrients in most plants, as compared with the other elements which comprise most plants, is great. Also present in great abundance are C, H, and O, but these elements are easily gained from air and water, rather than from the soil. Often chemical fertilizers are spoken of as "5-2-2," or "10-5-2." These numbers refer to the percentage of N, P, and K found in the fertilizer.

Strictly in these chemical terms, dried sludge (the settled solids portion of effluent) is a poor fertilizer. However, the whole effluent is a good-to-excellent fertilizer in terms of its chemical analysis. The difference lies in the fact that a good portion of the N in the effluent is in the liquid (supernatent) and in the form of ammonia (and related compounds), which rapidly evaporate (or are washed away) when the solids are drained and dried.

Local use of effluent, however, should mean that it will *not* have to be dried— indeed, it may have to be diluted for ease of pumping. This, and careful handling, will mean that a much higher portion of the N in effluent will reach the soil than would be the case were only dried sludge used.

ii. Economics

It has been demonstrated over and again that the N in the original substrate remains in the anaerobic slurry to a greater degree than in aerobic composting. Therefore in NPK terms, the biogas process produces a "superior fertilizer." Essentially, the whole NPK value of the original substrate remains and is available, and one method of evaluating the fertilizer value of the effluent is to value the amount of N, P, and K in the effluent according to what those amounts would cost if they were purchased as chemicals.

Remember, however, that these chemicals are not created by the biogas process: they are available in any case, although sometimes to a lesser degree in the original substrate or an aerobic compost made from that substrate. Further, we are not interested in mere chemicals. What we really want to know is: how well does effluent make plants grow?

The true fertilizer value of the effluent, then, becomes a matter of weighing factors other than a simple chemical analysis. Probably the most accurate comparison is with aerobic compost, since this is often the destiny of substrates if they are not used in making biogas.

Aerobic composting will result in a 25% loss of N as compared with anaerobic effluent, but the aerobic compost will have more of that N in a form which is not so easily lost— e.g., not as ammonia, but rather tied up in some kind of slow release form. For application on pasture and grass-related crops— corn, grains— ammonia N is often preferable. For application on tree crops, legumes, and most vegetables, slow-release N is generally preferable.

The large-scale production and use of aerobic compost will involve time and equipment comparable to the time and equipment necessary for the biogas process. It is probable that the time involved in running a well-conceived and constructed biogas generator and in spreading the pumpable liquid effluent will be less than the time involved in an aerobic compost venture, but the equipment (generation plus systems, pumps, etc.) necessary for the biogas process will, on the other hand, generally be more expensive than the equipment (tractor with skip loader, manure spreader) necessary for making aerobic compost.

For aerobic compost, substrate handling may be more difficult, since it is not feasible to simply add water— for example, to a manure substrate— and pump it away to the compost bin as could be done were it to be used in biogas production. Aerobic composting, unless well done, can also be a source of flies, and manure cannot be stored in the open without rain water washing out nutrients, so a storage structure may be necessary.

Generally, the economic benefits of using effluent as fertilizer come primarily in the lowered costs of handling. If we are not considering the value of the biogas produced, then anaerobic composting will have an economic benefit over that of aerobic composting where some factor or factors make handling expensive. Feedlots, or other intensive animal production situations, are often of this nature.

But these factors are situational, and the relative economic benefits of aerobic versus anaerobic change according to a person's needs. Often a more expensive option in a particular situation will still be so much more beneficial that it will prove to provide a greater dollar return than an option initially less expensive. The economics question involves factors particular to your own situation.

iii. Biology

Biologically speaking, it is nearly impossible to compare aerobic compost and anaerobic effluent in terms of their effect on crop quality. The reason lies near the heart of our comments about modern agriculture:

it has not developed inexpensive tools to give such comparisons. The literature often refers to such things as "percent nitrogen uptake" or "dry weight increase"— we can roughly compare compost with effluent, or either one with chemical fertilizers— but that doesn't really tell us anything good or bad— or even very useful— if we want to know about the qualities of the plants grown with these different nutrient sources, rather than their quantities.

Food, after all, is more than "dry weight." It is discouragingly difficult to answer a seemingly simple question such as: Which process produces more healthful food? We cannot blame the scientist for wanting to answer questions which are more easily answerable— Which nutrient source provides a greater increase in dry weight?— but we might blame a science which seems to feel that only the easily answerable questions are important.

All we can do then, to answer our presently unanswerable question, is to extrapolate. Since plants have evolved in a certain biotic situation, it is likely that they will respond best to attempts to enhance rather than radically alter that situation. Mother Nature makes aerobic compost, for the most part. This doesn't mean that she can't be improved upon, but it does tend to indicate that compost will produce a better, more healthful plant under most circumstances than will effluent.

iv. Agricultural Use

Dr. H. H. Koepf, an authority on soil biology (and Biodynamics) has suggested that effluent be treated with straw and stinging nettle (1974) to help balance its effect upon the soil. Biodynamics has interesting, useful, and subtle answers to some of the questions raised earlier.

