Northern
Forests
Compost
Collaborative

Final Report
May 2006

Linking
Manure Best Management Practices
To
Improved Compost Production

New York State Department of Economic Development
Environmental Services Unit
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I. Background

The Northern Forest Compost Collaborative (NFCC) project was conceived by several farmers located in central New York State. These farms were interested in improving the production and quality of farm composts. Cornell Waste Management Institute (CWMI) and WASTE NOT Resource Solutions (Waste Not) worked with the farms to develop a proposal that would facilitate the development and exploration of a collaborative that would share equipment, technical assistance, supplies and farmer-to-farmer knowledge with the intent of improving compost production and end-use practices. The New York State Department of Economic Development, Environmental Services Unit (ESU) awarded the project funding for Research and Development (R&D) activities in March 2003.

Waste Not was designated as the primary contractor with project team members as subcontractors and farmer participants as collaborators. Waste Not consists of Brian Jerose, Darren Kupinsky and Brian Luton. Jean Bonhotal, compost specialist at CWMI, Ed Staehr and Jacob Schuelke, economists at Cornell Cooperative Extension, and Maureen Knapp, the Farmer Chair for NFCC, were the primary project team members. Scott Potter of Dairy Support Services, Inc (DSS) and Steve Wisbaum of the Champlain Valley Compost Company served as advisory project team members. An initial group of eight farms expressed interest in participation. Five of the original interested farms and three other farms are currently collaborators.

The eight farms that are active compost collaborators listed below by town:

McMahon Farm, Summerhill, Cayuga County- Sean and Nancy McMahon
Cobblestone Valley Farms, Preble, Cortland County- Paul and Maureen Knapp (chair).
Dairy Development International, Homer, Cortland County- Larry Jones.
Twin Oaks Farm, Truxton, Cortland County- Kathy Arnold and family.
Jerry Dell Farm, Virgil, Cortland and Dyrden, Tompkins County- Sherman family.
Sto-Ridge Farm, Fenner, Madison County- Hank and John Stoker
Casey Farms, Fabius, Onondaga County- Bill and Joanne Casey
Toad Hollow Farms, Onondaga, Onondaga County- Bill Guptill

Livestock farms in New York and other states have faced increasing production costs related to fuel, fertilizer and other expenses. At the same time, increased scrutiny is placed on farms to manage manure in ways that do not contaminate water with nutrients, pathogens and solids. Integrating composting practices into farming operations and refining compost production and utilization methods was the goal of this project. Determining the most cost-effective scale and approach was accomplished on an individual farm level.

II. Learning Targets

Three learning targets were the basis of project tasks and milestones. The research and development work focused on addressing the following:

1. *Determine optimal logistical, operational and technical components that lend to profitable compost collaborative.*

    The success of farmers combining resources on any shared goal is based on a combination of factors. In this case, the use of common and/or other appropriate equipment and sharing technical assistance in a timely and effective fashion was key. Identifying the economic parameters for shared equipment use, improving farm and site-specific economic efficiency and improving the composting knowledge base has increased the economic sustainability and ultimately the production of compost on all participating farms.

2. Evaluate the costs of a compost collaborative and appropriate scale.

    The economic attributes of a composting enterprise begin on a farm and site-specific level. The costs and benefits of composting manure and companion feedstocks and the ultimate on-farm utilization or off-farm distribution of the compost products have been determined to be inherently farm and site specific. The benefit of developing a collaborative is in the shared knowledge and resources. By sharing knowledge and resources, individual farms have been able to achieve their own efficiencies of scale and improve the economic efficiency of their composting enterprises.

3. Evaluate grading and certification programs relevant to compost quality.

    Grading and certification is developed to improve consistency and predictability in composting operations and ultimately improve compost product quality and end use performance. A number of grading and certification programs exist in this capacity to assist compost producers with their production processes and product marketing or on-farm use. Sampling and monitoring procedures, and the development of a Quality Control-Quality Assurance (QCQA) document have enabled the project technical team to recommend site-specific best management practices to farmer participants that will maximize economic efficiency and compost quality.

III. Methodology

A number of steps were taken as part of accomplishing the learning described above under II. Learning Targets. As Waste Not and the other project team members prepared the EIP application, farms were contacted about their potential interest in compost collaborative participation. These farms were identified via word of mouth of the originating farms (Cobblestone Valley Farms, Casey Farms, Twin Oaks Dairy) and through recommendations of local Cornell Cooperative Extension (CCE) and soil and water conservation district staff. The project activities, outcomes, highlights and questions raised are described below:

1. Farm and Compost Site Visits:

Farm and compost site visits were initiated at the onset of the project and have taken place regularly through the entire project term. The project team consists of Waste Not project management, technical assistants, and project subcontractors such as CCE and CWMI. Project team members would meet directly with participating farmers.

Group site visits provided a forum for:

- Initiating the development of site-specific manure handling and compost production plans
- Initiating the development of operational economic analyses
- Initiating the development of farm-specific sampling and analysis procedures and tasks
- Initiating the development of collaborative and farm-specific QAQC protocols. Depending on the intended compost end-use, farmer composters may or may not need the same protocols as commercial, municipal or biosolid compost facilities.

Site visits continued throughout the project term by individual project members to work on specific area tasks and project milestones.

For instance, during the spring, summer and fall of 2005 the Waste Not technical assistant visited farms on a regular basis to record pile temperatures and volumes, take compost and soil samples, and photo document the layout and site use characteristics of participating farms. These visits were essential to the sampling and analysis milestones, as well as being important to the development of revised Manure Handling and Compost Production Plans.

During these individual technical visits, the project team members had opportunities to discuss in detail the logistical, site, and management decisions that were of key importance to their area of expertise. Seasonal and site appropriate tasks were also suggested during these visits and consisted of information relating to: turning procedures and frequency, screening and use, pile construction and form, site improvements and maintenance, etc.

Site visits were the primary forum for farmer/participant feedback and dialogue. Through this exchange the project was able to actively respond to the ongoing research needs and questions of farmer/participants.

For instance on a site visit during the fall of 2005 a farmer/participant indicated that they were very pleased with their production procedures and the quality of their compost. However, as we began to address compost end-use per their farm's needs, the farmer recognized that there was very little research information available regarding the application of compost to intensively managed rotational pasture. Specifically, this farmer requested information on compost application timing as related to levels of pasture rejection by lactating dairy cows. This knowledge gap had been explored through the sampling and analysis approach, and is partially addressed by the economic analysis of compost use on-farm. The discovery of this research gap has additionally led to the further exploration of research and funding opportunities to address this question specifically. During the fall of 2005 a Northeast USDA Sustainable Agriculture Research and Education (SARE)-Partnership Proposal was developed that would allow for an expansion of the NFCC sampling and analysis procedures and would partner local farms with independent contractors and CCE personnel in exploring this issue. This proposal was not funded and remains an identified farmer and project team research need.

2. Describe existing manure management practices, review additional manure handling options, and develop Manure Handling Plans:

Through site visits, phone interviews and discussion amongst project team members, *Manure Handling Plans* were written.

Manure handling assessments gathered a range of information including:

- Animal numbers by age group and species
- Housing type and bedding materials
- Grazing / Loafing Periods
- Other farm specific herd and manure production factors

This background information provided the necessary data to calculate expected manure production. Manure handling assessments also gathered technical information related to:

- Farm Labor
- Land base and site analysis
- Existing manure handling equipment
- Existing seasonal manure handling and spreading methods
- Other site specific manure handling factors

Preliminary recommendations or options were listed to guide research and prompt further discussion. Draft manure management plans were provided to the farms and on-going correspondence provided updates and revisions to the plan throughout the project period.

The outcome of the plans was a benefit for both the farmer participant and the project team members. The plans along with verbal recommendations during site visits helped to determine on-farm compost site locations, as well as providing steps towards obtaining additional compost feed-stocks from on and off-farm sources. Utilization of Agricultural Environmental Management (AEM) Tier I and Tier II worksheets, along with other standard questions, provided a standardized assessment tool that could accommodate the unique circumstances of each farm. This approach is used by Soil and Water Conservation Districts in New York, as well as Watershed Agricultural Programs for the Catskills and Skaneateles Lake watersheds. This methodology can be used and modified by other farm technical support personnel and adapted to specific programs such as composting and compost use. Ultimately the plans confirmed that farmers and project team members were working with as much shared information as possible and aided in projecting the impacts of possible management changes on manure handling practices.

3. Develop Compost Production Plans and maintenance procedures:

Once the farm background was sufficiently documented in the manure management plans, Compost Production Plans and maintenance procedures were developed. Draft plans were produced to aid in the discussion of the scale and intensity of composting operations that would be implemented on each individual farm. Other resources such as guidance on compost quality (reducing weed seeds and potential pathogens) and recommendations on compost utilization were included.

The intended outcome of the Compost Production Plans was to provide a checklist of Best Management Practices (BMPs) for the farmer participant. The plans were provided to farmer participants in comprehensive project binders that included additional resources such as Economic Analyses, Sampling and Analysis results, QCQA protocol documents, CWMI Compost Fact Sheets, resources and contacts, links and other appropriate referrals. Compost Production Plans ultimately confirmed or reinforced recommendations made during site visits, and was geared toward individual on-farm compost sites. The Compost Production Plans will be a benefit to the farmer participants as well as agricultural technical support staff (agency, private or non-profit).

Compost Production Plans provide an overview and description of:

- Composting activities

- Describe composting procedures
- Approximate production volumes
- Describe operational goals
- Integrate composting activities into the full-farm plan

4. Acquire and evaluate composting equipment including turners, bale choppers and screeners:

While most farms have tractors, skid loaders, manure spreaders and/or other useful equipment, it was not clear if dedicated pull-behind turners, specialized loader turning, and other equipment would improve the cost-effectiveness of on-farm composting practices.

After trials of 2 compost turners and a site visit from a commercial custom windrow turner business operator in Vermont, the initial equipment was selected by project team and farmer consensus. The Sandberger windrow turner was effective for the majority of the collaborating farms. Its purchase price and ability to be pulled over the road by existing tractors was the primary factor in Dairy Support Services, Inc. (DSS) acquiring this model. This turner was shared between the farms and transported and operated by DSS, who charged the collaborators for its rental. Three farms, Cobblestone Valley Farm, Toad Hollow Farms and Dairy Development International (DDI), rented and ultimately used other equipment for production of compost that they determined best suited their needs and scale of composting. Not surprisingly, these farms were the largest producers of compost products and needed equipment that could be used for compost production more frequently.

