Organic Manures and Fertilizers for Vegetable Crops

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Animal manures contribute more to the soil than just nitrogen, phosphorus, and potassium. Continued use of manures builds organic matter in soils and improves soil structure. This modification of soil structure helps improve water holding capacity, aeration, friability, and drainage. In addition, many trace nutrients needed for optimum plant growth are available from manures. Plant nutrients are also released more slowly and over a longer period of time than from most commercial fertilizers.

Disadvantages of using manures are the handling and transportation problems associated with large amounts of manure required to obtain sufficient quantities of nutrients for vegetables. The use of fresh manure may also introduce new weeds into fields since certain weed seeds remain alive even after passage through animals. Another concern is that the careless use of manures can expose fresh produce to human pathogens like *E. coli* which can cause serious illness. Food safety must be a primary consideration in any vegetable operation but especially where manures are being used.

General Considerations

Fresh vegetables, not fresh manure. Manure should never be used fresh (raw) if you intend to plant directly into it; composting results in a more readily usable form of manure. Composting will also destroy many weed seeds that could otherwise be introduced into new fields or gardens. For more information on the composting process, see UK Extension Publication **HO-75**, *Home Composting: A Guide to Managing Yard Waste*. This guide along with other home and commercial vegetable publications are available from the Horticulture Department website at http://www.uky.edu/hort/home-horticulture. Links to additional information on commercial vegetable production, including organic practices, can be found at http://www.uky.edu/hort/documents-list-commercial-vegetable.

If fresh manure is used on soil, it should be worked in as soon as possible or covered with other organic materials such as straw, hay, or grass clippings to prevent the loss of nitrogen through leaching. No fresh manure may be used during the year of harvest for certified organic production so you may want to plant a green manure or cover crop on this ground for the first year (see website above for information on Kentucky cover crops). See also for detailed information on organic certification in Kentucky. If you are not concerned with organic certification you must still allow at least one or two months to pass before planting after fresh manure applications. This allows soil microbes to start the decomposition process that regulates nutrient availability and prevents burning of young plant roots.

Remember that some types of animal manures have higher nitrogen contents than others (see **Tables 1 and 2**). These include horse, sheep, chicken, and rabbit manures. These are sometimes referred to as "hot" and are best used after composting. Cow and hog manures are considered "cold" because of their lower nitrogen levels.

Application. Composted manures can be broadcast and worked into fields or worked into rows and beds for various vegetable crops. A general recommendation for vegetable gardens is to broadcast poultry, sheep, cow, or horse manure at 25 to 100 lbs per 100 square feet (approximately 5-20 tons per acre). This amount may need to be supplemented with 1-2 pounds of a complete inorganic fertilizer such as 10-10-10. Organic growers can supplement with ground rock phosphate or raw bone meal to obtain phosphorus required (see

below). For crops such as melons, squash, and cucumbers, composted manure can be worked directly into planting hills and mixed thoroughly with the soil. Manures can also be side-dressed with up to 5 pounds per 100 square feet of row.

Nutrient contents. It is important to remember that nutrient contents in manures vary widely according to age of the animals, feed used, moisture content, degree of decomposition, and the amount of litter or bedding material mixed in with the manure. The only really accurate way of determining the nutrient content of the manure you are using is through laboratory analysis. You may need to adjust your application rates up or down according to what you know about the age, quality, and moisture content of the manure.

When buying or getting ready to spread manure, remember that moisture content greatly affects the total pounds of nutrients in a ton of material. For example, broiler manure at 25-30% moisture when removed from the house will contain about 34 lbs of nitrogen, 37 lbs of phosphate, and 31 lbs of potash per ton. But a ton of fresh manure at 75% moisture will contain only 27, 28, and 14 lbs of these nutrients, respectively. At 75% moisture you will be hauling around 1500 lbs of water and only 500 lbs of solid material. Not all nutrients in manures are available to crops during the season of application. In poultry manure, for example, 90% of the N, most of the potassium, *but only half of the phosphorus* becomes available in the first year.

Since **phosphorus** in manure must decompose before it becomes available and since it is not very mobile in soil, broadcasting manure is not considered a very efficient way of applying this element for establishment of vegetable crops. For poultry manure, phosphorus and potassium portions are considered to be about 50-75% as effective as they are in commercial fertilizers during the year of application; the remainder is released as the litter decomposes. Supplement manures with a complete inorganic fertilizer or with an organically approved material like bone meal or ground rock phosphate.

How to use and convert fertilizer recommendations in UK's *Vegetable Production Guide for Commercial Growers*

Plant nutrient requirements provided for each crop in publication **ID-36** (*Vegetable Production Guide for Commercial Growers*) which is available at your County Extension Office or on the web at http://www2.ca.uky.edu/agcomm/pubs/id/id36/id36.htm. These nutrients are expressed in terms of the amounts of **nitrogen** (N), **phosphorus** or phosphate (P_2O_5), and **potassium** (K_2O) required by the crop.

Amounts of phosphorus and potassium recommended vary according to what may already be present in the soil. For this reason both conventional and organic growers should always have their soil tested, preferably in the fall or early spring. Soil test sample boxes and instructions are available from your County Extension Office.

