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Managing Manure in Potato and Vegetable Systems

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Figure 1. Farmer-to-farmer agreements to spread manure over a larger land base can contribute to higher soil productivity.

Role of manure

Maintaining and improving soil quality in vegetable and potato systems is a difficult task. Heavy equipment can cause compaction, crop residues tend to be minimal in these rotations, and sandy soils generally have low organic matter levels. Degraded soils can be revitalized by adding manure or compost. To minimize costs while enhancing organic inputs, a combination of manure and cover crops is recommended to rebuild soils.

Both short-term yield benefits and long-term soil building can occur through the addition of organic matter. Recent studies in Michigan suggest that application of poultry manure with a reduced fertilizer rate can enhance potato tuber yields by 30 to 60 cwt/acre at some sites (Figures 2 and 3). The mechanism is under study but may be related to any of the following: enhancement of soil microbial activity, the active organic matter fraction or enhanced nutrient supply.

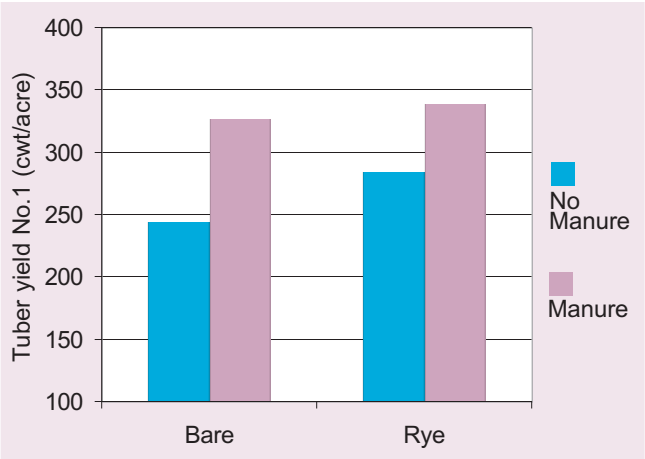

Figure 2. Chip potato response to 160 lb N/acre fertilizer plus 5,000 lb/acre aged poultry manure, supplying about 40 lb N/acre. The soil was left bare in the winter or a rye cover crop was used. (J. Nyiraneza and S. Snapp, unpublished data.)

Other benefits take time to accrue and are generally associated with manures that contain large amounts of organic materials, such as dairy manure or manure from straw-bedded livestock. Soil quality benefits include increased water-holding capacity, improved soil structure

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and nutrient buffering ability (Grandy et al., 2002). An increase in soil organic matter of 0.5 percent will increase water-and nutrient-holding capacity by about 10 percent.

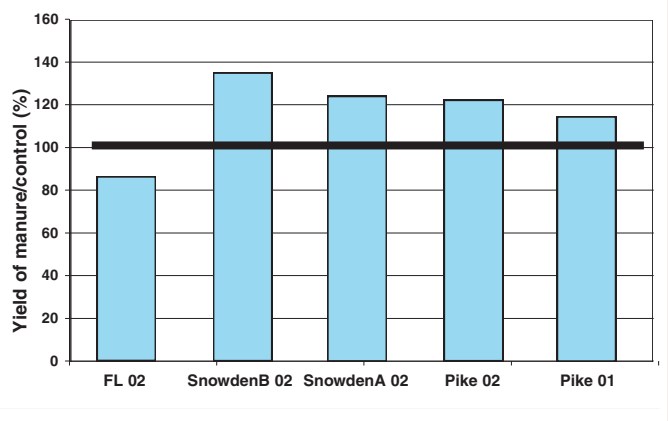

Figure 3. Summary of potato yield response as a percentage of control for experiments with five chip potato varieties conducted in 2001 and 2002 (Snapp et al., 2002a).

Benefits and potential negatives associated with using manure depend on the type of manure, how it is stored and the timing of application. It is highly advisable to obtain a laboratory analysis to judge the quality of the manure. Your county MSU Extension office has a list of manure testing laboratories. The list can also be accessed at <http://www.maeap.org/cnmp.htm>.

Manure analysis: Nitrogen and phosphorus content, pH and the amount of organic matter added are all useful measurements that provide insight into the quality of the manure. Total N and inorganic N (ammonia and nitrate) are particularly useful for estimating N availability. Phosphorus builds in the soil, and the amount added with manure should be accounted for and subtracted from fertilizer applied.

A sample is only as good as the sampling technique used, and it is important to obtain a representative sample from the manure storage facility. Your county MSU Extension office can provide guidance, or check with the testing laboratory to determine a recommended sampling procedure. One useful method is to obtain a sample from at least three different depths of the storage facility, preferably just after the slurry or pile has been well mixed.

Estimating nutrient fertilizer credit

Tools to improve estimates of how much and when nutrients will be released from manure include forms and software to help calculate nutrient budgets from manure applications (http://www.maeap .org/resources.htm#1). See the information available through the Michigan Manure Resources Network (http://web2.msue.msu.edu/ manure).

One of the most accurate ways to adjust nitrogen fertilizer rates is to sample soil just before planting and measure the soil inorganic nitrogen. If soil nitrate is above 20 ppm, reduce N fertilizer application by about 60 lb/acre (Snapp et al., 2002b).

Recent research indicates that nitrogen is released at a slow, steady rate from mixed quality organic inputs, such as those supplied by incorporating cover crops plus manure. Figure 4 shows the pattern of nitrate release from rye cover crop residues combined with composted manure at a reduced rate of fertilizer. This combined treatment supported the highest potato yields and the lowest fertilizer cost.