The logistics of shared equipment use required frequent communication and resulted initially in some sequencing issues. DSS as a custom operator often needed to prioritize its primary business of crop harvesting and manure spreading, and save its windrow turning work for rainy days. Operating on wet soils caused more field compaction, rutting and damage to the compost sites. A possible solution would be for DSS to leave the turner for farmer participant operation during periods when site conditions are more desirable. All eight collaborative farms intend to continue composting, with five expected to continue using the DSS turner. DSS has been able and will continue to rent the turner to other farm composters in Cayuga County who are not formal NFCC collaborators. Additionally the sequencing and communication between farmer participants and DSS has greatly improved and will ultimately contribute to the financial sustainability of DSS being able to offer windrow-turning services.

5. Conduct on-farm workshops and meetings for training farmer collaborators and project team members:

Five on-farm meetings and workshops were held during the course of the project with the fifth and final on April 7th, 2006. One was held at Smith Quality Eggs, a poultry and dairy heifer farm in Lafayette. The rest were held at Cobblestone Valley Farms, an organic dairy and diversified strawberry and pastured poultry farm in Preble owned by Paul and Maureen Knapp.

The workshop meetings provided NFCC participants with:

- Progress updates
- Economic Analysis discussions
- Compost quality and production discussions
- Sampling and analysis discussions
- Production practices troubleshooting
- Site design and Best Management Practice discussions
- Opportunities for farmer to farmer discussion
- Opportunities for farmer to project team feedback and discussions
- Equipment use demonstrations and new equipment demos

The outcome of these workshops was a net knowledge gain of greater insight into planning and implementing composting practices amidst diverse farm and site-specific scenarios. Most farms indicated that they benefited from the meetings although Smith Quality Eggs, a host of one early meeting ultimately decided not to adopt composting practices. Attendance was very positive with the exception of one summer meeting that coinciding with good haying weather. These types of meetings were attractive to both NFCC and non-NFCC members interested in improving their technical knowledge and understanding of farm composting issues and management practices.

6. Test bale-chopping equipment to capture additional composting amendments and feedstocks from bales no longer suitable for feeding livestock:

Three bale choppers have been evaluated, and trial operated for practically managing unused, baled hay. It is now commonplace to see discarded round-bales, either plastic-wrapped or unwrapped, along the fringes of crop fields and farmsteads. These bales are no longer suitable for feeding to livestock and are not perceived to have other value. As they weigh 400-800 lbs. and may contain nearly a 1/2 cubic yard of material, they represent a potentially recoverable resource through composting. Specifically, they can bulk and amend wetter manure to become suitably dry and solid for handling through composting.

The first two bale choppers evaluated to date did not perform well with bales that were not uniform, relatively dry and consistent with feed quality baleage and/or haylage. The discarded bales were often molded, with inconsistent, moist and/or gummy portions and portions of decent drier hay. After additional research in selecting and locating bale-chopping equipment, the project team discovered a bale chopper that was be better suited for processing these discarded bales.

Double-R Manufacturing of Prince Edward Island, Canada manufactures the Bedding Pro® bale chopper. The Canadian province also has a situation where numerous bales of hay are discarded after being rejected for livestock feed. The manufacturer attempted to specifically utilize these wetter, moldy bales for mulching, bedding and other applications. A Highgate, Vermont farmer was observed using the equipment. The implement attaches to the 3-point hitch behind a tractor and is powered by the tractor's power take-off (PTO). As with all tested models, a second tractor is required to load the round bale on to the bale chopper. Three farms rented a Bedding Pro® for use at the end of the project and now intend to continue to use this equipment to varying degrees in the future. A full cost-effectiveness analysis of using this equipment was not possible in the time frame but the farms were confident this was the appropriate implement for this task versus the earlier two choppers that were tested.

7. Sampling and Monitoring Programs:

Sampling and Monitoring Programs were initiated during the first composting season and have been on going throughout the project. Sampling and monitoring peaked during the 2005 growing season and would wrap up during the spring of 2006. Sampling and monitoring took place across an array of research and operational areas and was responsive to the feedback received during farm and compost site visits.

Sampling and monitoring procedures were developed to:

- Evaluate the quality of compost produced on participating farms
- Assess the effectiveness and economics of various compost production procedures as directly related to end-use goals
- Develop an inventory of compost chemical analysis as relates to fertilizer value and economics of composting vs. daily hauling manure
- Develop comparative analysis of compost quality as related to compost production methods
- Support the development of compost quality assurance measures as determined by QAQC protocols
- Provide farms with chemical analyses of their compost products to support either commercial sales and/or on-farm use as fertility and soil building amendments

Data ascertained through sampling and analysis was critical to the development of the economic analysis reports, provided context to the QAQC protocols and ultimately led to the revision of Compost Production Plans. Sampling and analysis allowed farmer/participants and the project team to better understand the dynamic relationship between compost production procedures, economics and end-use.

Sampling and monitoring procedures and outcomes are described in detail in Appendix C – Sampling and Analysis Reports.

Sampling and analysis consisted of:

- Compost/Soil Chemical Analysis
  - *ref. C1* - Comparative Compost Analysis spreadsheet
  - *ref. C2* - Sample Laboratory Report – Compost
  - *ref*. C3 – Sample Laboratory Report – Soil
- Growth Assay Series
  - *ref. C4* - Trial(T) 1,2,3 – Descriptions and Methodologies
  - *ref. C5* - Growth Assay Comparison spreadsheet
  - *ref. C6* - T1 Sample - “Resident Weed Seed Density and Type”
  - *ref. C7* – T2 – “Controlled Field Application of Compost Control Plot and Applied Plot Soil Chemistry” spreadsheet
  - *ref. C8* – T3 Sample – “Germination and Growth Trial Evaluating Maturity and Quality”

8. *Create tracking and documentation protocols, gather economic data and present economic analyses of composting operations:*

Documentation and economic tracking protocols were initiated during the introductory project period. Ed Staehr, formerly of CCE-Onondaga County, in close association with project team members was responsible for developing an initial framework for monitoring the costs of producing compost on-farm. During the fall of 2004, Ed Staehr accepted a position with Cornell University’s – Farm Link Program. The project team evaluated opportunities for bringing on a new Agricultural Economist and subsequently began working with Jacob Schuelke of CCE-Tompkins/Tioga/Cortland County Dairy Team during the spring of 2005. Jacob has been a great asset to the project and, through close association with project team members and farmer participants, has developed a series of comprehensive economic reports and analyses.

These reports are described in detail in Appendix A – Economic Analysis and Reports.

Economic Analysis reports consist of:

- Composting Economics Write-up
  - *ref. A1* – detailed analyses on costs of composting manure in site-specific farm settings as compared to daily

hauling raw manure. This report also includes farmer participant responses to a series of questions/composting goals that they had previously developed.

- Comparative Economic Analysis
  - *ref. A2* – this report integrates economic data with sampling data and analyzes the economic value of compost as a fertilizer, compost as a fertilizer in a pasture system and compost as a fertilizer in a field crops system.
- Compost Economic Fact Sheet – "Did You Know"
  - *ref. A3* – This fact sheet provides a sound-byte type summation of the economic, environmental, and farm operations implications of composting.

The economic analysis portion of the NFCC project contributed a great deal to the knowledge base and understanding of farm and site-specific composting systems. The project team and farmer participants within the collaborative were able to gain valuable insights into the economic factors that impacted the sustainability and efficiency of their composting operations. This information was and will continue to be utilized to revise Compost Production Plans and will fundamentally provide a foundation for developing and expanding on-farm composting operations across the region and beyond.

9. Quality Assurance Quality Control Protocols:

The development of QAQC protocols is integral to the ability of a collaborative of producers to effectively market and efficiently use the materials that they produce. QAQC protocols are developed with the intent of establishing a "standardized" base that ultimately directs and informs producers and consumers of compost products on the proper procedures for maintaining and recognizing high quality appropriately produced composts on the farm and in the marketplace. Commercial composters managing regulated municipal solid wastes, including food scraps, may need to take additional methods to ensure quality related to pathogen reduction, plastic wastes or other potential contaminants.

Matching appropriate quality and use goals to the "least cost" compost production methods is a factor in overall cost-effectiveness. QAQC measures communicated to farmer participants during site visits are represented in Manure Handling and Compost Production Plans and are ultimately revealed in the Sampling and Analysis, germination trials and observations of on-farm use of finished compost materials. QAQC protocols were supported by tasks such as the development of the Comprehensive Farmer Participant Binder that included CWMI Compost Fact Sheets, and the distribution of the On Farm Composting Handbook to farmer participants.

A detailed QAQC report is provided in Appendix B. This report contains detailed explanations and descriptions in QAQC areas such as:

- Management scenarios and impacts on compost quality
- Impacts of production methods on compost quality
- Compost Analysis and Testing – descriptions and concerns
- Descriptions of Industry Labeling, Seals, and Use Specifications

The further development and refinement of QAQC protocols brings to light the research needs of an entire industry. QAQC protocols attempt to develop particular standards and expectations. In doing so however it becomes apparent that there is still a great deal of information that is underdeveloped. Improved understanding of compost characteristics as related to ultimate end-use is of great importance. The methods of producing compost can and should be directly linked to the intended end use. To best attain this, the on-farm and commercial composting industry must continue to research compost applications and appropriately tie these end use factors to the production methods that are most economically appropriate.

IV. Summary of Learnings / Next Steps

All collaborating farms increased production of compost through the course of the project. This is part due to the success of recognizing the logistical, operational and technical constraints of a collaborative approach and adopting strategies that can address those challenges. Building upon the strengths of a collaborative approach, such as sharing of knowledge and sharing capital costs of equipment, also guided some of the decisions made throughout the project.

In determining the optimal logistical, operational and technical components of a composting collaborative it became immediately apparent that shared knowledge, shared experience, and shared equipment was integrally important.

Developing shared knowledge and shared experience came throughout the projects work tasks, such as described in Section III – Methodology. This base of knowledge and understanding continues to grow and the direct relationship between farmer participants, service providers, and technical and managerial members continues to mature.

Shared equipment has been determined to be successful in certain circumstances. The exploration of additional shared equipment and refined procedures for managing and operating shared equipment is important to the further success of a collaborative enterprise. The risk of trying new implements is spread over multiple farms and quickly informs those multiple farms of its effectiveness.

Logistics of providing the turning services through a custom service operator have been functional, not always smooth, but continually improving. Specifically, the shared DSS windrow turner was not always available when the farmer participant could best utilize the turner, and when compost site conditions were best. Fortunately, the amount of windrow turning necessary to achieve the desired compost characteristics in most circumstances was less than originally projected. The five NFCC farms that intend to continue hiring DSS for windrow turning are currently only producing compost for on-farm use. Compost used on pasture and crop fields does not need to achieve the level of maturity and uniformity as would compost to be used for commercial vegetable production or public gardening use. The need for rapid production of high quality, mature compost for sale is only present on the three higher production farms that decided to rent and/or acquire more dedicated compost windrow turning equipment.

