** FINAL REPORT **

Submitted to the Massachusetts Department of Food and Agriculture Agro-Environmental Technology Grants Program.

Biological and economic aspects of composting leaf trash from cranberry production systems in Massachusetts

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Attainment of Project Goals and Objectives

The overall objectives of this project were to evaluate several basic composting procedures for their effectiveness in decomposing cranberry leaves and to produce a Best Management Practices document. This BMP would relay the information garnered during the course of the study.

Specific project objectives were defined as:

- Define an optimal procedure needed to achieve a desirable composted product, within a reasonable timeframe on a small-scale farm and on a large handler operation scale.
- Conduct assessment of pest mortality (weeds and diseases) during the course of composting.
- Identify any special handling needs required to produce a consistent product.
- Evaluate the benefit/cost economic of composting in different cranberry production systems.
- Produce a BMP document on composted. Completed by early March 2001.
- Print document (1000 copies). Delivered from print shop mid-March 2001.
- Incorporate results into Chart Book recommendations and Cranberry Station newsletters as appropriate.
- Distribute new and revised BMPs to Massachusetts cranberry growers. Completed by end of March 2001.

Likelihood of implementation of project results

The Composting BMP will join the other BMP documents produced through the DFA Agro-Environmental Technology Grants Program. The BMP guide has been well received and heavily used by Massachusetts cranberry growers, farm planners, and other public officials. Effective and sustainable pest management will always be a major priority for cranberry growers. This project has demonstrated that composting leaf trash can be performed relatively easily and cheaply on a small-farm scale. However, the financial crisis that many cranberry growers have found themselves in will greatly impact the implementation of any new practice. Many growers have had to take alternative employment and are less likely to be spending as much time on the farm. Unfortunately, the release of this information coincides with time when grower resources are especially thin. Hopefully, as the economics of the industry rebound, new practices such as composting will become more commonplace.

There is virtually no information available on composting any organic materials that are generated on a commercial cranberry farm (see Literature Review section). In the wake of the current economic crisis, public officials, industry personnel, and researchers were struggling to obtain any information on composting cranberry materials (mostly fruit in 2000). A direct result of this project is new information on composting cranberry leaf trash that contains up to approximately 12% fruit. The BMP also includes resources and references to the most currect information available.

The BMPs continue to be vital in the education of public officials regarding the growing of cranberries in an environmentally responsible manner. In addition, BMP documents are routinely incorporated into Conservation Farm Plans developed for cranberry farms. It is the goal of the CCCGA to have farm plans in place for as many bogs as possible and for all bogs that are in zones surrounding sensitive water resources.

Economic, environmental, and other impacts of the project

Small-scale firm operations will be able to incorporate composting of leaf trash into their normal agricultural practices. No special equipment is needed and the compost need not be handled in any special way that requires additional expenditures. If growers need to bring in additional materials to incorporate in the trash piles (not found on the farm), this will increase their costs of composting cranberry leaves. Some growers should have bulking materials and nitrogen sources located on-site that could be utilized in die composting process.

Due to the economic crisis that has gripped the industry, the large-scale handler facilities opted to discontinue the investment of time and money to explore the potential of composting on their operations. Thus, we were not able to make economic comparisons between small-scale farms and larger operations.

Use of this composting BMP will assist Massachusetts cranberry growers in growing their crops in a sustainable manner. Composting cranberry leaves improves the carbon:nitrogen ratio of the original raw material and makes the compost an attractive material for re-use on the farm. The potential for growers (or other operations) to sell the compost to members of the Commonwealth has also been considered. Again, when economic conditions improve, it is anticipated that more growers will incorporate this practice.

Tables 1-3 present data submitted in previous reports to the DFA. These tables show the initial recipe testing that was performed in the early part, of the project (1998-99). This work generated the recipe that was utilized in the 2000 demonstration study. Three recipes were compared in this evaluation: leaves only, 10:10:1, and 10:10:2 ratios of cranberry leaves:horse manure and bedding:fish hydrolysate. Several analyses of the finished composted products were conducted by the University of Massachusetts Soil Testing Laboratory. The compost recipes were analyzed for possible pesticide residues by the Massachusetts Pesticide Analysis Laboratory. Both laboratories are located in Amherst, MA.

Table 4 shows the general compost analysis of the three mixtures. Percentage moisture readings for the three recipes were all within the acceptable range. The finished compost products were more acidic than most other composts (values below 6). Electrical conductivity (soluble salts) readings indicate that the composted material would be safe for most applications. Nitrogen levels were at or below the low-end of the acceptable range (0.75%-2.5%) for most compost. The high ammonium content of the 10: 10:2 may be damaging to sensitive plants. There is no ideal organic matter content for compost, but most materials tested by the UMass lab tend to fall within the range of 25-40% OM. A final C:N ratio of 20-25 is within the acceptable range for many uses.

