Magnan Composting and Compost Heat Energy Utilization Project

VT Alternative Manure Management Report – Integrating Composting Technologies and Livestock Bedding and Compost Utilization Practices

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Final Report and Summary of Activities

June 1 through October 10, 2007
Summary of activities:

Deliverable: Monitoring and analysis of phosphorus, nitrogen and carbon (organic matter) in composting process

The final compost samples were submitted to the UVM Laboratory and Woods End Research Laboratory (for replicates) in April. Due to a backlog of analytical work at the UVM lab, the sample results were not obtained until August. The Woods End samples confirmed the data obtained from UVM. See Attachment A: Compost Sample Analytical Results. Project team members Heather Darby and Brian Jerose met to review the analytical results and reporting needs. Darby and Jerose met with Terry Magnan and Paul Stanley to review preliminary results and connect to project objectives and implications for management of farm nutrients.

With few exceptions, there were no statistically significant differences in the Total P or Total Soluble P between different compost recipes or over time. See Attachment B: DHCH Final Report by Dr. Heather Darby on review of the sampling and analysis for the project. While the three recipes used for mixing compost feedstocks utilized different sources of bedded manure or incorporated additional carbon/bulking agents in the form of woodchips, their relative differences in moisture content and most importantly, carbon to nitrogen (C:N) ratios were minor. The starting C:N ratio measured was between 18:1 and 22:1 for all recipes. This is lower than the recommended 25:1 to 30:1 ratios listed in many references (Rynk, et al, 1993). However the excellent thermal energy production was achieved in all compost mixes, with recipes that included more woodchips resulting in the greatest thermal energy production over the longest period of time. This is believed to be due to both improved porosity within the compost pile and longer-term carbon availability. The relatively low starting C:N ratios likely resulted in some losses of ammonia –N from the material during the first few days of composting activity. All compost recipes resulted in similar end products of finished compost that were of high quality, without negative odors, free of weed seeds and good physical texture (crumbly aggregates without clumps). It is possible that using significantly greater portions of carbon rich ingredients would have resulted in a higher C:N ratio and had some influence on P dynamics but was not practical in this particular farm setting.

Conducting the sampling experiment in an operating farm setting had several impacts on the project. Estimates of manure and bedding volumes were lower than originally forecast. Original planning and design had accounted for up to 3000 tons of bedded manure as feedstocks. In the first 18 months of operation, the average annual production is between 1400 and 1800 tons, with a finished compost volume of 900 tons. The individual compost batches used in the testing period averaged 117 tons. See Attachment C: DHCH Compost Mix Log. The timing of mixing of batches related to other farm labor needs extended the period of sampling for experimental batches. Operation of the thermal energy recovery system using a negative aeration composting method also was a factor in timing of new compost batches relative to the heating demand of the adjacent facility (radiant floor slabs and hot water preheater).

The compost sampling method, specifically depth of sampling was also impacted by the negative aeration (blowers on the vacuum cycle) composting method. The average depth of sampling was 50 to 100 cm from the pile surface, mixing 10 grab samples from a single windrow to form a composite sample. While this sampling method creates a representative sample at this depth, it was influenced by both the static pile aeration and the overhead irrigation. The composted materials tended to form a stratified moisture regime, meaning the base of the pile closest to the aeration channels (gutters) would be drier than the upper layers of the pile most often moistened through irrigation. Therefore the sampled compost likely represents compost that is both higher in moisture and in nutrients. The project team believes this may also impact the low C:N ratio observed versus what is commonly found in the literature about effective composting as well as observations on other composting projects.

Better understanding of the composting system nuances created by the negative aeration and irrigation components may have led to an improved sampling design. In retrospect, placement of compost "pouches" connected to a string or a core-type sampling method may have given more representative samples for this particular operation. This only would be true given the mode of operation over the past year. Should more intensive irrigation, higher compost mixture starting moisture content or other operational variables be introduced, these would also need to be evaluated in a future composting sampling design.

