

A Hot Issue- Chicken Manure

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At Pragtree Farm we have been faced with the problem of improving and maintaining organic matter and fertility on a market-garden scale. Macro and micro nutrients are constantly being shipped away from the farm, lost by leaching through our sandy soil, and oxidized or volatilized into the air. Large quantities of manure, both animal and green, and considerable outlay of effort are required to promote healthy organic soil conditions. In an earlier time our farming operation would have been nearer to the city where easy access to horse manure was possible. Now our rapidly evolving livestock systems have brought about widely varying animal manures.

During the past 20 years there has been a dramatic concentration of the chicken industry by agribusiness interests into larger and larger units. Around our farm near Arlington, as in other rural areas in Western Washington, fryer and egg factories have become significant sources of large quantities of chicken manure. If you've ever been in one of these places you know what an eerie experience it can be. A small fork-lift type truck with a rubber blade and a cubic-yard bucket in place of the forks winds its way through a dimly lit tunnel lined with caged leghorns, 4 hens to each 2 square feet (with an occasional escaped bird running wildly before the wheels of the approaching vehicle), lapping up the accumulated droppings. A heavy buzz resonates throughout the interior, driving off the unprepared. For many organic farmers this kind of operation is now their primary source of manure.

The manures produced by these factories differ from the horse manure that farmers formerly used in a number of significant ways:

- 1) as a part of "agribusiness international," these factories are powered by high inputs of petroleum;
- 2) fryer litter and straight chicken manure are highly concentrated, requiring special management.
- 3) supplements added to chicken feed can produce conditions detrimental to a healthy soil life.

To the extent that organic farmers are dependent on what is left behind when the fryers and eggs go on their way, they become enmeshed in the larger scheme of agribusiness international.¹ Organic farmers are at the tail end of an entropic process which begins with drilling for petroleum and the manufacture of artificial fertilizers and ends with the production of pure chicken guano or of fryer litter (a mixture of guano and alder shavings or some other bedding material).

As prices rise and fluctuate in artificial fertilizer markets, organic farmers are getting squeezed at the chicken factory because chemical farmers are now coming in to compete with them for the droppings. In 1977, the nutrients in broiler litter (which would be similar to fryer litter) were valued at approximately \$22 per ton (equivalent artificial fertilizer value).² We've been buying fryer litter from a nearby fryer factory for \$20 per truck load (at 2 to 3 tons per load) so you can see that it is a relatively cheap source of fertilizer. But the price will probably go up as the price of artificial fertilizers rises and other farmers begin looking for alternatives.

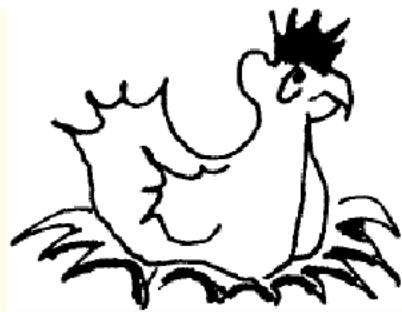
Aside from its source, other questions have been raised about the use of chicken manure. What is the proper rate of application? Are there potential toxic effects from additives to the feed? What are the best ways to manage chicken manure? Because the use of chicken manure as one of our

major sources of fertilizer became an important issue at our farm this past summer I set out to find answers to as many of these questions as I could. What follows are the conclusions of my research.

How Much to Use?

Although "manures" are treated with rough equality in all the organic literature, their differences are very real and very important. Much of this confusion seems to stem from times when horse manure was the mainstay of the truck farmers' fertility program. It's hard to get current and accurate information-Thompson and Kelly's much valued Vegetable Crops- having not been revised since 1957 and the Rodale Press's anecdotal form presenting research in an often obscure manner.

If recommended rates of application of "manure" ^{3,5} for farm vegetable production of 20 tons per acre are followed for both horse manure and fryer litters, then an acre fertilized with horse manure receives 280 lbs. of nitrogen, 120 lbs. of phosphorus (as P_2O_5), and 240 lbs. of potassium (as K_2) (Encyclopedia of Organic Gardening, p. 689). An acre fertilized with fryer litter at 20 tons/acre would receive 1120 lbs. of nitrogen, 940 lbs. of phosphorus and 740 lbs. of potassium.⁶



Two situations must be clearly differentiated at this point if we are to determine the most appropriate application rates for chicken manure. One is application to pastures; the other is application to row crops. Early experiments (1962-1964) showed that chicken litter applications of four tons/acre produced greatest yields on fescue grass pasture, while 10-12 tons/ acre produced yields no better than when no lit-ter was applied. Rates of 25-30 tons/acre eliminated almost all plants.⁶

The situation with respect to row crops is not so clear. One experiment indicated corn yields maximized at 2-4 tons/acre.¹³ in the Midwest, 20-40 tons/acre of broiler litter are commonly applied to corn fields. Research in Maine has indicated that 20 tons/acre caused nitrate levels in plants to be 4 to 5 times what was considered maximum desirable levels. Les Hileman, broiler litter researcher at the University of Arkansas, stated that he would consider 10 tons/acre the maximum application rate .