Table 5 shows the heavy metal and nutrient analysis of the three recipes. As mentioned previously, the nitrogen levels are low. In addition, the magnesium and iron levels are low (where compared to what growers would tend to see in a typical tissue analysis). All heavy metals are within the normal ranges of an average soil. Table 6 shows detected pesticide residues from the finished composted products. Nine products were selected for detection: carbaryl (Sevin), chlorpyrifos (Lorsban), Diazinon, chlorothalonil (e.g., Bravo), dichlobenil (Casoron and its breakdown product, 2,6-dichlorobenzamide), napropamide (Devrinol), norflurazon (Evital), and simazine (Princep). Only two compounds were present in the finished products, chlorpyrifos and the breakdovai product of Casoron. The levels of Lorsban in the composted products were well below the food tolerance limit for cranberries of 1 ppm.

Graphs I and 2 show the temperatures of the interior (1 m deep) and exterior (0.3 m deep) portions of the pile during the course of the experiment. Some temperature data was lost (especially in the 10:10:2 recipes) because the temperature and moisture conditions were outside of the acceptable operating conditions for the temperature probes. In spite of the lost data, the available data indicated that the piles attained high enough temperatures for a sustained period of time. These temperature-time durations are within the acceptable range for normal compost processes (i.e., typically 2-3 weeks at temperatures between 110-150'F). Table 7 shows the percentage germination of weed seeds placed in the various compost piles. No weeds seeds germinated from either recipe that contained die fish and horse manure/bedding mixture.

The above information would suggest that the composted product would be acceptable for use on-farm, as well as for distribution to other off-farm sites.

Literature Review

(presented in a previous report to the DFA)

Leaf trash from cranberry *(Vaccinium macrocarpon)* production systems not only pose problems of disposal but also have been identified, from a pest management perspective, as a source of secondary inoculum for many fungi that can cause fruit rot in cranberries. The piles can also serve as secondary sources of weed seeds that re-infest the bogs. Best management practices recommend that growers remove trash piles to sites at least 1/4 mile away from bogs. This can prove to be quite inconvenient or even impossible for some growers to accomplish. Removal of these plies by composting could not only lead to improved bog conditions and reduced use of pesticides through improved pest management, but could also generate an additional product with economic value for Massachusetts cranberry growers.

While one can easily find thousands of articles on composting organic residues from chicken carcasses to lawn clippings, the literature provides virtually no information on composting cranberry trash. Even though growers in Massachusetts and other cranberry production regions-have attempted methods of composting cranberry trash in a small-scale fashion (personal communication with author), effective recipes have not been published in the current literature. The few articles available on any aspect of cranberry composting do not deal with cranberry leaf and vine trash but instead focus on cranberry press cake, the remnants of the juice-making process.

Cranberry press cake, along with other wastes, was included in a composting study by Bugbee and Frink (1989). The finished products were then found to be suitable alternatives to peat as a potting media. The cranberry industry can certainly produce large amounts of organic by-products. Bye (1993*),* in an article on composting at the Massachusetts Natural Fertilizer Company, reported 480 cubic yards of cranberry press cake could be delivered to the site for composting on a given day. In Wisconsin, cranberry pulp was mixed with duck litter and poultry manure (Gilmore, 1994). The authors reported that the product produced a saleable compost available to the general public that was pH-balanced, virtually odorless, and free of weed seeds. Verville and Seekins (1993) described methods of composting waste from another Vaccinium species, low-bush blueberry (V. angustifolium). The article describes how composting could be used to alleviate problems the Maine blueberry industry faces with post-harvest waste disposal. Methods of determining appropriate recipes as well as logistical arrangements of setting up composting experiments were discussed.

Literature Cited

Bugbee, G.J. and C.R. Frink. 1989. Composted waste as a peat substitute in peat-like media. HortSci. 24(4):625-627.

Bye, J. 1991. Privatized composting in a farm setting. Biocycle. 32(10):60-61.

Gilmore, C. 1994. Cranberry leftovers become community asset. Cranberries 58(5):21-22.

Verville, R. and B. Seekins. 1993. New use for blueberry residuals. Biocycle 34(4):71.

News Articles

Cranberry composting experiments, East Wareham, MA. 1998. Biocycle 39(6):20.

Composting experiments with cranberry leaves, East Wareham, MA. 1999. Biocycle 40(10):20.

FINANCIAL STATEMENT

Funds from MA-DFA

Labor for field technician	$4,515.00
Equipment:	
Microscope	$2,087.00
Temperature probes	$1,139.00
Laboratory supplies	$ 555.00
Laboratory analyses:	
Compost	$ 150.00
Pesticide residues	$1,000.00
Printing costs:	
Composting BMP (1000 copies)	$ 515.00
Total	**$9,961.00**

Funds from UMass Extension

Salary match- permanent employees (Caruso/Bewick)	$3,830.00
Salary match- temporary employees (Caruso/Bewick)	$4,634.00
Fringe benefits	$1,306.00
Mailing costs	N/C*
Total matching	**$9,770.00**

* The Composting BMPs were mailed in conjunction with the 2001 UMass Cranberry Chart Book, thus no additional mailing costs were incurred to be charged specifically to this project.