The relationships of the composting system and use of compost to nutrients in farm waste streams are multiple. On mass balance and nutrient distribution levels, 6.5% of the farm manure P was converted into compost and 4.3% of the total farm manure P was exported as compost sold off-farm. The majority of the farm manure nutrients are spread on farm fields in the form of liquid manure stored in the two farm manure lagoons. See Attachment D: Mass Balance for Phosphorus and Attachment E: P Export via Compost. These two attachments describe how calculations for the total pounds of P for liquid manure and composted manure were performed. The Archambault manure lagoon referred to in Attachment D is 3 miles from the home farm and none of the manure was transported and incorporated into the compost operation. The total proportion of manure diverted to compost is expected to grow in future years provided affordable carbon and bulking agents can be sourced. The high cost of sawdust, wood shavings, straw and wood chips act as a limitation to mixing higher C:N ratio compost batches and for the total tonnage and volume of compost produced.

The production of compost has important benefits for the timing of nutrient applications. The ability to store compost for use at optimal times on crop fields or for optimal periods of compost sales avoids the need to set aside acreage for spreading of solid manure during the growing months or construction of some other type of manure storage. The P-Index for the farm's 62 fields indicates that presently 2 fields are in the high range. Improving the flexibility in timing of manure and nutrient applications is an important factor in reducing P loss risks. See Attachment F: P Index and Heifer Numbers.

Other important connections to the P-Index are related to the use of the compost. Two inputs into the P-Index model, 1). Annual Soil Loss (tons/acre), and 2). Percent soil cover, are impacted by the use of compost based on observations from project demonstration applications. Plots of crop fields where compost was applied were subject to considerably less erosion than the control plots left bare (VT AMM Report DHCH, 30Sep06). Factors in the tons/acre of soil loss equation, RUSLE II, would need to be created to accurately model events in the field. Some additional research would be necessary to establish criteria for compost characteristics; tons/acre applied relative to slope, soil type and other site conditions. The percent soil cover factor is only chosen as above or below 20%. Again research would be necessary to determine the tons of compost applied to meet the greater than 20% criteria.

Should these changes to the P-Index be made, additional estimates of P loss reductions could be made relative to the utilization of compost on crop fields. The incorporation of additional soil information such as use of the Cornell Soil Health Program, Soil Health Test Report for soil aggregation and other parameters into the P-Index would also show a response to applications of compost and other soil conservation strategies such as reduced tillage and rotations. The Soil Conditioning Index in use by NRCS could also provide a means to more accurately reflect the improvement in soil conditions to the reduced risk of P loss. As discussed in several references, increased soil organic matter increases rainfall infiltration, increases soil moisture holding capacity and reduces the total volume of runoff that can lead to concentrated flows and soil erosion (Magdoff and van Es, 2000).

Deliverable: Conduct open house to share project information with farmers, agency staff, professionals, municipal officials and interested public

The open houses conducted in May and November 2006 were attended by nearly 200 people including farmers, agency staff, municipal officials, contractors and interested citizens. Numerous other visitors have toured the compost operation and farm to learn about its design and operation. There are a number of farm operations that are now interested in use of this type of composting system with thermal energy recovery. Agrilab Technologies, a division of Acrolab of Windsor, Ontario is offering these systems to operations in the Northeast United States and southern Canada.

Deliverable: Seek and find alternative uses for compost such as erosion control

The project demonstrations provided examples of compost products effectively reducing erosion and aiding in rapid revegetation of disturbed soil sites. The compost applications in athletic field turf building and in constructed wetland creation also had positive results through this project. The local interest in using the compost for gardening and landscaping led to over 90% of product sales in 2007 going into these traditional applications. Some compost was blended with lime and sawdust for animal bedding with favorable results. This use may increase in the future, depending on bedding costs.

The sites used for compost product use demonstrations included:

1) Construction site stabilization and revegetation (on-farm) – four plots
2) Crop field erosion control (on-farm) – two plots
3) Motor cross track gully restoration (on-farm) – two plots
4) Construction site stabilization and revegetation (Enosburg Town Recreation Fields) – 3 plots
5) Athletic fields topdressing (Enosburg Falls High School) – 3 plots
6) Constructed wetland for household wastewater treatment (Fairfax development) – 1 system

The farm is interested to continue to work with contractors, engineers, agencies and municipalities to create custom blends of conservation mix to meet erosion control needs. As the VT Agency of Natural Resources Stormwater and Construction permits are more fully implemented and enforced in this region of the state, it is anticipated there will be a significant demand for local erosion control products and create an opportunity for value-added products at DHCH.

