Final Report on
Manufacturing High Value Products From Commercial Food Waste
East Coast Compost - Contract No. H200045

The purpose of the compost facility that was set up at a Sugar Hollow Farm (SHF) was to 1) demonstrate methods for diversion of food waste to composting and 2) demonstrate the results that could be achieved by creating value added compost products from these ingredients. This project was funded by the NC Dept. of Pollution Prevention and Environmental Assistance and East Coast Compost (ECC). This report will be divided into 6 sections to correspond to the 6 main tasks that were achieved. Photographs of food collection, compost production, potting soil production, bioassays and the apple spray project have been taken and are available for presentations or slide shows.

TASK # 1
COMPOST PRODUCTION

Handling of Food Waste

A pilot application permit for composting was received in Feb. of 2000. During March and April the compost site was set up and carbon sources were stock piled . To collect water for cleaning of food cans and composting, a gravity feed system was set up with a 425 gallon holding tank. When coupled with a pump and hose reel , this setup allowed us to have good pressure for washing food of cans and with the use of a tractor loader allowed us to dump waste water directly into compost windrows. Source separation training began in late April of 2000. Source separation training consisted of 2 meetings with FOOD LION staff and the general manager Allen Jenkins. During the first meeting a video produced by Cornell University entitled "Compost.. because a rind is a terrible thing to waste ! " was shown to the staff and a handout was given out describing why we compost and what is required for good ingredients. After the presentation, their was a question and answer period. ECC explained about how we would start by picking up food 3 time per week and showed examples of the type of signs that would be used in source separation areas and the red food collection cans that would be used. At the second meeting, 3 of the red 35 gal. cans were brought in and placed in the deli and produce areas along with signs. Signs that were used and the handouts that were provided to FOOD LION staff are shown in TASK #6 "Guidance Document for Food Waste Composting". While we expected to throw out the first round of source separated food waste, we soon found that by the end of the first 2 days, FOOD LION staff had a done such a good job of separation that we could go ahead and move this material to the compost site. Collection of food waste began the 2nd week of May and continued for 32 weeks. Food collected from the produce department was very clean and with the frequent pickup was still fresh when delivered to the compost site. The food from the deli however, started out fairly clean but within a week or so contaminants were no longer manageable. After several conversations with the deli staff and store manager it was finally decided that to much time was involved time in picking out the glass , metal and plastic contaminants. Therefore after several weeks of collection, we decided to discontinue picking up material from the deli.

Matching Feedstocks

At SHF, 652.5 yards of total feedstocks were composted in 10 different blends from April 2000 through February of 2001 (see Description of Product Blends below) .

Type and quantity of materials composted at the facility:

HORSE BEDDING (manure and wood shavings)	145	YARDS
SHEEP BEDDING (manure and spent hay)	202	YARDS
WHEAT SILAGE	116	YARDS
SOURCE SEPARATED FOOD WASTE	114.5	YARDS
DAIRY MANURE	65	YARDS
CORN STALKS	8	YARDS
HAY	2	YARDS

In the first few week of April of 2000, food waste was received from Brevard College (Brevard, NC) as part of a project that was begun by Applied Organic Agricultural Technologies (in which ECC was a subcontractor). This material had very high moisture content, and was difficult to handle due to high amount of liquid content. In most cases this material was over 200 lbs. per 35 gallon container. The benefit of this material was that with the low moisture content of our other ingredients, it served to add much needed moisture to the windrows. The first 2 windrows that were made at the SHF site contained some of the Brevard food waste plus sheep bedding, corn stalks and cow manure. The sheep bedding that we cleaned out of the barns at SHF had good nutrients and was mostly spent hay. The C/N ratio was low but when matched with corn stalks made a good mix . These materials worked very well, (for windrows 1,2 & 3) but once the sheep bedding was used up, a new carbon source had to be found.