Table 3. *Dewar Flasks Trails.* Recipes were tested in the laboratory during the period from 26 October 1998 through 11 January 1999 utilizing a Dewar flask set-up. The volume of each Dewar flask was approximately 1.9 cubic liters.

Materials Used	Ratio	Min Temp (°F)	Max Temp (°F)	Days to max T
Cow manure/cranberry leaf trash	1:1	50	97	6
Cow manure/cranberry leaf trash	1:2	59	91	4
Cow manure/cranberry leaf trash	1:3	60	109	4
Cow manure/cranberry leaf trash	1:4	48	109	6
Cow manure/cranberry leaf trash	1:5	52	97	7
Cow manure/cranberry leaf trash	1:6	55	102	7
Cow manure/cranberry leaf trash	2:1	50	99	7
Cow manure w/ cedar bedding/ cb leaves	2:1	68	87	5
Cow manure w/ cedar bedding/ cb leaves	1:1	68	93	13
Horse manure w/ bedding/ cb leaves	2:1	69	115	2
Horse manure w/ bedding/ cb leaves	1:1	72	107	3
Horse manure w/ bedding/ cb leaves	1:1	61	90	6
Horse manure w/ bedding Cranberry leaves, and Fish fertilizer	7:7:1.6	91	117	8 hrs

Table 1. *Demonstration Compost Piles.* Large demonstration compost piles were established at State Bog, East Wareham, MA during the summers of 1998-99. Two separate trails were conducted. Trial A involved various turning timings and Trial B incorporated fish fertilizer into the recipe. Each pile was approximately 300 ft.³

Materials Used	Ratio	Min Temp (°F)	Max Temp (°F)	Days to max T
Trial A (conducted from 28 Aug. 1998 through 21 July 1999)				
•Horse manure/bedding •Cranberry trash (pile turned 1x per month)	1:1	73	120	5
•Horse manure/bedding •Cranberry trash (pile turned every month)	1:1	72	122	12
•Horse manure/bedding •Cranberry trash (pile never turned)	1:1	74	116	12
Trial B (initiated on 8 August 1999)				
•Horse manure/bedding •Cranberry trash •Fish fertilizer	5:5:1	86	150 (for 1 day)	3
•Horse manure/bedding •Cranberry trash •Fish fertilizer	7.5:7.5:1	100	150 (for 2 day)	2

Table 2. *Yard Composter (Tumbler-type) Trial.* A conventional yard composter was utilized to run initial recipe trials on a slightly larger scale than the Dewar flasks (see Table 3). Approximate volume size of the container was 16 ft. ³ This trial was initiated on 21 July 1999.

Materials Used	Ratio	Min Temp (°F)	Max Temp (°F)	Days to max T
•Horse manure/bedding •Cranberry trash •Fish fertilizer	5:5:1	81	136	2

Table 4. General analysis of compost piles containing no horse manure-bedding or fish amendments (leaves only), a 10:10:1 ratio (leaves: bedding: fish) or a recipe with higher amounts of fish using a 10:10:2 ratio.

	Dry bulk density (g/cm³)	**Moisture (%)**	**Moist bulk density (g/cm³)**	**pH (v:v)**	**Soluble salts (dS/M)***
10:10:2	0.23	49.9	0.45	5.8	3.50
10:10:1	0.20	59.4	0.49	5.2	2.31
Leaves only	0.23	51.0	0.47	5.7	0.31

	Total N (%)	**Nitrate-N (mg/kg)**	**Ammonium-N (mg/kg)**	**Organic matter (%)**	**Organic C (%)**	**C:N**
10:10:2	0.75	225	749	31.1	16.8	22.5
10:10:1	0.86	270	120	40.4	21.8	25.3
Leaves only	0.45	4	9	31.2	16.8	37.6

* Decisiemens per meter: equivalent to millimols per cm.

Table 5. Nutrient and heavy metal analysis of compost piles containing no fish amendment (leaves only, a 10:10:1 ratio (leaves: bedding: fish) or a recipe with higher amounts of fish using a 10:10:2 ratio.

	10:10:2	**10:10:1**	**Leaves only**
Nitrogen	0.75	0.86	0.45
Phosphorus	0.30	0.25	0.05
Potassium	0.21	0.20	0.08
Calcium	0.39	0.55	0.50
Magnesium	0.11	0.14	0.12
Iron	0.32	0.42	0.41
Aluminum	0.19	0.23	0.23
Zinc	35	47	54
Copper	14	17	19
Manganese	116	152	161
Boron	13	19	21
Lead	6	9	6
Cadmium	0	0	0
Nickel	4	5	5
Chromium	10	21	8

Normal ranges for heavy metals:

	Concentration (ppm)	**"Average soil"**
Zinc	10-300	50
Copper	2-100	30
Lead	2-200	15
Cadmium	<1	0.1
Nickel	5-500	40
Chromium	1-1,000	100

Sandler and Caruso. April 2001. Final report to DFA Agro-Environmental Technology Grants Program.