A number of tests were carried out at the University of Arkansas to determine the cause of the detrimental effects of high rates of broiler litter application on pastures.^{7,8,9,10} In one experiment, litter was mixed with the top four inches of soil in pots in greenhouses at rates equivalent to 5 to 20 tons/acre. The report noted that "ammonia was released from decomposition of the litter resulting in rapid rise in soil pH. The odor of ammonia was quite evident, especially when the soil was disturbed during the first 4 months. Fescue was seeded three times with complete failure each time."⁷ Within the first year of application, 75% to 90% of the nutrient in fryer litter becomes available.^{8,11} This is not your slow acting, long-lasting manure. In further greenhouse experiments, high levels of soluble salts, known to interfere with germination and plant growth, were measured when broiler litter was applied at rates of 4-20 tons/acre.⁹ Soluble salts were not a problem on pastures, indicating that standing pastures were more able to absorb nutrients than cultivated soils, especially in small pots. Working fryer litter thoroughly into the soil on row crops would be an advisable practice, considering both the ammonia and soluble salt problems.

In both pasture and greenhouse tests, displacement of calcium by potassium with corresponding leaching of calcium and lowering of pH was noted.^{10,12} Practices indicated by this finding include careful soil testing to determine potassium levels and reduction of fryer litter use, switching to a

more nitrogen-sup-plying source, combined with applications of lime (Dolomite) on a regular basis.

Nitrate build-up in both plants and water supplies has been experienced with commercial nitrogen fertilizers. Considering that the nutrients in fryer litter are highly available, high nitrate levels could become a problem for organic farmers as well. When broiler litter was placed on top of pastures, run-off water carried nitrates to nearby pond water, causing excessive nitrate levels.' When mixed in soil in greenhouse experiments, no significant differences in groundwater nitrate concentration, at application rates between 0 and 40 tons/ acre, were noted. This indicates that the soil was able to absorb all the nitrates in the clay micelles and organic matter.

Pragtree Farm Research

A greenhouse experiment was conducted at Pragtree Farm June 6 - July 23, 1977 to measure the difference in growth of oat seedlings under four different fertilizer treatments. Three sets of four 4-inch pots with eight seedlings in each were treated with approximately 21 ton/acre rate of:

- 1) fryer litter, 4 months old;
- 2) freshly collected goat manure mixed with alfalfa hay and fir wood chip bedding;
- 3) compost--fryer litter mixed with addition al carbonaceous material, well-decayed, red wigglers quite evident;
- 4) control-the same top soil as other pots without any added manures, amendments, or compost.

The manures did not appear to interfere with germination, as all seeds in the manured pots germinated. After 49 days, the oat plants were measured for length. The mean length for plants in each treatment is recorded in the table below.

Unless later measurements would have shown oat growth to be too lush (leading to poor development), the results indicate that application rates of 20 tons/acre had positive effects on plant growth, with the freshest manures having the most positive effect.

Oat Seeding Growth*

Treatment #	Mean Plant Height	Standard Deviation	Significance of Difference from Total Population: Height
1	6.83	2.14	none
2	7.44	1.29	significantly greater
3	6.79	1.02	none
4	5.16	1.19	significantly lower

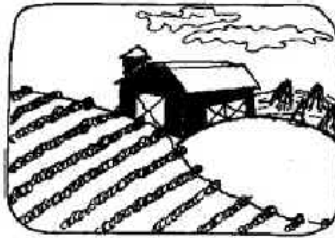
Total population: 6.64 mean height

*Although both chicken manure treatments 1 and 3 yielded slightly higher than the population mean, their respective means were not significantly different from each other. The fresh goat manure treatment resulted in significantly taller plants and the control treatment resulted in shortened plants, both with very high significance. Analysis of variance, showing a very strong significance (F=6.4), indicated a high level of significant difference between individual plants or pots within treatments. But, since sample size varied, the Student's test was used to locate areas of difference (not shown).

Toxic Effects?

In addition to its highly concentrated nature, fryer litter differs from plain old horse manure in another crucial way. Growth stimu lants and antibiotics are added to the feed in agribusiness chicken factories. First, herbicides and insecticides are sprayed on the fields that grew the feed. And then arsenic compounds -- 3-nitro, 4-hydroxyphenylarsenic acid and arsanilic acid -- have been added to fryer feed since the 1940's.