The operational aspects of a collaborative approach tended to focus more on the individual farm level. While coordination with DSS for hired compost windrow turning was involved, the majority of decisions on manure handling and composting practices were farm-specific. Farmer-to-farmer collaborative exchange of compost operations knowledge gained through experience was valuable, but ultimately the farmer commitments to the practices recommended were implemented through their own efforts and labor.

The technical aspects of a collaborative approach proved to be very positive. Project team members assigned to providing the technical guidance found it easier to assess and provide recommendations to several farmer participants at once versus an entire project focused on a single farm. Using the modified AEM planning approach to focus on manure management and composting challenges and opportunities, gave a standardized method of performing initial assessments and the follow-up recommendations for material handling methods. Questions of the practicality and economics of compost utilization prompted the project team members to provide answers to the entire group of collaborators. As a result, technical support was provided more efficiently to collaborators. Specifically, sharing technical concepts for producing and using compost in different scenarios helped farmer participants assess their own circumstances relative to other farms' circumstances.

The costs of the compost collaborative were assessed through the work of Cornell Cooperative Extension. Hours, equipment, supplies and other expenses were tracked relative to manure and compost handling. Information derived from sampling and analysis has been integrated into a comprehensive economic analysis that has been used to improve the economic efficiency of compost production and utilization.

All collaborating farms increased production of compost through the course of the project. Additional information and analysis will be used to determine the appropriate scale and inputs into the on-farm composting operations of farmer participants. The recommendations on where to most cost-effectively utilize compost on the farm, such as on animal pastures and remote crop fields, have been of particular value to farmer participants and have directly impacted their profitability.

The improved understanding of composting procedures and economic analyses that were derived from this project will undoubtedly be transferable to additional on-farm composting operations and will positively impact the profitability of those farms and simultaneously continue to progress towards opportunities in collaborative and mutual marketing of farm produced composts. The joint marketing of farm-produced composts to larger municipal, commercial and/or vegetable production projects has not yet occurred to the extent originally projected. Several collaborating farms are continuing to work towards this goal as confidence in the production methods, enhancements in economic efficiency and improvements of compost quality has come first. Appropriate marketing and sales to the above projects is identified as an on-going need for the farms that wish to diversify farm revenue from compost and compost products sales.

Through organizations such as those listed in the QAQC protocols and research projects such as NFCC we continue to learn a great deal about the production, economics, end-use classifications, and marketing opportunities surrounding the on-farm composting industry. It will be through the continual integration of composting knowledge and on-going analysis and research that the industry will be best equipped to proceed. Of fundamental importance to the growth, development, and proliferation of on-farm composting and the continued development of comprehensive QAQC protocols will be the recognition of and response to the diversified resources of compost producers and ultimately the diversified needs of compost end-users. Production methods are integrally linked to both composting economics and compost quality. The quality of composts is determined by both the feedstocks and production methods but ultimately should be dictated by the end-use application. Pairing end-use with production methods in economically and environmentally sustainable ways is the crux of successful composting enterprises and ultimately will be the measure of the success of the practice of on-farm composting. The needs of improved water quality protection, farm viability, energy efficiency and soil quality are all impacted by finding more cost-effective means to manage nutrients, organic matter and manure.

VI. Appendices

A. Economic Analysis Reports *(A1,2,3)*
B. QAQC Protocols *(B1)*
C. Sampling and Analysis Reports *(C1-8)*
D. Manure Management Plans *(D1)*
E. Compost Production Plans *(E1)*
F. NFCC Photo Journal *(F1)* in compact disc format

Note: Entire report and appendices is included in electronic format on enclosed compact disc.

New York State
Environmental Investment Program
Research Project Summary

Linking Manure Best Management Practices to Improved Compost Production

Background
Farmers and technical professionals intended to evaluate composting methods and increase compost production efficiency and quality on eight NY livestock farms. WASTE NOT Resource Solutions acted as primary contractor with project team members Cornell Waste Management Institute, Cornell Cooperative Extension, Northern Forest Compost Collaborative (NFCC) Farmer Chair Maureen Knapp, Champlain Valley Compost Company and Dairy Support Services, Inc.

Manure is a farm resource that can be recovered for the improvement of farm soils and crops, as well as for uses off-farm in the form of compost and compost blends. Manure nutrients and pathogens can also cause water quality problems when wet areas runoff or saturate. Cost-effective manure handling is critical to farm viability.

Project Description
Compost equipment suitable for the range of farm operation scenarios was identified, demonstrated, selected or rejected. Currently four compost turning machines/methods are used on the eight farms. Complementary equipment such as bale shredders and screeners were and continue to be used on NFCC farms. Compost production quality methods were devised and adapted to suit the farms' assets and intended compost end use. An economic evaluation was performed on six of the eight farms composting practices and supported further management adaptations. Participating farms and project team members met individually and at several on-farm workshops to discuss management practices, effectiveness of equipment and share knowledge.

Project Results
Composting a greater portion of manure, farm residuals and other materials has been cost-effective for a group of eight farms in five central NY counties. Composting and compost use can conserve nutrients for farms. All farms plan to continue to compost all or a portion of manure in the future for some on-farm use. Three farms are selling compost and compost blends. Six farms identify composting as a component of their organic farming management. Most farm scenarios reduce costs for spreading manure, organic matter and nutrients by applying compost on fields further from barns. Compost research on pasture, soil improvement and marketing is recommended.

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Counties:	**Cayuga, Cortland, Madison, Onondaga, and Thompkins**	**NYS EIP:**	**$155,000**
Contract Project Manager:	**Brian Jerose, Partner**	**Contractor Match:**	**$167,185**
Phone:	**(802) 933-8336 and (315) 469-4225; ph/fax (802) 933-8789; jerose@together.net and www.farmcomposting.com**	**Total:**	**$322,185**
ESD Project Manager:	**Brenda Grober**	**Completion Date:**	**May 1, 2006**
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Composting Economic Analysis
Prepared for the Northern Forests Compost Collaborative

Introduction

These data were collected from seven participating NFCC farms. Four of the farms were composting manure to spread on their own fields and wanted to consider alternatives. The remaining three farms were taking steps to generate a higher quality compost product to sell as well as spreading a portion on their farms.

Volume Composted

Manure deposited while grazing was not collected on any farm. Two of the farms composted all other manure collected on their farms every day of the year. Two farms composted cow manure during the summer months, and field spread manure during the winter. Three of the farms composted the manure and bedding waste from bedded packs for heifers.

On average, an estimated 2,542 yards of manure was composted per farm, and each experienced a 50% reduction in volume that resulted in the production of 1,271 yards of finished compost.

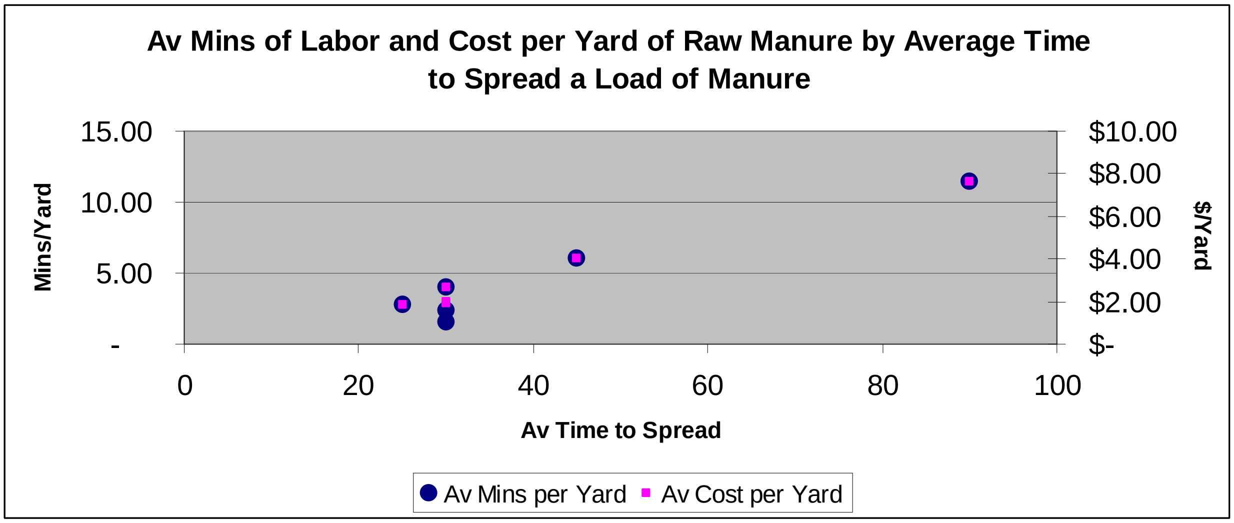
Daily Haul Analysis

Daily haul information was not available for one of the seven farms that had a methane digester that required it to store its manure for use generating energy. So, since daily hauling was not an option for that farm, it was not included in this analysis.

Of the six remaining farms in the NFCC study, all field spread 100% of their manure before adopting a compost system. This allowed researchers access to information about the time and costs associated with both field spreading and composting. However, the cost to compost manure as compared to daily spreading of raw manure on fields was of most importance to the four farms that were not planning to sell finished compost in a consumer market.

Each farm was asked about the average size of their manure handling equipment and how long it took to spread a load of manure. Then, applying information from the *National Agricultural Statistics Machinery Custom Rate Guide for Pennsylvania*, custom rates to operate specific sizes of equipment were applied. The average rate to operate a 10 cubic yard spreader was $40/hr, with rates going as high as $90/hr for larger equipment. Four of the farms had spreaders under 10 cubic yards in size so $40/hr was used, one farm had a 12.7 cubic yard spreader and $50/hr was applied, and the remaining farm had a 19.8 cubic yard spreader so $75/hr was applied.

Overall, this analysis resulted in an average cost of $3.34/yard and 4.70 minutes/yard to apply a yard of raw manure to a field. The biggest variable accounting for differences in cost to spread a yard of raw manure was the average time that it took to spread a load.



The four farms capable of spreading a load of manure in 30 minutes or less took an average 2.68 minutes and spent $2.11 per yard to apply it. The remaining two farms spent an average of 67.5 minutes to spread a load of manure with an average of 8.73 minutes and $5.82 per yard of applied raw manure.

Compost Analysis

Pad Preparation

Only one farm had done any site preparation to the area where it kept its compost piles. That farm prepared a five-acre area by plowing, disking, dragging, performing two rock rake operations, and finally compacting. Plowing, disking and dragging are conventional field operations that cost an estimated $15/acre per operation ($225) and require a laborer who would work at a pace of about three acres/hr (five hours of labor). The rock rake operation cost $30/acre, and the five acres could be done in two hours for an additional cost of $300. Compacting cost $100/hr and would take two hours ($200), plus two hours of labor. In total, pad preparation cost approximately $725 and required 12 hours of labor spread out over five years. The five acres of land that could no longer serve as pasture also represented annual lost income of $200, or $40/acre for the farm. The opportunity cost for the farm was $345 and 144 minutes of labor each year.