Table 6. Analysis of pesticide residues of samples collected from compost piles containing no fish amendment (leaves only), a 10:10:1 ratio (leaves: bedding: fish) or a recipe with higher amounts of fish using a 10:10:2 ratio.

	Chlorpyrifos* (ppm)	**2.6-dichlorobenzamide** (ppm)**
10:10:2	0.39	0.72
10:10:1	0.59	1.43
Leaves Only	0.83	1.30

* Food tolerance of chlorpyrifos on cranberry is 1 ppm.

** Breakdown product of dichlobenil.

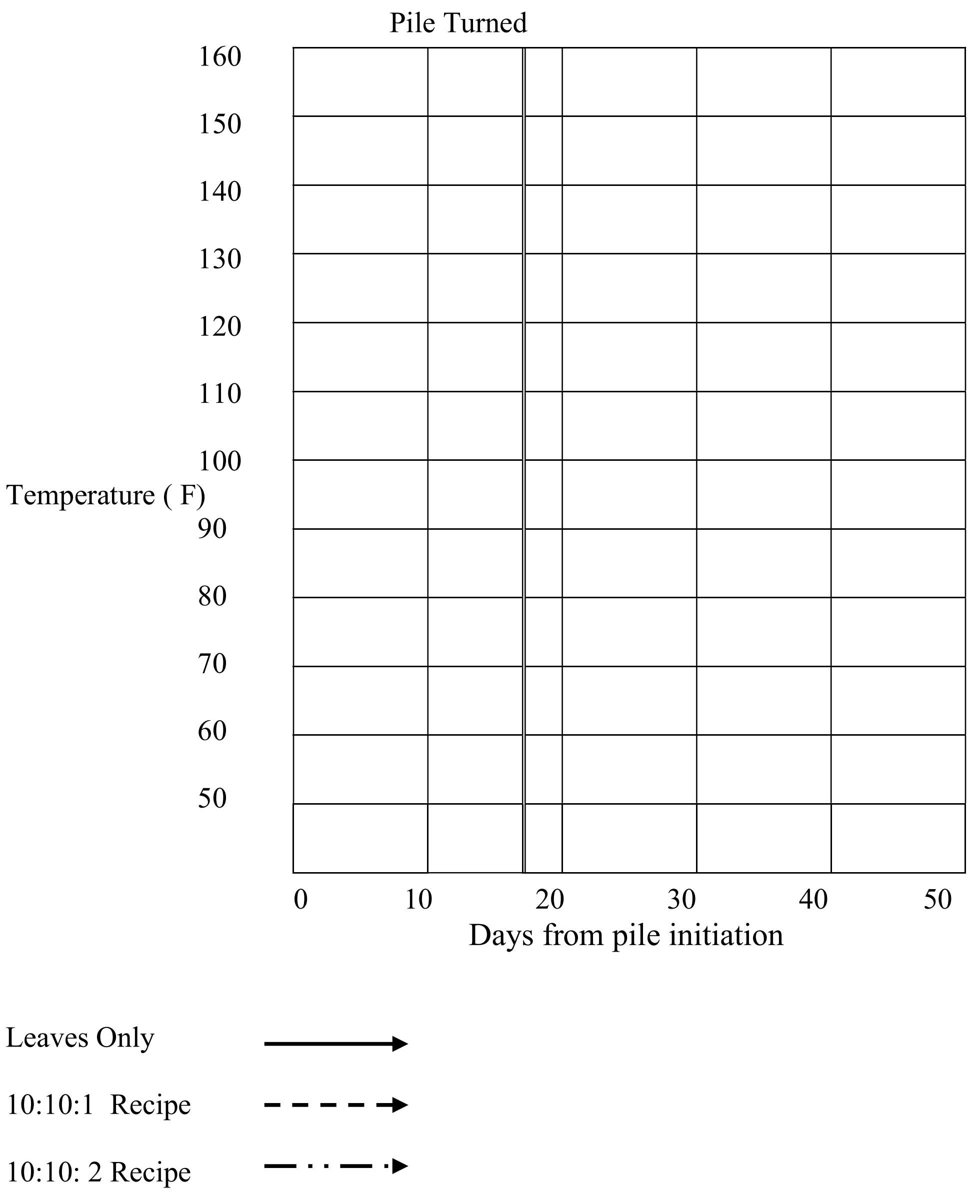
Also, tested, but not detected.
carbaryl, simazine, and dichlobenil (detection limit of 0.016 ppm).
napropamide, norflurazon, diazinon, and chlorothalonil (detection limit of 0.16 ppm).

Table 7. Percentage seedling germination of week seeds placed in various cranberry leaf compost recipes (20:0:0 denoted the "leaves only" pile).