Nettle and straw could be used either in lagoon storage of the effluent, or in conjunction with the composting technique suggested by Ransome (1944). Using 45 centimeters (18 inches) of straw, effluent of 6% solids was applied at the rate of 6 liters effluent per kilogram of straw (9.63 cubic feet per 100 pounds, 1400 gallons per ton). The pile is built up in layers, and treated like ordinary compost. For air-dried sludge, 5 centimeters (2 inches) of sludge is used for every 45 centimeters of straw.

More often, however, effluent is used directly, or the sludge is settled and dried. For information on the special problems of the agricultural use of effluent from human excrement, see the relevant subsection in Chapter 16: Manure Substrates, p. 65.

Since it is unlikely that, in the circumstances in which most of us find ourselves, we will be drying the effluent, we will discuss only liquid effluent. (Briefly, use dried sludge like compost.)

v. Spreading

Liquid sludge can be spread in many ways. Commonly, it is spread either by a truck with a tank on it, or by irrigation. There are five kinds of irrigation to be considered:

1. sub-soil;
2. furrow and ditch;
3. flood;
4. open pipe; and
5. spray.

Because of the high solids content, and (often) the large particles of biogas effluent, spray irrigation is not always possible. Also, the higher pressures required necessitate higher energy and equipment costs. For soils without any appreciable slope, furrow and ditch irrigation is not always possible. If there is not enough water or effluent to make flooding practical, then the use of a tank truck or a movable open-ended pipe to spread the effluent may be required. Sub-soil irrigation requires buried pipe, and may suffer in orchard situations from root invasion of the pipe. The higher initial cost of buried pipe may be outweighed in some situations by greater safety (when an effluent with possible parasite or pathogen contamination is used) and/or less evaporation. Porous clay pipe can be used. In a situation where home sewage is used, a leach line system may fulfill sanitation code requirements, yet still allow biogas production before the sewage effluent is put in the leach lines.

vi. Soils

Some soils respond better to effluent than others. Open porous soils— sandy or loamy— will in general be more apt to remain friable (loose, tillable) than silt or clay soils, when effluent is used as a soil amendment.

The nutrients in effluent encourage the growth of soil bacteria, an occurrence which can have many benefits for the soil structure and humus content. However, if excessive use, or excessive soil saturation, causes the soil to become "clogged" with the products of this growth, slime organisms begin to grow. Water percolation is then seriously reduced, and the CO_2 released by decomposition processes and plant roots cannot leave the soil environment, causing it to become more acidic. A close check on the soil pH will provide indications that this is happening. The use of effluent could probably be increased if the soil is tilled (harrowed or plowed) a few days after application. More compact clay soils respond to effluent by clogging more rapidly than sandy, open, or porous soils.

vii. Ponds

While this decrease in porosity may be unwanted in an agricultural soil, it has been used in the Asia for centuries to seal the bottom of ponds. Where a pond is desired on a soil with slight or low porosity, the pond should be shaped and its surface cleared of stones and other such debris. Then undiluted effluent or (even better) settled sludge can be sprayed or spread onto the pond bottom and sides. According to *The Book of the New Alchemists* (1977, p. 73) each layer of material which is applied to the pond should be just thick enough to cover the previous layer. After the effluent layer is placed, it should be covered with a layer of fresh vegetable matter (such as cut grass), or cardboard. Then a layer of soil is sprinkled over all, and tamped down. After 2 or 3 weeks, the pond may be filled.

The use of effluent in ponds to grow substrates or to fertilize algae for growing food fish is an excellent possibility in many areas. Consult the references in the Bibliography, p. 265, for further information on fish culture.

Effluent hydroponics has been mentioned as a possibility, but not much work has been done in researching this possibility. One brief investigation by Eby (1966) on the suitability of pasture grasses to growth in effluent (from untreated dairy wastes), was done. Of the grasses tried (orchard grass, timothy, brome, reed canary, rye, and fescue), the fescue outperformed the others in terms of nutrient removal and growth. Eby indicates that the grasses should be grown in ponds 45 centimeters (18 inches) deep, filled with pea gravel, with a 5-day effluent detention time. His purpose was to remove unwanted nutrients from the effluent prior to surface water disposal.

A better option, it seems, based on what limited research has been done, would be the use of water hyacinth, a plant which has been shown to have a rapid growth rate and to be an excellent scavenger of the unwanted nutrients. When effluent is used in ponds, it should be diluted.

Plowing before treatment allows a heavier application. The use of agricultural lime or dolomite before effluent application will, to some degree, mitigate the acidifying tendency of effluent, but the real cure is to keep the soil open, so that CO_2 can be released, and O_2 enter.