The other farms were assigned a charge of $25 per 1,000 yards of manure composted as the opportunity cost of taking productive farm land out of use. This is equivalent to a cost of $0.025/yard of manure and/or $0.05/yard of finished compost.

Manure Separator

One of the NFCC farms used a manure separator to remove solids out of the slurry. The building housing the separator cost $20,000, and the separator cost $30,000. The useful life of the machinery and building is estimated at 10 years, yet its costs are spread over 6.67 years (15% of construction costs or $7,500/year) to cover the costs of maintenance, insurance, interest, and repairs.

The solids separator also has an operating cost, as it runs a 10hp motor for 8 hours to generate 30 yards of solids. At an estimated usage of 8 kilowatts an hour at $0.05/kw, electricity (farm-generated from methane digester) cost $3.20/day or $0.11/yard of initial compost. No labor is needed to run the separator.

Since the farm generates an estimated 1,500 yards of finished compost, the fixed cost of this separator is $5.00/yard ($7,500/1,500 yards). If the farm were to separate all of its manure, it would run the machine 265% more and generate 3,975 yards of compost, which would bring the overhead cost down to $1.89/yard. If the farm were to triple herd size, and the machine were able to run 24 hours a day, it would process enough material to create 11,925 yards of finished compos and reduce costs to their lowest achievable level of $0.63/yard.

At the current size, the cost for that farm to separate out solids cost $5.11 per yard.

Compost Screener

Selling finished compost to a consumer market requires a quality, uniform, and garbage-free product. One farm that purchased a screener noted it cost $42,500, with a residual value of $15,000 in five years. This represented a depreciation cost of $5,500 and 20% of purchase value ($8,500), which was used to cover costs of maintenance, insurance, interest, and repairs. That farm paid $3.05/yard for 2,787 yards of finished compost that it generated.

The farm above avoids screening by using the solids separator, but a compost screener is required for those who start with a less than uniform product. Running the screener used about .83 gallons of gas per hour, and someone had to be there the entire time to operate a skid loader at a total estimated cost of $40/hr ($13/person, $25/tractor, $2/fuel for screener. It can process an average of 25 yards/hr for an average variable cost per yard of $1.60. This is a total cost per yard of $4.65 and total time per yard of 2.4 minutes.

Shaping and Building Piles

Four of the farms only used bedding straw and manure of the appropriate C:N ration to generate compost, so pile shaping was simply a matter of spreading manure on the pile and potentially moving the pile around with a skid steer once a year. The farm with a manure separator does not need to add carbon, and pile shaping requires no more than an hour or two each year.

However, the remaining two farms added significant levels of carbon to their compost and spent several hours mixing everything together and building rows. One farm estimated that they spent 30 minutes for 180 days a year (5,400 minutes) and the other estimated that it took 5 hours to make a row and they made 10 rows/year (3,000 minutes). These operations used a small tractor or skid loader to make their piles, so a cost of $40/hr was used for this study.

Turning Piles

Information about the number of times that each person turned a pile, the average time to turn that pile, and a custom rate for the size of equipment that they used was collected.

Adding Manure/Compost to Piles

Each farmer was asked how many loads of manure they added to their compost pile each year, how long it took them to add that load, and a custom rate for the size of machinery that they used was assigned.

Per Yard Cost of Finished Compost

Given all the inputs above, the average yard of finished compost (laying in a compost pile) had a cost of $6.10 and required 5.71 minutes of labor.

The four farms making lower quality compost for on-farm use experienced an average cost of $4.41/yard requiring 4.99 minutes of labor, while the three farms making consumer grade products had an average cost of $8.36/yard and each yard required 6.67 minutes of labor.

Compost Spreading on Fields

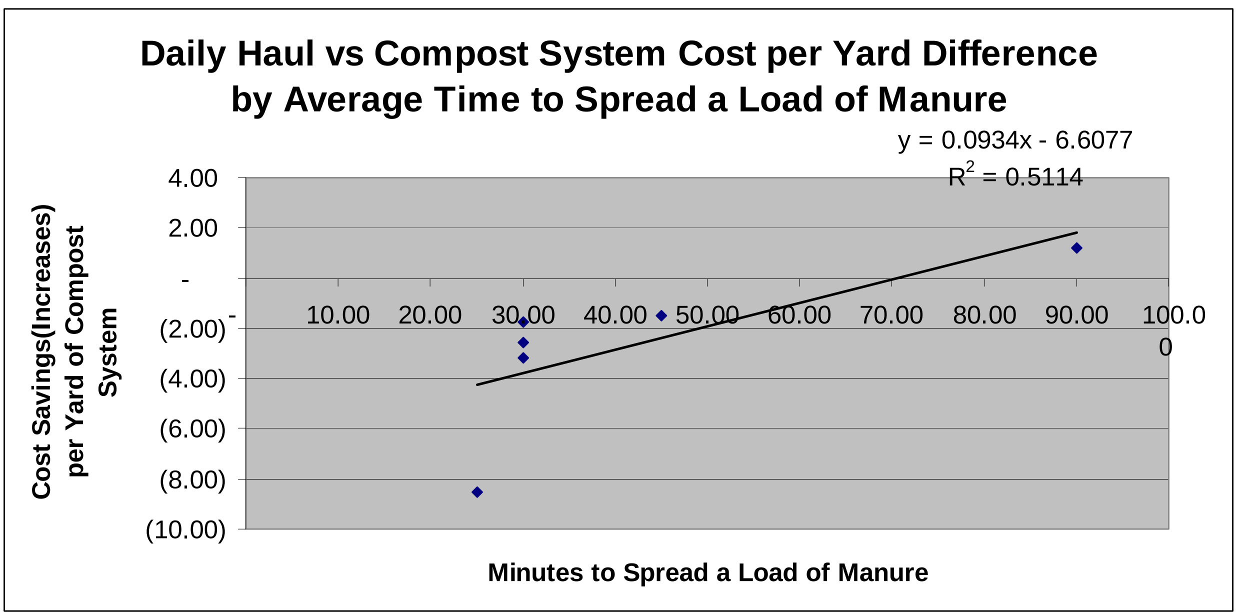
There were six farms that considered the option of field spreading their manure versus composting it and then spreading the compost. Each noted the number of loads of manure that they would have to haul each year, the average time that it would take to spread a load, and a custom rate for the size of equipment that they used. These amounts were applied to determine the average cost and time spent to spread raw manure.

Each farmer then noted how long it took them to load compost from a pile onto a manure spreader and then spread it. Applicable custom rates were used to analyze this operation.

Compost vs. Daily Haul

The average farm could spread their raw manure for $3.42/yard at a rate of 4.81 minutes/yard, which when compared on an equivalent size basis (it takes two loads of raw manure to equal one load of compost) represented a cost of $6.84/yard and 9.61 minutes for finished compost.

Though you would only need to physically make half as many trips into the field to spread compost, the time involved with building, maintaining, and unloading piles resulted in an average cost of $9.55/yard and 11.64 minutes/yard of compost, or an average cost increase of 39.62% and an additional time commitment of 21.12% over the conventional haul system. However, every farm surveyed responded that the additional costs and time required were well worth the quality benefits that each got by using compost in their cropping system. All were going to continue to compost.



Comments

Farms were Asked to respond Yes, No, or Not Applicable about their compost system

	Yes	No	NA
Reduce Flies	1	2	4
Reduce Pasture Rejection	1	0	5
Reduce Clumping of Manure When Spreading	6	0	1
Avoid Long-term Storage Facilities Costs	2	0	5
Reduce Manure Management Labor	0	6	1
Reduce Odor	5	1	1
Improve/Maintain Sanitation	1	3	3
Maintain Nut Mgt Plan	6	1	0
Compost for Consumer/End Market	3	3	1
Keep Barn Dry for Heath Reasons	1	1	5
Reduce Manure Run-Off	1	1	5

Some Open Ended Comments by Farmers

Problems finding Carbon

Simply don't want to spread raw manure on fields for environmental reasons

You can see the difference in hay yield where compost goes… will continue to do and looking into own turner

Will keep doing it… Allows us to spread on a field that traditionally gets flooded in spring

Extends storage and reduces crusting in slurry system, reduces odor in slurry system

Just the right thing to do… Better fertilizer than raw manure

Compilation of Information:
Related to Compost Quality, Use and Testing

QAQC Protocols – Northern Forests Compost Collaborative

Management practices have a significant influence on the quality of compost.

Improving and Maintaining Compost Quality

Overview

Many different factors determine the quality of composts. While some, such as precipitation and ambient temperature, are clearly beyond the control of compost producers, many other factors can be managed with proper planning. Examples include type of equipment used for turning, frequency of turning, quantities and/or ratios of feedstocks, and composting method. Understanding the interactions and tradeoffs associated with such factors will help compost managers adjust the quality and consistency of their compost product.

While farmers may have limited options for what sort of compost they can produce, small changes in how a compost system is managed can result in a more marketable product. For example, if a manager has problems with weed seeds, increasing the frequency of turning may solve the problem, because weed seeds will be exposed to high internal temperatures for longer periods of time. The ability to make small adjustments without incurring significant additional costs makes it easier to customize a compost product for a specific end use.

In any composting system, there are trade-offs. Compost managers need to understand their product thoroughly and be well-informed of what is demanded for its end use. A decision tree can help a compost producer think through the choices. There are logistical and economic constraints in any compost management situation, so production limitations and consumer needs should be prioritized. Once the compost producer has an understanding of these, reasonable changes and adjustments can be made to improve compost quality.

Managing a pile well requires optimizing the moisture content and the ratio of carbon to nitrogen in the mix, ensuring that the particle size allows good airflow, and monitoring temperature. Turning serves to homogenize feed-stocks, incorporate air and reduce particle size. If a good mix is developed, microorganisms can function efficiently and air will circulate through the pile naturally. If temperatures throughout the pile are in the thermophilic range (between 130oF and 160oF), the pile is functioning well and turning will only force productive microbes to expend energy re-colonizing. In dry weather conditions, moisture will be hard to retain and more turning will dry out the piles. If the material is dense and does not allow for air flow, more turning will be necessary simply to keep the microbes working. If the pile is too wet, turning more frequently will incorporate air and drive off moisture. Monitoring piles for temperature, oxygen and moisture can help a compost producer make management decisions. If temperatures fall below 110oF, turning to restructure the pile may return it to a thermophilic stage. At temperatures over 180oF, there is a risk of spontaneous combustion. Adding moisture while turning will cool the pile.