			Percentage germination		
Seed	**No. Planted**	**Potting soil**	**20:0:0**	**10:10:1**	**10:10:2**
Common goldenrod	200	5	0	0	0
Dodder	200	4	2	0	0
Lurid carex	100	2	17	0	0
Narrow-leaved goldenrod	100	10	2	0	0
Nut sedge	200	13	8	0	0
Poison ivy	50	26	30	0	0
Switchgrass	100	6	0	0	0

Graph 1.

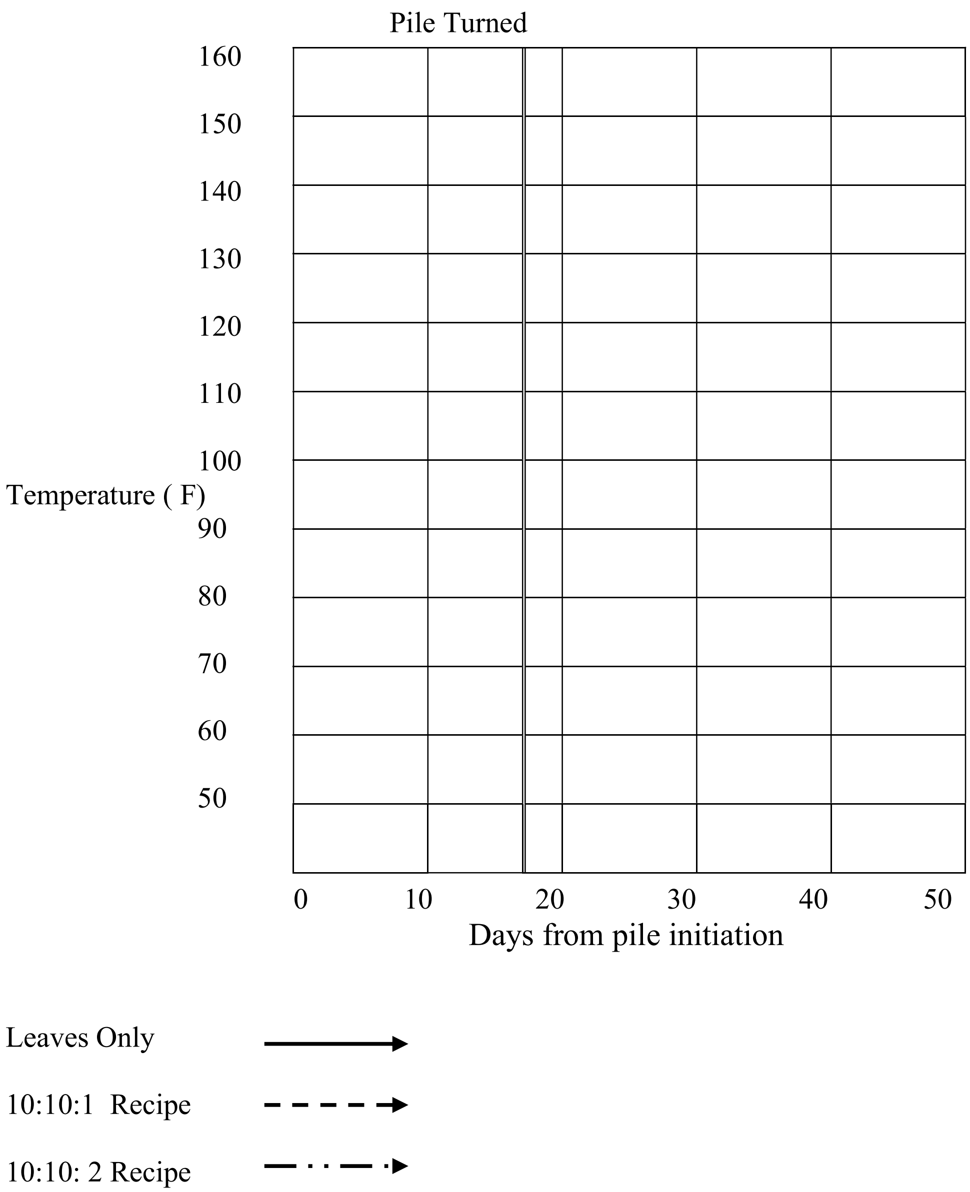
Interior Pile Temperatures
Cranberry leaves: horse manure & bedding: fish



N.B. Graph would not print in this document

Graph 2.

Exterior Pile Temperatures
Cranberry leaves: horse manure & bedding: fish



N.B. Graph would not print in this document

BEST MANAGEMENT PRACTICES GUIDE FOR MASSACHUSETTS CRANBERRY PRODUCTION

Composting Cranberry Leaves

Natural by-products of harvesting and handler operations are cranberry leaves that have abscised (either naturally or mechanically) from the cranberry plant and have fallen on the bog floor. During the harvest flood and post-harvest trash flood, leaves and small fruit may be removed from the bog surface. Leaf piles may contain up to 12% fruit (mostly small berries). This debris is commonly stockpiled in close proximity to the actual producing farm acreage.