One of the first lessons we learned from windrows 1,2 and 3 was that when food waste was added to piles and turned right away we could get good heat . However, the next question that came up was "How do we handle the continuous flow of food that we were getting by picking up food 3 times per week?" In windrows 1,2 and 3 we did this by making pairs of rows (1A &B and 2A &B) or by making 2 sections of a row (for row #3) and then combining them after they had gone through the 15 days of >132° F temperatures. This worked ok for small rows that had materials that would break down quickly. But once we got more rows on the pad and much longer rows (rows 4,5 & 6), it was no longer easy to combine piles whenever we wanted. We had to: 1) have more time to finish the older rows and get them out of the way 2) increase the size of the pad or 3) develop a new system. Whatever strategy we developed had to assure that we would still get good temperatures for 15 days with a dwindling source of water.

We observed with windrow # 3, that if we held off on manure additions till all food was in the row, and made sure to cover the windrows so they wouldn't get wet we could actually start rows when we wanted. In effect for windrows 4,5 and 6 we actually "cooked" the ingredients twice. Once under fairly dry conditions, and then again when we added cow manure and water. For the high carbon horse bedding, this worked especially well and allowed us time to build rows without having a space problem. It also reduced the labor required in constantly having to shovel food back into the pile that was dislodged with turning. By the time the windrow was "officially " started (by the addition of manure) most of the food was well on it's way to full breakdown. By fully encasing it in the bedding and covering it with the windrow cover we also seemed to prevent rodents (which we would have expected in the old system if food did not heat up fast). With horse bedding, pile construction was much easier and more time was available to collect materials. For fast breakdown, both the silage and the sheep bedding made the best product and therefore for windrows 7,8 and 9 we went back to more frequent turning. From the various blends that were tried in this project, we learned that for quick composting, the silage and sheep bedding made the best product. Unfortunately these ingredients are in short supply and would not be enough to match with a continuous supply of food. The horse bedding from the Ag Center proved to be useful substitute and allowed larger rows to be built while loading the weekly food inputs. The main problem with this material was that it was so dry that it took very large amounts of water to get it to break down effectively. Also, this material required many hours of hand picking to get out bottles and plastic trash. This material would have to be managed very differently if it were to be used on a regular basis. Pre-soaking the bedding in a contained area, and getting better source separation at the Ag Center would be good steps toward making this material more useful.

The most locally available carbon to this site was the horse manure and bedding that was being generated at the WNC Agricultural Center in Fletcher, NC. The Ag Center expressed interest in having another outlet for their excess material and with the farm being only about 20 minutes away, this was a good fit. In general it was very dry material with only 30 - 40% actual horse manure. One of the first problems encountered with this horse bedding was lack of sufficient water. To get water to the compost site, a garden hose was hooked up to the gravity fed spring that supplies the farm. Unfortunately this spring did not have sufficient pressure or supply to meet all the needs of the compost facility. To supply ample amount and pressure of water for cleaning food cans and pumping water into compost windrows, a 425 gallon storage tank was set up along with a pacer pump.

Using old "lay flat" hose that ECC had from other projects, water could then be pumped about 40 feet. After repeated repairs, it was decided that this hose could not handle the pressure and had to be replaced. A stronger, 125' hose was added. This allowed for longer windrows thus increasing production. To prevent this hose from getting tangled up, a hose reel was added. By cranking the hose back upslope after each turning, labor for moving the hose was greatly reduced and the water system could easily be set up for the next windrow. With the dry weather that occurred in June through July we soon realized that the spring was having trouble keeping up with the water needed for composting. To help this problem, aged compost was added back in to mixes 4 and 5 to hold more moisture. The next problem encountered with the horse bedding was the high amount of carbon. Not only did it take several tanks of water to get windrows wet enough to compost; the high C/N ratio of this material (as high as 43.98) and the slow degradability made it hard to work with. Also, by the time this material arrived, we were no longer working with the Brevard liquid food waste and therefore much more water was needed than before. In windrow #4 we added a wheat silage that was locally available. This made for better moisture holding capacity and structure but did not solve the slow degradability of the bedding. By windrow #5, we realized that although we could get necessary temperatures, we were still not getting the full breakdown we wanted. To solve this problem, less horse bedding was put into windrow #6. Since our goal for these mixes was to make potting soil grade compost, most of windrow 5 was stored for use on pastures. As they finished off, windrows #4 and 6 were combined with the rest of #5 for curing. By combing these windrows we were able to accelerate curing and make a better product.