Management Scenarios that Impact Compost Quality

To help farmers and other composters better understand the interactions between management and compost quality, the Cornell Waste Management Institute (CWMI) conducted a two-year study of twenty-five agricultural composting operations across New York State. These farms included both dairy and poultry facilities producing compost. Specific management practices examined included pad type, turning frequency of compost piles, and type of equipment used. Some key results of this study are discussed below.

Impact of Different Turning Rates

Analysis of the study data showed that lower nitrogen (N), lower organic matter, higher maturity, and lower viable weed seed content were associated with turning frequencies greater than twelve times per year. Lower N would be expected since turning provides greater opportunity of ammonia volatilization. Although lower viable weed seed content was found in the more frequently turned composts, good weed seed control can be provided as long as the seeds are exposed to thermophilic temperatures and weed seeds aren’t allowed to blow onto finished piles.

The association of higher turning with lower organic material and higher maturity can be anticipated since turning will help break down particle size, homogenize the pile and speed the stabilization process to an extent. However maturity cannot be expedited much because it is a natural aging process. Even with in-vessel compost systems where there is better control of moisture and air, substantial curing time is still required. In making decisions about turning, composters need to consider the trade-off between the limited acceleration of stabilization that could result from more turning and the reduction in organic matter and N which may be important to a compost end user.

Impact of Different Turning Methods

The study looked at three turning methods; dedicated windrow turners, bucket loaders and passively aerated systems (static non-turned piles). Passively aerated systems were associated with the highest nitrogen and organic matter contents of the three turning methods since without the increased aeration that is provided though the turning, it is more difficult for the oxygen-dependent microbes to break down the organic matter. Without turning, less of the pile would be exposed to the atmosphere thus less of the ammonia-N would be volatilized. Passively aerated systems were also associated with lower maturity. The lower N and organic matter found in systems turned with bucket loaders as compared to windrow turners may be related to the incorporation of mineral soil directly from the compost pad which dilutes the compost.

Impact of Different Pad Types

Differences can be found among composts that are produced on dirt surface pads compared to improved pad materials such as gravel or concrete. The study found that total N and organic matter are lower in products that are made on an unimproved earthen pad than on other types. As compost is mixed, either with a turner or a bucket loader, soil is incorporated into the compost, in effect diluting it. The end result can be a relatively low nitrogen, low organic matter compost. In a comparison of facilities that use concrete surfaces to those that don't, similar results were found. Non-concrete compost pads produced composts that were lower in organic matter and total nitrogen. Potassium and pH were also lower at non-concrete sites, and weed seed counts were higher.

When Testing, What Should I Look For and Why

Feedstock- If you are proud of your compost ingredients shout about them. It can be important to users to know what the compost is made of. Gardeners and organic vegetable produces are particular about what sources they want to use.

Total Kjendahl Nitrogen (TKN), Phosphorus, Potassium- assessing nutrients in amendments is important for balancing nutrients in the soil and ultimate plant response. Additional nutrients may be important for certain plants, therefore if trying to meet certain plant needs or avoid certain nutrients that may have a negative plant response, it may be desirable to test for additional items

Organic Material- level of organic matter in organic production and where water holding capacity is important.

Moisture content, Density & C:N ratio- effect the compost processes natural aeration and N loss.

PH-should be tested depends on plant requirements.

Soluble Salts-high salts in compost will effect plant growth, immature composts and many poultry composts can be high.

Maturity- Composts can be used at different levels of maturity depending on what your goal is. Most compost should be used when it is at least 75% mature for good plant response. If your goal is weed control you may want an immature compost (high ammonia, salt, and volatile organic acids), but remember some weed species can survive anything.

Copper& Zinc- It is important to test for these metals if the farm generating the organics uses copper sulfate or zinc sulfate for hoof health.

Metals in General- Most metals are not high on farms unless previous practices required chemicals that are now banned. Old orchard land can have high levels of arsenic.

Pathogens- Fecal Coli form, Salmonella and e-coli are greatly reduced or eliminated in a well managed thermophilic composting operation. Pathogens can be reintroduced to a finished pile when animals have access to the piles or a dirty bucket is used to load or move a finished product. (If selling compost or using as a pathogen free medium invest in a second bucket or disinfect)

***Weed Seeds* –** Most seeds are killed in the thermophilic process. In a Cornell study, dormant seeds in well-managed compost were non-viable.

Plant Germination & Plant Response- These tests are done with a number of sensitive indicator plants. If using compost for a specific plant you may want to do a few growth tests with the varieties you are using. They are good indicator tests to show you if there is a problem in your compost.

Pesticides-Bioassays are developed for pesticides that have proven to be problematic. Recently there was an issue with an herbicide called clopyralid so tests are developed and done on a limited basis.

<u>Compost Control of Johne ’s disease</u> (Mycobacterium Para tuberculosis)

A concern regarding dairy manure composts is the degree to which composting reduces or kills *Mycobacterium Para tuberculosis*, the organism that causes bovine Johne ’s disease.

To investigate this issue, we conducted a field experiment. A 6'x 6’x 20 compost piles was built on the Cornell Farm Services compost pad using manure obtained from a Johne’s-free farm and then inoculated with ~200 pounds or ~ 2 cow days worth of infected manure from a heavily shedding cow. The pile was turned weekly with a loader and daily temperatures in 6 locations in the pile were taken.
Composite samples were taken on days 1,7,14, 21,28 and 35 from several locations in the pile. In addition to Johne’s analyses, samples were analyzed for compost parameters as well as fecal strep and fecal coli form. Johne’s was detected in the initial pile before composting. The analyses completed from day 7 to 35 were all negative, demonstrating that in this experiment, Johne’s was killed in the first 7 days employing very simple composting methods. Johne’s was not believed to be present in most of the farm operations included in the full study. To investigate the ability of typical on-farm composting to reduce Johne’s, composts from four farms with a high incidence of Johne’s were sampled. Raw manure ranged from 92 –21,000 (colony forming units) CFU/ gm. Four composite samples of compost were taken from each farm. The material that was tested varied in age from 6-12 months and in each case was reported to be ready for use. The farms each employed different management techniques including forced air, bucket and turner turned windrows. Only one of the 16 samples detected any Johne’s and

that was a single sample. This positive finding of a single CFU may have resulted from cross-contamination.

This testing supports the finding that composting will greatly reduce or eliminate Johne's

COMPOST LABELS, SEALS, SPECIFICATIONS AND USE GUIDANCE FOR CONSUMERS

Any successful program requires broad recognition among potential compost users, necessitating significant advertising. It also requires oversight to ensure that participants are meeting program requirements and "earning" the right to display the seal.

Affordability to agricultural composters is another important consideration. Many farmers compost as a means to manage manure and do so on a scale that does not provide for expensive testing, registration and marketing.

There is a range of existing label, seal, specification and guidance programs. The following is a compilation and review of existing compost guidelines, label requirements, specifications for use and seal of quality or certificate programs that could be identified in order to consider their potential utility for achieving the project objectives. We did not include those generated by a compost producer since those might be influenced by the attributes of their own compost.

Regulations, Standards and Guidance

• ***USEPA and NYSDEC:*** The environmental regulatory agencies at the federal and state levels have adopted rules pertaining to certain composts. Composts that include sewage sludge are covered by these rules. These rules pertain to environmental protection and do not address constituents or parameters that may be important to compost users but that do not have environmental implications. At the federal level and in most states (including NYS), agricultural and yard waste composts are not subject to such standards. Therefore these standards are not included in the discussion that follows.
• ***Mulch and Soil Council:*** formerly the National Bark and Soil Producers Association. The MSC mission is to "define quality products and promote an open marketplace for producers of horticultural mulches, consumer soils and commercial growing media." They have identified pH and soluble salt ranges for compost, topsoil and other products. http://www.nbspa.org/consumer/soilnomenclature.html
• ***Natural Resource Agriculture and Engineering Service:*** NRAES is an interdisciplinary, issue oriented program sponsored by cooperative extension of fourteen member land grant universities. Their On-Farm Composting Handbook includes guidelines for compost produced and used in agriculture settings.
• ***Rodale Organic Gardening Compost Quality Seal:*** A partnership between Rodale Organic Gardening and Woods End Research Laboratory (WERL), Inc. Rodale is well known as the publisher of Organic Gardening Magazine. WERL tests and conducts

research on compost and produces compost testing kits and supplies. Under the Rodale Organic Gardening Quality Seal of Approval Program, compost producers submit samples to WERL where it is tested for key nutrients and trace elements, pH, C:N ratio, heavy metals, pesticide residues, weed seeds and pathogens. Where the product is not compost, but a soil amendment blend, the samples submitted are the final product and not the compost input. Based on the results, the tested material is then classified for best use as seed starter, container mix, garden compost, topsoil blend, mulch or fertilizer. For the purposes of this project, specific values for parameters for the different uses were obtained from WERL on December 19, 2002. The program is designed to provide "a marketing edge for manufacturers, which can guarantee the quality of their products by displaying the seal on packaging and in promotions." Check for current costs.
http://www.organicgardening.com/compostseal
http://www.woodsend.org/pdf-files/seal_appl.pdf

• ***U.S. Composting Council:*** This not-for-profit organization published a USCC Field Guide to "Compost Use" which contains guidelines for different uses (US Composting Council 1996). They have also compiled specifications for compost use by state Departments of Transportation (US Composting Council 2001) and developed guidelines for use in the landscape industry(US Composting Council 1997). USCC also created and administers the Seal of Testing Assurance (STA) program. Participating compost producers can display the seal if they submit samples to STA certified laboratories for analysis of selected physical and chemical parameters and meet standards for 9 metals equivalent to those required by US EPA for sewage sludge used as a soil amendment. There is no classification of composts for different uses. There is a fee for this program. Check for current costs.
http://tmecc.org/sta/index.html

• ***State Departments of Transportation:*** A number of states have established specifications for compost used in transportation (DOT) projects. The USCC has compiled those in a publication (US Composting Council 2001). These specifications are used by DOTs as requirements for composts used in DOT projects. Since these differ from state to state, for this project we considered the NYS DOT specifications.