Piles of leaf trash can be found at almost every commercial cranberry farm operation. It is estimated that one acre of bog can generate 0.5-1.5 cubic yards of leaf trash each year. A local handler facility reported that they receive 10,000-30,000 cubic yards of leaves each year. Thus, leaf trash piles may accumulate onsite very quickly.

Leaf trash has been identified as a source of secondary inoculum for many fungi that can cause fruit rot in cranberries (Oudemans et al., 1998). Trash piles can also serve as a secondary source for weed seeds that can blow back onto and re-infest the cranberry b . eds. Presently, pest management BMPs recommend removal of trash piles to sites at least 1/4 mile away from the bog. However, this can be difficult or impossible.

Once established, trash piles tend to persist decomposing slowly, if at all. It is likely that the thick waxy epidermis (Croteau and Fagerson, 1971) of cranberry leaves may slow the natural decomposition of abscised leaves (assuming no additional amendments).

Composting may offer a reasonable alternative to facilitate the management of these leaf piles. Composting hastens natural breakdown processes associated with biological materials. Fan-n-produced compost fits well as part of a more sustainable food production system.

The organic matter produced from the composting process could be incorporated back into the cranberry production system, used in other agricultural settings, or marketed to the public as a soil amendment or mulch.

Owners of both large and small cranberry operations could incorporate composting into their current farm activities. The overhead is usually minimal and any necessary equipment is typically present on site.

Before beginning a composting process on a large scale, check local and state requirements and obtain any necessary permits. Specific information relating to bringing materials onto your farm from off-site locations is given on Page 4.

<u>Recommended Practices</u>

● **Select an appropriate site.**

The location of the compost site should allow easy access and a minimum of travel and materials handling. A fin-n surface to support heavy vehicles under various weather conditions is preferable. The convenience of a site must be weighed against other factors such as proximity to neighbors, visibility, drainage, and runoff control. The best site may not be the most convenient or a convenient site may need modification.

Choose an upland site with well to moderately drained soil and a slope of 1-4% to prevent ponding or runoff. If your site is subject to surface runoff, a berm or diversion can be constructed to divert surface runoff away from your compost pile. Runoff leaving your site can be filtered through vegetated buffer strip that will reduce the velocity of your runoff and prevent sediment from moving offsite. Contact Natural Resource Conservation Service (NRCS) for assistance in developing your compost site.

● **Promote optimal composting conditions.**

Composting is most rapid when conditions that encourage the growth of microorganisms are' established and maintained.

- Organic materials are appropriately mixed to provide the nutrients needed for microbial activity and growth, including the proper carbon-to-nitrogen (C:N) ratio.

- Appropriate oxygen levels are maintained to support aerobic organisms.

- The material is moist, but not saturated, to permit biological activity without hindering aeration.

- Temperature is high enough to encourage vigorous microbial activity from thermophilic (heat-loving) organisms.

Table I lists the recommended conditions for rapid composting.

● **Include a high nitrogen source in your recipe.**

To compost cranberry leaves, you need to add a moist, high-nitrogen source, which helps to establish a reasonable carbon-to-nitrogen (C:N) ratio. Onsite demonstration cranberry leaf piles at the Cranberry Experiment Station were successfully composted when hydrolyzed fish waste (obtained from a local distributor) was added as a nitrogen source. A recipe using 10:10:1 or 10:10:2 ratios of cranberry leaves: horse bedding and manure: liquid fish fertilizer was capable of producing temperatures within the reasonable range (110-150F) for 20-30 days. Both recipes prevented the germination of several common cranberry weed seeds (see Table 2). Other researchers have reported similar results (Eghball and Lesoing, 2000).

Continued experimentation by researchers and growers will most likely yield other suitable amendments.

● **Proper blending of feedstock materials facilitates the composting process.**

The proper initial mixture can be achieved by adding the feedstocks (in the proper proportions) to a manure spreader, feed wagon, or by utilizing a loader or backhoe.

If a well-constructed pile, made with a good recipe, is maintained At the proper moisture and is thoroughly blended, a static compost pile (see Figure I)should need to be minimally turned. lf conditions are just right, the pile may not need to be turned at all until the composting process is complete. A properly blended mixture will allow air and moisture to move uniformly through the pile allowing the microbes to do their job.

Table 1. Recommended conditions for rapid composting (from: On-farm Composting Handbook, p. 7.)

Condition	Reasonable range *	Optimal range
Carbon to Nitrogen (C:N) ratio	20:1-40:1	25:1-30:1
Moisture content	40-65%	50-60%
Oxygen concentration	greater than 5%	Much greater than 5%
Particle size (diameter in inches)	1/8-1/2	varies **
pH	5.5-9.0	6.5-8.0
Temperature (IF)	110-150	130-140

* Recommendations for rapid composting. Conditions outside these ranges can also yield successful results.
** Depends on the materials, pile size, and/or weather conditions.