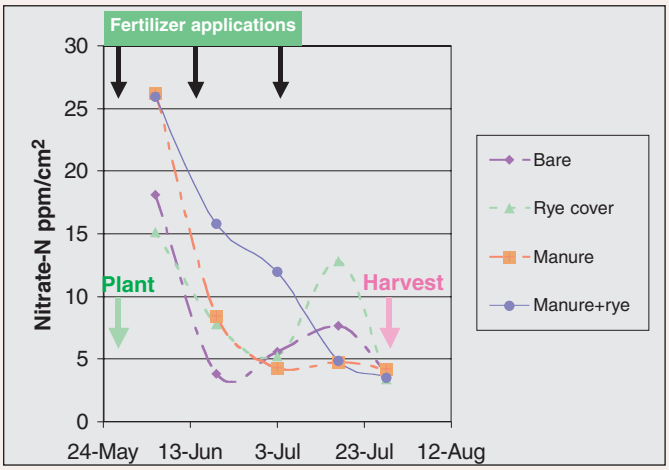

Figure 4. Soil nitrate measurements indicate availability of nitrogen (N) from 5,000 lb/acre of poultry compost applied to a bare or a winter rye cover crop-potato rotation, where N fertilizer was applied in three splits as indicated by the arrows. Total N availability was adjusted to 180 lb/acre for each treatment. Yield data in Figure 2 (J. Nyiraneza and S. Snapp, unpublished data).

Timing of manure application

There are trade-offs to be considered in timing manure applications. Manure application in the fall is easier to manage to obtain nutrient release in the spring when crop nutrient demand is high (Table 1). Manure applied in the spring has the advantage of not being vulnerable to nutrient loss over the winter, but it may be a challenge to estimate fertilizer credits accurately.

Applying manure to soil with wheat residues or a living cover crop helps optimize nutrient efficiency and benefits from manure.

Another timing question is whether to apply manure ahead of or after fumigation. The lowest risk approach is to apply manure in the fall, just ahead of fumigation. Further research is required because it is also possible that benefits can be obtained from applying manure after fumigation.

Adding manure directly before planting can increase risk of disease, such as common scab (Streptomyces scabie) in potato. Consider carefully manure effects and disease potential before incorporating manure in the spring. Composted manure will generally be much safer and reduce disease risk.

Table 1. Positive and negative aspects of fall vs. spring manure application.

Fall application		Spring application	
Positive	*Negative*	*Positive*	*Negative*
Easier to estimate nutrient availability	Potential for N, P loss over winter	Less opportunity for nutrient loss	Nutrient release may be slow if temperatures are cool.
Lower disease risk	Bare soil after manure is applied	Availability from livestock producers	Disease risk may be higher

Management strategies

To optimize benefits from manure, growers need to consider both timing and placement. Improved management options include the following:

- Broadcast manure on a forage crop or a cover crop before production of vegetables or potatoes in a rotation sequence.
- Apply manure in the fall through injection or spreading followed by an incorporation operation, then plant a winter cover crop such as rye or wheat that can take up any nutrients released over the winter.
- Apply manure to a field with no-till wheat stubble or significant amounts of other crop residue remaining on the surface.
- Because manure is a heterogeneous substance and does not apply smoothly, double spreading (30-foot instead of 60-foot centers, for example) or applying the manure first in one direction and then in the other will improve uniformity of application.
- Calibrating the manure spreader is the foundation of good manure management and accurate estimation of nutrient supply.
- Apply poultry manure or slurries for short-term benefits, but do not expect long-term soil building unless manure with significant amounts of organic matter (e.g., straw-filled or solid dairy manure) is applied.

Manure effects on crop disease

In the past, manure has been associated with soilborne diseases such as common scab (*Streptomyces scabie*). Tuber soft rots also may be enhanced by applying manure, particularly large amounts, such as 20,000 lb/acre. Manure management and quality have changed, however. Straw bedding and solid material is no longer common. Lagoon storage of slurries is becoming the norm. Recent research suggests that acidic slurry manure does not consistently enhance the risk of common scab and may occasionally suppress it (Conn and Lazarovits, 1999). To reduce disease risk, however, it is still highly advisable to use scab-resistant potato varieties and to apply manure in the fall rather than the spring.

Recent research from the Great Lakes region indicates that two or more years of applying composted poultry manure, swine manure or composted paper mill residuals can suppress soilborne diseases in some cases. At some sites, root rot disease was suppressed and a healthy crop of snap beans, cucumbers or potatoes was produced (Cooperband, 2002; Snapp, unpublished data, 2003). Further research is required to improve knowledge of how manure quality and quantity interact with site and crop type to influence disease management.

The bottom line for healthy crops is that manure and compost should be applied with sufficient time for decomposition to occur. Ideally, these organic inputs should be applied to crops grown in rotation with vegetables, such as field crops, forages or cover crops.

Food safety

It is important to reduce any risk of contamination from manure to prevent food-borne illness from E. coli or other bacteria. General guidelines are available in "Food Safety Begins on the Farm". They are summarized here, though the full text is recommended:

- Manure should never be used as a sidedress. It should be applied at least 120 days before a crop is harvested.
- Manure should be stored for 60 to 90 days before application, if possible.
- Well-composted manure is preferred, in particular when a 120-day waiting period is not feasible.

Figure 5. To build soil quality requires high levels of organic matter inputs.

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