Table 1 Summary of Guidelines Provided by Compost-related Organizations

	Container Mix/Potting Soil	Topsoil Blend	NYS DOT Specifications	Vegetable Crops	Erosion Control	Nursery Beds	Turf Establishment	Backfill for Trees & Shrubs
Mulch & Soil Council	yes							
NRAES				yes				
NYS DOT			yes					
Rodale	yes							
US Compost Council	yes*	yes*		yes*	yes*	yes*	yes*	yes*

*Recommendations provided for two or more k as parameters are identical to other marked categories

These various organizations have each published some specifications or guidelines for some or all of the following major compost uses:

- Backfill for Tree and Shrub Plantings
- Container Mix/Potting Soil
- Department of Transportation Uses
- Erosion Control
- Nursery Beds
- Topsoil Amendment
- Turf Establishment
- Vegetable Crops

Requirements of Compost for Use in Organic Production

Subpart C - Organic Crop, Wild Crop, Livestock, and Handling Requirements
General Requirements for compost used in Organic Agriculture

A producer of an organic crop must manage soil fertility, including tillage and cultivation practices, in a manner that maintains or improves the physical, chemical, and biological condition of the soil and minimizes soil erosion. The producer must manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials. The producer must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances. Plant and animal materials include raw animal manure, composted plant and animal materials, and un-composted plant materials. Raw animal manure must either be composted, applied to land used for a crop not intended for human consumption, or incorporated into the soil at least 90 days before harvesting an edible product that does not come into contact with the soil or soil particles and at least 120 days before harvesting an edible product that does come into contact with the soil or soil particles. Composted plant or animal materials must be produced through a process that establishes an initial carbon-to-nitrogen (C:N) ratio of between 25:1 and 40:1 and achieves a temperature between 131F and 170F. Composting operations that utilize an in-vessel or static aerated pile system must maintain a temperature within that range for a minimum of 3 days. Composting operations that utilize a windrow composting system must maintain a temperature within that range for a minimum of 15 days, during which time the materials must be turned five times.

NYS Dept of Agriculture and Markets

Express Terms

In January 2006 a change was made in the fertilizer law to exempt agriculture based composts.

1 NYCRR section 153.1 is amended by adding new subdivisions (c), (d) and (e) to read as follows:

(c) Compost consisting entirely of animal(other than human) manure, vegetative matter and animal bedding, for which plant nutrient claims are made, shall be exempt from the definition of commercial fertilizer for purposes of the fee requirements of Agriculture and Markets Law sections 146 and 146-c and the guaranteed analysis requirements of sections 144 and 145(4) of said Law and Part 153 of Title 1 of the Official Compilation of Codes, Rules and Regulations of the State of New York. Any such compost, for which plant nutrient claims are made, which is distributed in this State in containers shall have placed on or affixed to the containers a clearly legible label setting forth total nitrogen (N), total phosphorous (P) and total potassium (K). Other compost characteristics may also be set forth. Any other compost characteristics stated for such compost shall appear in the format set forth in subdivision (d) of this section. If distributed in bulk, a statement, in such format, setting forth any compost characteristics stated for such compost shall accompany the compost and be supplied to the purchaser at the time of delivery.

(d) The format for setting forth compost characteristics stated for composted animal manure, composted vegetable manure and composted animal bedding, for which plant nutrient claims are made, shall be as follows:

- (1) General Characteristics
  - (i) Feedstock
  - (ii) Maturity
  - (iii) Organic matter
  - (iv) Weed Seeds/Liter
  - (v) Density
  - (vi) Solids
  - (vii) CN Ratio
  - (viii) pH
  - (ix) Conductivity
- (2) Nutrients
  - (i) Total nitrogen (N)
  - (ii) Total phosphorous (P)
  - (iii) Total potassium (K)
  - (iv) Total Calcium (Ca)
  - (v) Total magnesium (Mg)
- (3) Metals
  - (i) Copper
  - (ii) Iron
  - (iii) Zinc
  - (iv) Arsenic
  - (v) Cadmium

(e) Analytical test results supporting compost characteristics stated for composted animal manure, composted vegetable manure and composted animal bedding, for which plant nutrient claims are made, shall be filed with the Department with any license application and prior to the distribution of such products. The values of such compost characteristics may be stated as average values based upon such analytical test results. Analytical tests shall be conducted using the methods in Test Methods for the Examination of Composting and Compost, edited by Wayne H. Thompson and published August 12, 2001 by the United States Department of Agriculture, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410 and the Composting Council Research and Education Foundation, 4250 Veterans Memorial Highway, Suite 275, Holbrook, NY 11741 or equivalent methods. Copies of Test Methods for Examination of Composting and Compost are maintained at the Department of Agriculture and Markets, Division of Plant Industry, 10B Airline Drive, Albany, N.Y. 12235, and at the New York State Department of State, 41 State Street, Albany, N.Y. 12231 and are available for public inspection and copying during regular business hours.

Prepared by J. Bonhotal, B. Luton and B. Jerose

The Value of Compost as a Fertilizer

As noted in the Composting Economic Analysis, the average farm had a cost for spreading raw manure of $3.12/yard, which represented $6.34/yard on an equivalent unit basis, and a cost for spreading finished compost of $9.79, an additional compost cost of $3.45/yard. All of the participating farms noted that they would continue to compost their manure.

Three additional benefits of an on-farm compost system were identified and are discussed in analyses below. The advantages include: 1) Fewer nitrogen losses through ammonia volatilization; 2) Less pasture forage rejection when used as fertilizer in a compost system; and 3) A greater resource in a row-crop system.

Raw Manure Versus Composted Manure as Fertilizer

Typical dairy manure has a carbon to nitrogen level of 10:1 - 12:1, and thus is too rich in nitrogen to compost by itself. (Composting requires a carbon to nitrogen level in the range of 20:1 – 40:1.) Excess nitrogen is generally released in the air in the form of ammonia, which causes both environmental pollution and farm fertility problems. According to the USDA's Economic Research Service, approximately 93.2% of the Northeast's corn acres had too much nitrogen applied in 2001. The following chart displays Natural Resource Conservation Service estimates of nutrient values of dairy manure as it is excreted from the cow and after loses associated with its natural deterioration process[1]:

Manure Nutrient Content Factors (Pounds/Ton)

	- Nitrogen -		- Phosphorus -		- Potassium -	
	as excreted	**after losses**	**As excreted**	**after losses**	**as excreted**	**after losses**
Milk Cows	10.69	4.30	1.92	1.65	6.7	6.04
Heifers & Heifer Calves	6.06	1.82	1.30	1.10	5.03	4.53

As shown above, dairy manure typically loses 60%-70% (60% milk cows, 70% Heifers) of its available nitrogen, 14%-15% of its phosphorus, and 10% of its potassium before it can be absorbed into the soil.

Of most importance are the nitrogen losses. If the manure is correctly composted within one day of excretion and with a good carbon to nitrogen mix, then losses are generally less than 5%. For this study, compost samples taken on site at each participating farms had the following average nutrient values, which roughly doubled the NRCS values since one ton of compost is made with two tons of manure in it, and nitrogen losses were negligible. (Differences from NRCS nutrient values are caused by differences in compost systems and rations feed to cattle.)

[1] Natural Resource Conservation Service, Technical Ressources : Maure Characteristics Guidelines http://www.nrcs.usda.gov/technical/land/pubs/nlapp1b.html

Pounds of Nutrients per Ton of Manure

	N	P	K
Average of all Farms	20.44	5.87	6.54
Weighted Average by Tons of Compost Made	19.44	5.10	6.42

The theoretical nitrogen loss of manure is 60-70% since the nitrogen in manure is roughly two-thirds inorganic ammonia and one-third organic nitrogen that does not volatize in the air. However, university trials actually show losses of nitrogen are not typically 60%-70% because as the manure is applied to a field the ammonia will bond with available carbon in the soil.

The Cornell University Nutrient Management **Spear Program** has done research on ammonia volatilization and determined the following utilization rates of ammonia for different cropping practices[2]:

Manure application method	Ammonia N utilized by the current crop (%)
Fall application	0
Pre-plant spring application	
Incorporated within 1 day following application	65
Incorporated within 2 days following application	53
Incorporated within 3 days following application	41
Incorporated within 4 days following application	29
Incorporated within 5 days following application	17
Incorporated more than 5 days after application	0
Not incorporated	0
Side-dress application	100

[2] Unstable Inorganic N (ammonia) Losses from Manure. Cornell University Nutrient Management Spear Program. Available at http://nmsp.css.cornell.edu/publications/tables/

On a pure nutrient basis, this means that a ton of manure from a milking dairy cow (NRCS nutrient values) has the following values if the loses of P and K are in the same proportion as N loss:

A Ton of Milking Cow Manure Values as a Fertilizer

	As Excreted	Starting Values In a Compost System	Sidedressed in an Established Crop	Incorporated in 1 Day	Not Incorporated / Incorporated After 5 Days
Inorganic Loss %	0%	0%	0%	35%	100%
Lbs/Ton					
N lbs. Inorganic	6.39	6.39	6.39	4.15	-
N lbs. Organic	4.30	4.30	4.30	4.30	4.30
Total N lbs.	10.69	10.69	10.69	8.45	4.30
P lbs.	1.92	1.92	1.92	1.83	1.65
K lbs.	6.70	6.70	6.70	6.47	6.04
Value/Ton*	$8.46	$8.46	$8.46	$7.21	$4.90

* N $0.50/lb, P $0.75/lb, and K $0.25/lb

As noted in the chart above, the fertilizer value of a ton of field applied manure decreases significantly as ammonia volatizes.

To determine the value of these different fertilizers in a cropping system, the chart below gives an analysis of the cost per farm to apply 100 lbs of Nitrogen to a field using compost, using incorporated raw manure, and using unincorporated raw manure.

Quantites and Cost Analysis to Apply 100 lbs of N Using Different Manure Fertilizers

	Composted Manure	Incorporated Raw Manure	Unincorporated Raw Manure
N lbs./Ton	21.38	8.45	4.30
P lbs./Ton	3.84	1.83	1.65
K lbs./Ton	13.40	6.47	6.04
Tons to Manure Needed to Apply 100lbs. of N	9.35	11.83	23.26
Yards to Compost/Manure Needed to Apply 100lbs. of N	7.46	15.77	31.01
Cost to Make and Apply a Yard	$ 9.79	$ 3.17	$ 3.17
Cost to Apply 100lbs. Of N	$ 73.06	$ 49.97	$ 98.24
Incorporation Cost/Acre	$ -	$ 12.00	$ -
Total Costs	$ 73.06	$ 61.97	$ 98.24
Tons of Manure as Excreted Needed	9.35	11.83	23.26
Lbs of N Lost in Atmosphere		26.46	122.15
Cost per lb of N to Keep on Farm		$ 0.42	$ (0.21)

In this analysis, field spreading manure cost $6.34/yard (on an equivalent basis) and composted manure cost $9.79, making composting seem 54% more expensive than purchasing and applying fertilizer. However, when evaluated from a more practical basis of cost to apply 100 lbs of N to a field, incorporation only costs 18% more. Field applying raw manure is actually 34% more expensive because of the estimated inorganic losses.

Furthermore, considering that the inorganic losses of nitrogen are wasted resources, with real, potential value for the farm, composting actually yields 26.46 pounds more nitrogen than incorporated field application, which is only $0.42/lb of Nitrogen gain and is less than the commercial nitrogen fertilizer price of $0.50 that was used. When comparing a compost system against raw manure field application, the compost system gives the cropping program an additional 122.15 lbs of N per acre and actually pays the farm $0.21 for each pound of N it gets, since fewer trips are needed to field spread.