Table 2. Percentage seedling germination of weed seeds placed in various cranberry leaf compost recipes.*

Seed	No. planted	Potting Soil	Percentage germination 20:0:0	10:10:1	10:10:2
Common goldenrod	200	5	0	0	0
Dodder	200	4	2	0	0
Lurid carex	100	2	17	0	0
Narrow-leaved goldenrod	100	10	2	0	0
Nut sedge	200	13	8	0	0
Poison ivy	50	26	30	0	0
Switchgrass	100	6	0	0	0

* Unpublished data from Sandier, Mason, Shumaker, and Caruso (UMass Cranberry Station).

● **Strive to achieve a balanced C:N ratio.**

Microorganisms use carbon for energy and nitrogen for protein synthesis and reproduction. It is important to provide these nutrients in the appropriate proportions. The optimum C:N ratio is in the range of 25-30:1 (see Table 1). Tested cranberry leaves fell in the range of approximately 35-40: 1. The horse manure/bedding material used in the test piles had a C:N of 55: 1. These values are certainly acceptable and will give good results.

Materials will release their carbon at different rates and this will affect the composting process. For example, straw releases its carbon more quickly than woody materials (that contain lignin, such as stems and cranberry leaves), but more slowly than the simple sugars found in fruit wastes.

See Table 3 for a list of common raw materials used in composting and their associated C:N ratios.

● **If using new or innovative materials, consider analyzing the material prior to use.**

Commercial laboratories are available that will analyze raw materials as well as finished compost. If you are using materials ftom a new or unknown source, the lab analysis may provide you with valuable information. Most labs test for bulk density, C:N ratios, pH, moisture content, and other indicators of a material's potential as a successful compost pile ingredient.

● **Composting trash piles should be well aerated.**

This is particularly important in the initial stage of the process when oxygen demands are the highest. The most readily degradable raw materials are rapidly metabolized in the beginning and the microbes performing these activities need oxygen. If the supply of oxygen becomes limiting, the composting process slows. Therefore, it is most critical to monitor the pile in the beginning to insure that the most favorable conditions (adequate oxygen, moisture, and temperature) prevail.

Consider adding a 6" or 8" perforated pipe to the base of the pile (see Figure 1). A perforated pipe will encourage air movement through the pile and act as a drain for excess moisture. If water is coming out of the pipe, the pile is too wet.

● **Regularly turn the compost pile.**

Consistent turning exposes all of the raw materials to the high internal temperatures. This permits the breakdown and conversion of the materials into a useable product. Regular turning promotes aeration.

●**Consider adding a bulking agent**.

On farms, a composting recipe usually cont@ins a blend of materials. !3ulking agents provide structure so that the material can stay in the pile without collapsing (provides aeration). Bulking agents increase pore space needed for air movement. Since cranberry leaves are so small, bulking agents (such as horse manure with bedding) are recommended.

If you have the bulking material on your farm, you can compost according to the Department of Food and Agriculture (DFA) guidelines, without registering with the DFA. If you need to bring in material from outside your farm, you need to register with the DFA (see following information).

● **If you need to bring in any bulking materials from off the farm or will be receiving fruit or leaves from another farm, you must register with the Department of Food and Agriculture as part of an agreement with the Department of Environmental Protection (DEP).**

In order to register, an application must be submitted to DFA. The application can be found in the

Table 3. Summary of common raw materials that can be used for on-farm composting (from: On-farm Composting Handbook, p. 16.)

Material	C:N
Bark (hardwood)	110-435
Corrugated cardboard	560
Cattle manure	11-30
Corn stalks	60-75
Cranberry (leaves and stems)	35-60
Cranberry press cake	30-40
Finished compost	25-30
Fish processing wastes	2.5-5
Fruit wastes	20-50
Grass clippings	9-25
Hay	15-32
Horse manure	22-30
Leaves..	40-80
Newspaper	400-850
Paper mill sludge	54
Poultry manure	7-10
Sawdust and shavings	200-750
Seaweed, other aquatic plants	5-27
Straw	*50-150*
Swine manure	9-19
Vegetable wastes	11-13
Wood chips (hardwood)	450-820

Department's Guide to Agricultural Composting. To receive a guide, contact Craig Richov (DFA) 508.792.7711, x 14 or the Cape Cod Cranberry Growers' Association (CCCGA) at 508.295.4895. The publication gives detailed explanations about what a grower would need to do. The application asks for information about acreage, land uses, vegetative buffers, and more. Growers may also join together to register as one composting unit.

● **In most cases, water should be added to the cranberry leaf pile.**

Moisture is necessary to support the microbes that perform the composting activities. If the moisture content is below 15%, microbial activity will cease. Optimal moisture content is between 40-65%. Below 40%, microbial activity slows; above 65%, anaerobic conditions predominate.

A simple "squeeze" test gives a good estimate of a pile's moisture content. The material should feel damp to the touch with just a drop or two of liquid expelled when the material is squeezed tightly. If the pile is too we@ turn the pile. Adding dry materials may be helpful. If the pile is too dry, it can be rewetted with a trickling hose or similar device.