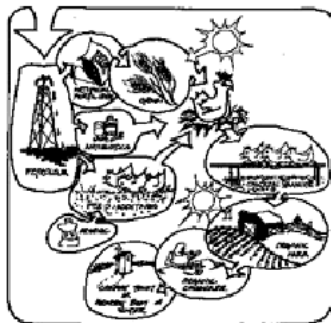
When I asked Les Hileman about the effects of arsenic in the soil, he stated that prior to the 1970's, when high levels of these compounds



were added to the feeds, arsenic build-up in the soil became a problem, causing depressed crop yields. Today, economics and federal regulations have reduced these levels to the point where he considers arsenic build-up in soils to no longer be a problem. Arsenic reverts to arsenate in the soil where it is strongly held in much the same way as phosphate by the clay fraction. This insures that arsenic will be released slowly.

Antibiotics are commonly used along with the arsenic compounds. When asked if any other compounds used to supplement chicken feed were known to cause problems with soil fertilized by broiler litter, Hileman stated that only antibiotics had caused such problems. At one time, antibiotics inhibited the development of mycorrhiza in legumes to the point of complete failure of legume fields for two years after application of broiler litter. Again, economics has pressed broiler factory managers, at least in Arkansas, to reduce antibiotic levels to the point where they no longer visibly check legume growth.

Antibiotics and arsenic compound use may differ in Western Washington from that in Arkansas, although the uniformity of agribusiness methodology argues that this is not the case. Local feed mixers and egg or fryer factory managers should be able to supply current feed supplement information.



Management Practices

It would appear that while chicken litter is a good fertilizer, it is not a great manure. In order to use it effectively to maintain a healthy soil life and high vegetable yields, it must be managed in a knowledgeable manner. We have not clearly determined which rates are applicable to row crops. However, given the high concentrations of nutrients in fryer litter, problems of soluble salts, potassium build-up with calcium depletion, and nitrate build-up in plant materials, quantities less than 20-40 tons/acre are called for.

Much discussion has gone on here at Pragtree Farm concerning whether and how to use fryer litter. We have engaged in a number of practices which I have outlined below as tentative approaches to fryer litter utilization:

- 1) For vegetable crops, fertilize lightly (less than 4 tons/acre of fryer litter) in the fall fields to be cover-cropped over winter. Then top dress the field in later winter -- again lightly. The green manure will benefit from the fertilizer, with the ratio of organic matter to macro-nutrients eventually turned under being on par with horse manure. The possibility of excessive nitrates in plants is of little concern with this practice as it will take place in the green manure crops, if at all. The nitrogen will be incorporated into living organisms which will then slowly re-lease it during the growing

season as they die off.

2) Manure "teas" and side dressings of fryer litter may be used later in the growing season for crops requiring high levels of available nutrients for quick growth.

3) Fryer litter can be composted, as is, just by stocking it in windrows and adding water. However, mixing hay, straw, weeds, leaves, garbage, silage toppings, etc., and especially some soil to add micro-nutrients, biological inoculum and buffering capabilities, is recommended.

4) If you are going to apply it in the spring, incorporate fryer litter and guano throughout the top soil a few weeks before planting, with addition of bone meal or other fast-acting phosphorus source to balance the readily available nitrogen and potassium. I would like to thank Woody Deryckx for reviewing this article and for the many suggestions he offered. Further exchange on the use of chicken manure on organic farms would be welcome.

Notes 1. Lappe, Frances Moore and Joseph Collins, Food First. 2. Chapman, Stanley L., "Soils and Fertility," Cooperative Extension Service, University of Arkansas, 1-77, 1977. 3. Thompson and Kelly, Vegetable Crops, fifth ed., McGraw Hill, 1957. 4. Rodale, J.I., Encyclopedia of Organic Farming, Rodale Books, Inc., 1971. 5. Kains, M.G., Five Acres and Independence, Dover Publications, 1973. 6. Hileman, L.H., "Broiler Litter as a Fertilizer," Arkansas Farm Research 14(1):6, 1965. 7. _____, "Pollution Factors Associated with Excessive Poultry Litter (Manure) Application in Arkansas," Cornell University Conference on Agricultural Waste Management, Rochester, NY, Ja 1970, pp. 41-43. 8. _____, "Effects of Soluble Salts in the Soil on Establishment and Growth of White Clover," Arkansas Farm Research, 20(3), 1970. 9. , "Effect of Rate of Poultry Manure Applications on Selected Soil Chemical Properties," Proc. International Symposium on Live-stock Wastes, American Society of Agricultural Engineers, 1971, pp. 246-248. 10. _____, "Response of Orchardgrass to Broiler Litter and Commercial Fertilizer," University of Arkansas Agricultural Experiment Station, April 1973. 11. Wolf, Ray, ed., Organic Farming, Rodale Press, 1977. 12. Hileman, L.H., "Transactional Dynamics of Poultry Manure in Soil," American Society of Agriculture Business, 1972. 13. Bandel, V. Alien, "Poultry Manure --An Underrated Fertilizer Material," The Agronomist, University of Maryland, 1972. For article whose viewpoint differs from the above, see: 14. Brinlon, William, jr., "Manure Management," Maine Organic Farmer and Gardener Nov-Dec 1976.