Raw Manure versus Composted Manure as Fertilizer in a Pasture System

The 2004 Cornell University Dairy Farm Business Summary noted that of the 28 Grazing farms sampled, 18 or 64% mechanically applied manure to their pastures.

The application of raw manure is less preferable to composted manure as the raw manure will break down in the field and composted manure is already broken down. As manure breaks down it will release ammonia, which has an unpleasant odor and it will also attract flies, many of whom lay eggs in manure piles. Both unpleasant odors and fly populations have been shown to cause pasture rejection and lower pasture intake in dairy animals.

During the grazing season of 1997, researchers at the Cornell University School of Veterinary Science conducted a survey of New York dairy farms on their sanitation practices and pest problems.[3] Flies on pastured cattle were indicated as the greatest pest problem causing losses of a 20-40% drop in milk production for heavily infested fields. These pests were ranked as the most difficult to control with currently registered active ingredients and because of that manure management was the most frequently indicated method used to control fly populations.

As indicated in their publication, most flies that lay eggs in manure have a 10 to 20 day life cycle so if manure is put on a field, a producer must wait at least one month for the flies to hatch and die off if they want to avoid production losses. Composted manure does not have the fly attracting effects of raw manure and has not been shown to cause pasture rejection by grazing animals after application.

From 1988 to 1990 Cornell Cooperative Extension[4] conducted an intensive study of 34 New York grazing farms and determined optimal pasture rest times for grass pasture and mixed grass/legume pasture of the following:

	Days of Pasture Rest for Optimal Regrowth					
	May	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Grass	18	19	35	38	42	55
Mixed Grass/Legume	19	21	26	29	34	37

Letting pasture grow past these re-growth times by as little as seven days caused significant drops in forage NDF (a measure of pasture quality) that translated to milk production losses of 5-10 lbs/cow/day in the sample farms.

It is common to apply 100 lbs of N in the spring and then 50 lbs of N in the fall to optimize pasture growth. It would be impossible, however, to apply 100 lbs of N raw manure in the spring and follow the recommended pasture rotation schedule with the recommended 30 day rest period afterward to let fly populations decrease. The following is an analysis of a farm applying 100 lbs of N to a field in May using composted manure, raw manure with an 18 day pasture rest for optimal forage quality, and raw manure with a 30 day rest for fly control.

[3] Waldron, J. K., D. W. Watson, P. E. Kaufman, D. A. Rutz. 2000. Integrated Management of Flies In and Around Dairy and Livestock Barns. Cornell University, Ithaca, NY. http://pmep.cce.cornell.edu/fqpa/crop-profiles/dairy.html

[4] Forage Quality of Intensive Rotationally Grazed Pasture, Ed Rayburn. Cornell Cooperative Extension Animal Science Mimeograph Series No. 151. December 1991

Costs to Apply 100 lbs of N with Manure Fertilziers to and Acre of Pasture in May

	Compost	Raw Manure with 18 Day Rest Period	Raw Manure with 30 Day Rest Period
Lbs of Forage Grown	2400	2400	2400
Av Forage Intake by a Cow	30	30	30
Cow Grazing Days in Field	80	80	80
NDF of Forage	48%	48%	53%
lbs. Milk Loss from Poor Forage			7.50
lbs. Milk Loss from Flies	-	12.00	-
Cost of Fertilizer	$ 73.06	$ 98.24	$ 98.24
Cos of Milk Lost - $15/cwt.	-	144.00	90.00
Total Costs/Acre of Pasture Systems	$ 73.06	$ 242.24	$ 188.24

In the pasture study, the average pasture grew 80 lbs of hay per day, meaning that an acre of pasture could supply the forage needs of 80 cows for one day, 40 cows for two days, etc. As can be seen, compost is a less expensive fertilizer (costs taken from comparative analysis above) and if you take into consideration the 12 lb (20% loss on a cow producing 60lbs/day) per day milk production loss from high fly populations or the 5 - 10 lb per day milk production loss seen from overgrown forages, compost is a much more profitable option.

Raw Manure versus Composted Manure as Fertilizer in Field Crops

Additional benefits noted of compost over raw manure are in a cropping system as farmers noted better timing of fertilizer placement, no clumping of manure on hay crops, and better weed suppression.

The time when fertilizer is placed in the field is important because a crop only needs nutrients during certain times of the growing season and if a farm places raw manure in their fields throughout the year, that manure will leach away nutrients in the winter. The spreading of manure in the winter is such an undesirable practice that it has been banned in the state of Maine.

The particular leaching from winter spreading of manure is field specific depending on the soils, winter, and field slopes, so a general 25% loss of organic nitrogen is used for winter months in the following example.

In this example, a farm applies 100 lbs of N to a crop with a compost system, an evenly distributed daily haul manure system from October to April, a system where the farm daily hauls an equivalent amount of manure as the compost system and supplements the nitrogen losses with conventional fertilizer, a where the farm uses 100% nitrogen fertilizer.

Quantites and Cost Analysis to Apply 100 lbs of N Using Different Manure Fertilizers and Strategies

	Composted Manure	Unincorporated Raw Manure	Manure with Fertilizer	Just Fertilizer
N lbs./Ton	21.38	4.30	4.30	
P lbs./Ton	3.84	1.65	1.65	
K lbs./Ton	13.40	6.04	6.04	
Leachate Run-Off %				
25% loss of Manure Manure Applied in 4 of the 6 Months		17%	17%	
Tons to Manure Needed to Apply 100lbs. of N	9.35	23.09	9.35	
Yards to Compost/Manure Needed to Apply 100lbs. of N	7.46	30.79	12.47	
Cost to Make and Apply a Yard	$ 9.79	$ 3.17	$ 3.17	
Additional N Needed	-	-	66.48	100.00
Cost to Apply 100lbs. Of N	$ 73.06	$ 97.54	$ 39.52	$ -
Fertilizer Cost*	$ -	$ -	$ 40.24	$ 57.00
Total Costs	$ 73.06	$ 97.54	$ 79.76	$ 57.00

*$0.50/lb of N + $7.00 Field Application Cost

As is shown above, conventional fertilizer is the cheapest way to apply 100 lbs of N to a field; however, given that the farm must do something with its manure, compost is the best utilization of that resource. This example also shows that the leaching of manure spread in the winter makes daily haul systems even more costly as the farm has the cost of spreading the manure but none of the benefits.

Northern Forest Compost Collaborative

Manure Handling Plan

Jerry Dell Farm
Vaughn and Susan Sherman
2219 Gee Hill Road
Dryden, NY 13053
(607) 844-8289

Farm background
3rd generation family farm
Registered Holsteins
350 milking cows
100 heifers
70 dry cows
75 calves

Farm staff: Sons: Ryan, Jeremy and Derrick, cousin Troy plus four Mexican laborers- mostly milking, feeding, calf care and barn help. Well organized, facilities well-maintained, should have sufficient time to learn and adapt to changes in management practices. Interest in "value-added" processing, perhaps butter or yogurt. Capable of refining activities and marketing products.

Grow hay, rye, oats and corn - makes some straw, some haylage, some corn silage
300 acres of pasture- gets liquid manure application in January (concerns of slope and drainage towards Fall Creek)
Buys in corn grain, minerals, wheat bits for mix ration
Carl Crispell does nutrient management recommendations for fields. No high P fields, higher concentrations in fields closer to dairy barn from past spreading. Could utilize more nutrients to improve crop yields. Chicken manure and especially composted chicken manure could provide concentrated nutrients, improve fertility and soil structure.

Bedding includes straw, hay and woodchips. Cedar/pine chips from Cote Lumber in Locke - considering change to sawdust because of high somatic cell counts in milking herd
3 points of manure generation (including small amount from calf hutches)
Have made some compost from scraped manure at heifer/dry cow barn, have experimented with mortality composting.

Equipment
Skidloader
Tractor with bucket loader
Knight side-discharge V-spreader (3500 gallon capacity)
Tank spreader 4000 gallons(dual axle)

See AEM Tier I worksheet for additional info

Manure handling goals:
Maintain sanitary conditions in livestock barns
Meet nutrient management plan contained in CAFO, including achieve targets for P
Utilize manure for maintenance of fertility for crop fields (utilize info from current soil testing and NMP program)
Improve fertility in pastures using manure without issues of decreased palatability or nutrient/pathogen runoff to ditches and creek.
Avoid costly investments into manure handling storage/equipment- currently considering additional liquid manure storage structure
Avoid insect infestations in barn, manure handling/storage areas or points of manure application
Avoid increased labor costs for manure management
Minimize odors and resulting complaints from neighbors
Produce manure compost for sales and revenue diversification

Manure handling recommendations:
Dairy barn-estimate 7670 tons/year (120 lbs. manure/cow/day) estimated volume may be reduced by 1500-2500 tons/year due to manure left in pastures while grazing.

Currently spreading daily from 1-day storage tank under freestall barn. Gravity pit- can spread directly from there or pump to Slurrystore. Confirm location of Slurrystore.

Does this also handle milkhouse waste and flush ? - if yes (volume?)
Volume of bedding used in dairy barn? Summer nearly nothing- occasional
2-3 10 wheeler loads of sawdust. Winter tractor-trailer load/week - 80 cy approx. volume

Continue this practice in colder and wetter months, avoid hydrologically sensitive areas (HSA's) if possible.

Maps should be obtained to view soil types, slope, proximity to barns, roads, creeks, wells and other locations.

Dairy barn- recommend currently maintaining existing practices
Summer and dry weather- recommend scraping with skidloader into spreader, 1500 to 2000 tons are possible. Form into windrows behind house on soil pad next to barn. May mix with spoilage from bunks or may need to use more bedding to get good pile structure. Can be turned with windrow turner.

Heifer and dry cow barn- estimate 2482 tons manure/year, (80 lbs. manure/cow/day), estimate may be reduced by up to 1500 tons/year due to manure in pastures.
What is volume of bedding used for heifers/dry cows? Summer nothing.
Calves 4-6 months in barn. 30 calves.
Summer, hay from bull pens, bunk spoilage.
7 months in barn, 5 on pasture

Freestall housing with gates. Cleaned by scraping with skidsteer and spread weekly. Recommend forming into windrows near barn (slightly sloping area just south of main pasture fence) or location across road from heifer barn. Turning with Sandberger on monthly basis. Should not require additional amendments as bedding and waste feed currently in manure provide good structure.

Dairy barn- New reserve water tank prevents water from overflowing through barn and adding moisture to manure slurry
2.5 loads every other day of slurry from dairy barn
Calf hutches- currently land spread. Avoid risk of transmitting diseases carried by youngstock by composting hutch cleanings with heifer/dry cow manure. Place temporary fence around windrows to avoid curious livestock disturbing piles.