During field trials, water was added to the piles after the ingredients were initially mixed together. If rainfall is insufficient, additional water may be needed periodically (every 2-3 weeks). Monitor pile temperatures. A drop in temperature indicates decreased microbial activity. This may be due to lack of moisture.

Covers (e.g., burlap, tarps, non-spun row covers) can be used to maintain moisture.

● **Monitor pile temperatures.**

Probes should be used to check temperatures every few days. Many companies sell probes that can be successfully used in active compost piles. Consider monitoring the interior portion of the pile as well as the exterior. Depending on the size of the pile, use a probe with a 2 to 4-foot stem for monitoring interior temperatures. Probes with one-foot stems should be adequate for exterior pile measurements.

● **Make piles the correct size to encourage the compost process.**

Piles less than 3.5 feet tall may fail to heat. On the other hand, piles taller than 8 feet or wider than 20 feet may overheat (temperatures exceed 150'F). Piles that are too large may become anaerobic, and therefore, excessively odorous.

Identify the machine that you will be using to turn your piles and adjust the size of the pile accordingly.

● **Monitor the odors emanating from the pile.**

Temperature and odor are probably the most important indicators of how well composting is progressing. Some odor is to be expected. However, if putrid odors persist, the pile has probably become anaerobic and needs to be turned.

● **Minimize odor concerns by properly managing the site.**

Anaerobic conditions promote foul-smelling odors. To avoid problems with odors, use a good mix of materials, avoid overly wet mixes, monitor temperatures, and turn or aerate piles regularly.

A key to minimizing odors is to start composting your raw materials as soon as possible and then keep them aerobic.

Odors can be controlled by the choice of raw materials. For example, a layer of peat moss or finished compost can be placed on top of a composting pile to trap odors. Mixes with large amounts of sawdust, compost, or peat moss can help absorb odors coming from other ingredients.

Build or use a site with a crown (-3%) to promote surface runoff. Puddling rain water promotes odors and inhibits your ability to properly work the pile.

● **Keep the site well drained.**

Good drainage at a composting site must be a priority. Locate the site on moderately to well drained soil.

Ideally, the site should have not have rocks. These can get mixed into the composting materials and damage machinery. If mud could be a potential problem, consider resurfacing the composting pad with gravel or sand.

Consider sloping the site (I -4%) to facilitate water run-off.

The site should be graded for handing surface runoff without creating erosion . Runoff, if needed, can be directed towards pasture areas, an infiltration area, or collected in a holding pond for later use. Runoff should be diverted away from the compost pad and storage areas.

● **Determine when the composting process has finished.**

A sustainable drop in temperature is probably the most reliable indication that active composting has been completed. Failure to reheat after turning is also another indication that the compost has proceeded to the point that it can be cured. However, be sure that the lower temperature is not due to the lack of moisture or similar factors. This can be checked by placing a small sample in a sealed plastic bag at room temperature. If the compost does not emit a foul smell within one week, it can be considered stable.

Commercial kits are also available from certain laboratories (see "For further information").

● **Use finished compost around the farm.**

Finished compost can be used in many areas around the farm. Consider using compost as a dressing on sandy dikes to facilitate the establishment of grass cover.

If enough finished material has been generated; it may also be used as part of the organic layer in the lining of new bed construction.

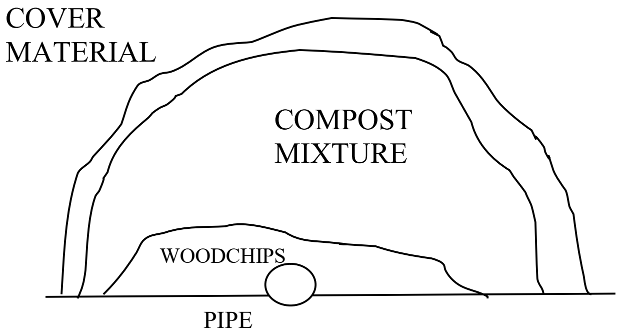


Figure 1. Diagram of a static pile construction with a perforated pipe insert.

Portions of this text were excerpted from:

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Dougherty, M. 1999. Field guide to on-farm composting. Natural Resources, Agriculture, and Engineering Service. Cornell Cooperative Extension, Ithaca, NY. NRAES- 1 14. 118 pp. -

Composting Program, Department of Environmental Protection. Contact: Sumner Martinson, Director, I Winter Street, Boston, MA 02108. 617.292.5969,

University of Maine Cooperative Extension Composting School. Multi-day workshop. Contact: Neal Hallee, Waste Management Specialist, 5741 Libby Hall, Orono, ME. 207.5 . 81.2722.

University of Maine Composting School Web Site. http://www.composting.org. Ask questions on-site and a Compost Team member will respond. University of Massachusetts Soil and Plant Tissue Testing Lab. Compost analysis. West Experiment Station, Amherst, MA 02001. 413.545.231 1.

Woods End Research Laboratory, Inc. Old Rome Road, Box 1850, Mt. Vernon, ME 04352. 207.293.2457. Lab analysis and suppliers of Solvita test kits for determination of finished compost.

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