The powerpoint file “2007 Compost Use” is available to organizations, agencies and others interested in seeing the effects of compost products in various erosion control, revegetation and turf building applications from this project. Several other states have had considerable success incorporating compost product use into routine construction site stabilization, transportation projects and other revegetation activities.

Summary:

The Magnan's as owners and operators of Diamond Hill Custom Heifers will continue to operate the composting system and intend to expand production if possible. They have seen multiple benefits for the composting system related to decreased manure handling labor costs, generation of thermal energy which reduces expenses for heating oil purchases (in addition to many other benefits of decreased fossil fuel consumption) and the production of high quality compost products sold as additional farm revenue or used on-farm to improve soil conditions.

The static pile composting method using negative aeration is viewed by the farm operators as preferable to other composting methods (most commonly outdoor turned windrows) or other types of manure management. The covered system allowed for some level of control in a dynamic process such as composting. The quality of the finished product was very high and was easily sold despite the reduced need for labor to manage the system. Runoff from the compost production and storage area is also minimal compared to other manure handling or outdoor composting operations.

The integration of thermal energy recovery into the aeration process of the composting system was the most innovative aspect of this approach, and may result in manure management through composting becoming more cost-effective and viable as a common practice. Optimizing the timing of aeration and irrigation has made the system more efficient to operate, increased the energy production (and fuel savings), and created high compost products. These variables along with others in a farm setting may have introduced some enough factors into the compost sampling and monitoring process to mask any trends related to P dynamics related to C, N, moisture and aeration.

It is also recommended that the UVM Plant and Soil Science Laboratory be kept open and instead expanded. This laboratory provided not only important data to this project for manure and compost samples, but also expertise on sampling and analytical methods. More importantly, the laboratory provides soil, manure, compost and forage analyses for Vermont farms to guide a wide range of farm decision-making. Specifically the P-Index used to guide decision-making related to water quality protection uses results from this laboratory. Having results returned in a timely fashion is necessary or otherwise leads to on-farm decisions being made on past experience, vendor recommendations or other factors not related to the P-Index. The Magnan's have a P-Index prepared for their 62 farm fields and are one of many farms that are required to have one as a component of their Large Farm Operation or Medium Farm Operation permit. The P-Index and nutrient management plan guide economic and environmental decisions as to manure, compost and fertilizer spreading rates and timing.

Losses of nutrients, especially P, from farm waste streams have considerable potential to be reduced through applications that result in erosion control. Use of compost on crop ground was observed to reduce soil loss and assumed to reduce loss of P. Like other conservation practices that increase soil organic matter and improve soil physical characteristics, compost applications allow rainwater and snowmelt to infiltrate the soil

surface, improve soil moisture holding capacity and therefore reduce runoff. Additional research is necessary to better quantify and qualify the effects of compost applications on reducing soil erosion and P loss.

Loss of P through soil erosion at non-farm sites such as municipal recreation fields, ditches, construction sites and transportation projects is also a major water quality concern. The utilization of compost products that were custom-prepared for their specific applications were demonstrated to promote rapid revegetation and stabilization of disturbed soil sites. Care to ensure that nutrients from manure-based composts are not leached or otherwise lost from slopes or riparian areas is necessary and can be addressed through understanding of compost nutrient test results and the blending of fibrous materials to give these compost products mulch-like properties.

Other Attachments:

Project Summary, Composting and Thermal Energy System – November 2007

Budget Tracking and Reimbursement Request

References Cited:

Jerose and Magnan, "VT AMM Project Report, 30Sep06." Diamond Hill Custom Heifers, Enosburg Falls, VT

Magdoff, Fred and Harold van Es, 2000. Building Soils for Better Crops, 2^{nd} edition. Sustainable Agriculture Publications, SARE. Burlington, VT.

Rynk, et al, 1993. The On-Farm Composting Handbook. NRAES, Ithaca, NY.