Northern Forest Compost Collaborative

Composting Operation and Maintenance Plan

Cobblestone Valley Farm
Paul and Maureen Knapp
2023 Preble Road
Preble, NY 13141
(607) 749-4032
cvfarm@twcny.rr.com

IN CASE OF FIRE OR EMERGENCY- DIAL 911

Purpose
The intent of this composting operation and maintenance (O&M) plan is to provide written guidance on composting manure and companion materials at Cobblestone Valley Farm. As a member of the Northern Forest Compost Collaborative, the project team intends to help the farm most economically produce quality compost with the most appropriate characteristics for the intended uses of compost at your farm.

For your farm the first goal is to eliminate or minimize nuisances such as odors, insects and runoff. The second goal is to produce composted material that is suitable for spreading on fields where animals are pastured and hay is harvested, without the problems of raw manure such as clumping and pasture rejection. The third goal is to produce compost that meets the needs of consumers (vegetable growers, home gardeners and others).

The O&M plan is intended to accomplish the above goals in a safe and efficient fashion. This plan is a "living document" that should be periodically updated and revised to reflect actual operating conditions, potential concerns or other risks. For assistance and/or troubleshooting the following contacts are available for support:

Jean Bonhotal, Cornell Waste Management Institute, (607) 255-8444 / jb29@cornell.edu
Brian Luton, (315) 469-4225 / bcluton@aol.com
Brian Jerose, WASTE NOT Resource Solutions (802) 933-8336 / jerose@together.net
Maureen Knapp, NFCC Farmer Chair, (607) 749-4032 / cvfarm@twcny.rr.com

Site Description

Site One- northwest of dairy barns off gravel drivewya (primary site)
Site Two- southwest of dairy barns in level pastures (secondary or temporary storage site)

Management and Labor
Paul Knapp, Maureen Knapp, farm labor, hired custom operators

Equipment
Box Spreader
Loader Tractor
Skidloader

Feedstocks

Dairy Manure- gutter cleaner
Heifer Manure- freestall pack
Calf Manure- small pens
Feed spoilage
Straw-baled - from neighbors or others
Straw-chopped - from neighbors or others
Old Hay - roundbales or other
Horse Manure- from Cortland County Fairgrounds

Feedstock Recipes

70% Dairy Cow Manure- bedded with woodshavings, sawdust, hay and/or straw
20% Bedded Manure from Cortland County Fairgrounds
5-10% Heifer Manure
2-5% Feed Spoilage
1-5% All Other Feedstocks

Operating and Maintenance Procedures

Bedded pack manure is removed from pens in Cover-all barn with tractor loader into manure spreaders or stacked outside the barn. Gutter cleaned dairy manure is loaded into box spreader. Amendments are added into box spreader if necessary in order to achieve targeted moisture content of 60-65% and carbon to nitrogen ratio of 30 to 1.

Box spreader unloads manure into rough windrow on pad (Site 1). New loads are added to the end of existing active windrows.

Other feedstocks are added to top of windrow with skidloader or loader bucket as available.

Pack manure or other off-farm sources of compost feedstocks may be windrowed separately when large clean-outs occur.

The tractor bucket loader or skidloader is used to create windrow dimensions of maximum 9 feet wide by maximum 4.5 feet high that will accommodate the tunnel size of the compost turner.

Windrows are turned with either the farms Sandberger compost turner or Dairy Support Services Company compost turner or with skidloader. This can act to incorporate other feedstocks into the dairy manure. Scott Potter of DSSC can be reached at (607) 842-6433 (shop) or (315) 683-9261 (home) to arrange for windrow turning.

Pile temperatures are recorded on a weekly or more frequent basis to ensure proper biological activity and decomposition in windrows.

For best results, piles must be turned to adequately incorporate all feedstocks into the interior of the windrow where elevated pile temperatures are 131 degrees Fahrenheit or greater. Three turns per batch of compost within two months of initial windrow construction may be sufficient. Additional skid loader turning to manage windrow sections that are too dense, too wet or otherwise not achieving adequate temperatures is recommended.

Windrows should not be capable of releasing leachate (runoff of free liquids) except in the event of large rainstorms. This may result in too much moisture within the pile, limiting oxygen and reducing composting activity. Windrow recipes should be altered to reduce moisture content. Active manure compost should be able to retain liquids up to 70% moisture content. Excessively wet windrows that are not composting should be broken up and remixed into new windrows with proper moisture content.

Leachate from windrows should be captured and treated as it is rich in nutrients and may contain pathogens. Leachate is a resource to be recovered for utilization in plant growth and for protection against soil, groundwater and surface water contamination. Placement of a berm (1-2 ft. in height) at the downslope end of the composting site of relatively dry materials (less than 50% moisture content) such as mature compost, old hay, leaves and woodchips, etc. will block the loss of leachate from the site. As the berm becomes saturated, these materials can be recovered and incorporated into new windrows and a new berm can be constructed.

Growth of weeds upon the active compost windrows indicates that the piles have not been turned frequently enough. Attention should be paid to windrows where weeds have begun to grow. If weeds are young, they can be turned into the pile and be broken down by the composting activity. If weeds go to seed, it is recommended to scrape the edges of the pile with the skidloader to remove the weeds, and incorporate this plant material and weed seeds into a fresh compost windrow.

Windrows become mature after the compost fails to increase its temperature above the ambient outdoor temperature after a turning of the pile. Weed seeds and plant material will no longer be destroyed and decomposed if incorporated into the windrow at this time. If weeds grow on piles at this time, they should be scraped off pile edges and be incorporated into fresh compost windrows.

Recommendations for handling of mature compost include:
a) Immediate utilization on pasture or hay fields,
b) Consolidation of smaller windrows into larger windrows to free up space on site,
c) Cover windrows with Compost-Tex or other suitable material - covering creates a physical barrier against weed seeds, and prevents saturation of mature compost.
d) Sale for regional vegetable and grain farmers, especially those in certified organic production as the farm's compost is approved for organic use

Saturation can cause the loss of nutrients through leachate and make compost more difficult to handle and apply. Active compost can utilize moisture from rainfall as it evaporates large volumes of moisture during the composting process and does not need to be covered. Mature compost instead retains moisture like a sponge and can hold up to four times its dry weight in water.

Weed seed contamination of windrows can also be reduced through weed management in the vicinity of the compost site. Removal of old manure stacks and feed spoilage piles with weed growth reduces the local weed seed supply. Mowing and trimming of weeds and grass will also reduce weed pressure. This may take several years to accomplish depending on site conditions.

Compost produced for field application can be less mature than compost produced for production of vegetables or container plants. Compost for field application should no longer have a manure odor and most or all feedstocks should not be identifiable as to their origin. Temperatures of compost should have returned to ambient levels. If composts are applied with high amounts of visible carbon feedstocks may cause temporary nitrogen deficiency in soils as soil microorganisms utilize nitrogen to complete the decomposition of the materials prior to making soil nitrogen available for plant uptake.

Compost for vegetable or container plant production needs to be mature to prevent damage to roots. High levels of ammonia and other compounds can damage plants or limit plant growth. Compost should have a darker color, have a humus or earthy scent and original feedstocks should not be identifiable. Tests such as the Solvita Kit can be used to confirm the level of maturity prior to compost uses in these more sensitive applications.

Additional Notes

Did you Know?

Composting facts derived from research based on Best Management Practices associated with the *Northern Forests Compost Collaborative (NFCC)*

1. Composting Dairy Manure Can be Cheaper than Daily Field Spreading

- Manure decreases 50% in volume when composted. Farms that compost do spend more time operating their compost systems but because of reduced volume, less time is spent spreading manure than farms that daily haul.
- The average farm spent $9.55 and 11.64 minutes to compost and field spread a yard of product. The same farms spent $6.84 and 9.61 minutes to daily haul an equivalent amount of manure. This is based on a 42 minute spreading round trip.
- Applications of compost are even more cost-effective versus raw manure spreading for fields further from the manure storage area. If a farm takes 70 minutes or more to spread a load of manure or compost product and return to the farm, compost systems are cheaper and less time consuming than daily haul systems. As described below, due to the lower moisture content and biochemical conversions during composting, more nutrients and organic matter are delivered to a soil and crop per ton of compost than raw manure.

2. Compost is a Better Fertilizer and Organic Matter Amendment than Manure

- About 67% of the nitrogen in manure is in its ammonia form, which releases into the air when spread on a field.
- Composting helps capture ammonia. The compost analyzed in the NFCC study contained an average of 10.22 lbs of nitrogen per ton of manure used. That same ton of manure would only have had 4.3 lbs of N if it were field applied as raw manure. Land applied manure represents a savings of 6 lbs of nitrogen per ton of manure, while the compost offers 12 lbs per ton of compost. Higher carbon mixtures using more straw, sawdust and/or hay, may conserve additional nitrogen in the compost product.
- With today's high fertilizer prices of $0.50/lb for conventional nitrogen, composted manure can save each farm $6.00/ton (12 lbs x $0.50/lb) in purchased fertilizer. Organic nitrogen fertilizers are even more expensive, so savings to Certified Organic producers could be even more substantial.

3. Composted Manure is Better for the Environment than Raw Manure

- Each ton of compost helps conserve 12 lbs of nitrogen.
- 11,908 tons of compost made during this research project helped keep 71.45 tons of nitrogen from leaching into our air and water.
- By better utilizing 71.45 tons of nitrogen already available, we avoided the need for 2.92 million cubic feet of natural gas, the fossil fuel required to make 71.45 tons of conventional nitrogen fertilizer, and its associated costs. Displacing fossil fuel consumption is important in conserving energy sources for future generations.
- Compost additions increase soil organic matter and soil aggregation thus reducing soil erosion and associated loss of phosphorus into surface waters

Did you Know?

4. Compost is Great for Pasture Applications

- Prepared properly, compost does not attract flies or have any offensive odor.
- Larger fly populations and odor problems have been shown to cause daily milk production decreases of 5-10 lbs/cow/day.
- Every farm participating in this research project utilized compost in their pasture system and noted that it did not cause any rejection or milk production losses. Compost use improves dairy profitability.
- Applying raw manure to pasture often causes rejection and reduces cows forage intake.

5. Composting is Great to Do in General

- Participating farmers noted that compost spreads more evenly (less clumps) than conventional manure thus leading to higher quality hay.
- 7 of 8 farms involved in this study noted that composting helped reduce on-farm odors.
- 2 farms that needed long-term storage facilities for manure management noted that composting helped avoid that expense.
- 7 of 8 farms found that composting improved their nutrient management plans.

All participating farmers will continue to compost all or a portion of their manure.

Compiled by J. Schuelke, B. Jerose and B. Luton
May 2006