To calculate the amount of manure required for application on a sweet corn crop, for example, first find the recommended nutrient application rates in publication **ID-36**. This information is usually presented in a table under that crop heading. ***Warning****: manure applications should never exceed the total nitrogen requirements of a crop in an attempt to satisfy phosphorus and potassium requirements--burning of the roots and leaves could occur.*

Nitrogen first. We will choose nitrogen as our "priority" nutrient which will be used to limit the total amount of manure to be used, i.e., we will calculate the manure requirements based only on the nitrogen recommendation. Although most manures high in nitrogen are also high in potassium (**Tables 1 and 2**), additional phosphorus may need to be obtained from other sources. Since soil and plant nitrogen tests are not

widely used in Kentucky and since much of the nitrogen in soils is used or lost from one season to the next, we make a blanket recommendation of 80-100 lbs of N per acre for sweet corn in ID-36. When commercial fertilizers are used, this amount is applied before planting and is supplemented by a sidedressing of 40-50 lbs of N per acre when plants are about knee high.

Consider the source. Now consider the source, moisture content, and quality of the manure or organic material to be used. If we are using a dry or composted material containing little or no moisture, we should use **Table 2** to make the necessary calculations. If we use fresh manure, the figures in **Table 1** should be used.

Making conversions. We have decided to use the lower N level of 80 lbs per acre, since we feel our soil may still have some residual N from last year's bean crop which was grown on this plot. We have found a source of composted poultry manure and plan to use it as our nutrient source. To calculate the manure required to provide the required 80 lbs of nitrogen, look at **Table 2** under poultry; the N content is 3.2%. Now divide the 80 lbs by 3.2 = 25 and multiply the result by 100 = 2500 lbs. This is the amount of this manure required to obtain the 80 lbs/acre of nitrogen recommended. To obtain this in tons simply divide again by 2000 (2500 Ã*f*Â·2000 = 1.25 tons).

In this example we will have obtained 80 lbs of nitrogen together with 130 lbs of phosphorus ($P_2O_{5)}$ and 45 lbs of potassium (K_2O). The amount of P_2O_5, and K_2O are calculated for the 2500 lbs of manure by multiplying 2500 by the appropriate percentages in **Table 2** and then dividing by 100. The amount of P_2O_5, for example, is 2500 lbs x 5.2 = 13,000 divided by 100 = 130 lbs For the amount of K_2O, multiply 2500 lbs x 1.8 and then divide by 100 = 45 lbs.

Additional phosphorus. Now suppose that the soil is very low in phosphorus and the soil test suggests applying 180 lbs of phosphorus. We have obtained 130 lbs of phosphorus from the poultry manure and need an additional 50 lbs, but do not want to apply much more nitrogen.

Looking at **Table 2** we decide to supply our phosphorus using raw bone meal which is 22% P_2O_5 and 3% N. Dividing 50 lbs of P_2O_5 by 22=2.27 and multiplying by 100=227 lbs Thus, 227 lbs of raw bone meal/acre will supply 50 lbs of P_2O_5. Performing a similar calculation for the N tells us that we will only obtain about 7 (6.8) lbs of N/acre using raw bone meal. Use this same means of calculation if additional potassium is needed.

Note: *Information in Tables 1 and 2 should be used only as guidelines*. *Nutrient contents for manures vary greatly and the figures below are averages from a range of possible values*

Table 1. Nutrients in FRESH animal manure.

Average nutrient composition

(*percent of fresh weight*)

Source	Water content	N	P_2O_5	K_2O
Beef cattle	80	0.70	0.45	0.55
Dairy cattle	84	0.60	0.25	0.60
Horses	60	0.60	0.25	0.45

Hogs	75	0.50	0.35	0.65
Sheep	65	1.05	0.35	0.95
Laying hens	75	1.00	1.25	0.50
Broilers (litter)[1]	30	2.95	2.75	1.85

[1]some broiler producers use Roxarson and Nitarsone in their feed mixes as medications. Growers using litter containing these products cannot sell produce grown with this manure as certified organic in Kentucky.

Table 2. Nutrient contents of DRY manures and organically approved fertilizer materials.

Average nutrient composition

Source (*percent dry weight*)

	N	**P_2O_5**	**K_2O**
Dairy cows	1.3	0.9	3.0
Feedlot cattle	1.7	1.2	3.0
Horse	2.3	0.9	1.7
Poultry	3.2	5.2	1.8
Sheep	3.5	1.4	3.5
Hogs	3.5	0.5	0.7
Goat	1.5	1.5	3.0
Rabbit	2.4	1.4	0.6
*Tobacco stems**	1.5	0.5	7.0
Bat guano	10.0	2.0-4.0	0-2.0
Blood meal	13.0-14.0	2.0	1.0
Bone meal, raw	3.0	22.0	--
Bone meal, steamed	1.0-2.0	11.0-15.0	--
Cottonseed meal	6.0	0.4-3.0	1.5
Fish meal	10.0	6.0	--
Fish emulsion	5.0	2.0	2.0
Feather meal	12.0	0	0
Soybean meal	7.0	1.2	1.5
*Tankage**	7.0	10.0	1.5
*Sewage sludge**	1.5	1.3	0.4
*Sewage sludge activated**	6.0	3.0	0.2
"soft" rock phosphate	0	14.0-16.0	0

Greensand	0	0	3.0
Phytamin 800	7.0	0	0

*Not cleared for certified organic production. Sewage sludge should *not* be used for vegetable crops because of possible heavy metal and *e. coli* contamination.