The wheat silage that was first used in windrow #4, turned out to be a readily available source and with a short transportation distance of 6 miles, proved to be a very good alternative to the horse bedding. SHF wanted the rest of the Ag Center material for bedding their beef cows in the winter, so we began trucking in more silage for the next windrows. Windrows 7,8 and 9 used this material and good results were achieved. Pile #10 was build with the de-watered manure we had used for earlier mixes and was set up as a comparison to what could be achieved (food waste vs. dairy manure).

Comparison of Compost Methods

The system of composting that was chosen for this project is called CMC (Controlled Microbial Compost). The CMC system of compost was developed over a 20 year period in Austria by Uta and Seigfried Luebke and is now taught and practiced at numerous sites throughout Central Europe, Norway, Finland, India and the United States. The method was first introduced in the U.S. in 1985. As with other forms of composting, the CMC system controls the carbon/nitrogen ratio, moisture, temperature, structure, and bulk density to provide optimum conditions. The CMC system, also goes beyond these standard practices by monitoring: carbon dioxide, pH, oxidation/reduction potential, conductivity, ammonium, nitrate, nitrite and hydrogen sulfide. Standards for various stages of composting have been developed for these parameters so that optimum biological activity can be maintained throughout the compost process. Using CMC standards usually results in more frequent turning than with more conventional methods (which turn 5 times in 15 days with temperatures greater than 132 degrees F) . The CMC method also takes an additional step in moisture control through the use of a water repellent poly woven windrow cover which prevents rainwater infiltration and excessive moisture losses following aeration of compost piles (trade name "Toptex"). Using these more stringent standards, CMC producers have been able to produce a non-phytotoxic product that can be replicated on a consistent basis.

As described above, when working with small additions of food waste with windrows that are already heated up, the more continuous frequent turning of piles that is part of the CMC worked very well (windrows 1,2 and 3). However, when working on a smaller site in which piles are being built up slowly over several weeks of additions of food, the CMC system looses it's cost effectiveness. Part of the problem is simply an economy of scale. If the site is large and food additions are only a small input, then frequent turning is preferable as breakdown does proceed more quickly. When food additions are 15 - 30% of pile volume, it doesn't make sense to turn frequently unless there is ample space and piles are already set up. In this pilot project, we estimated that turning represented a cost of about 2 dollars per yard of finished product. As we took up more site area with continual inputs of food, we could no longer afford the luxury of having active windrows built ahead of time. Even though more frequent turning would make product faster, in our case, the speed of composting was not fast enough to open up room for new piles when aged material was moved off for curing. Therefore, it was decided early on that starting piles with high carbon bedding and allowing them to " cook" slowly as food was added over several weeks proved to be more economic. Less turning frequency and less total number of turns did not seem to effect overall product quality and resulted in a lower cost of production. In the beginning stages of composting, ingredients such as tomatoes and melons would roll out of piles if turned frequently. By waiting till a pile was fully built before adding water and manure, these materials were broken down enough that they would stay in the windrow. This more "conventional" approach (ie. only 5 turnings over 15 days with temps over 132 degrees) also reduced labor costs associated with having to hand shovel food materials back into piles during the first 3-4 turns.

Ratios of Product Blends

Windrow #	Horse Bedding	Sheep Bedding	Food Waste	Silage	Corn	Hay	Dairy Manure (20% sawdust)	Aged Compost
1		52%	30%		9%		9%	
2		69%	22%				9%	
3		90%	6%				4%	
4	65%		6%	5%			17%	7%
5	59%		15%				20%	6%
6	56%		10%			7%	20%	7%
7			30%	62%				8%
8			32%	61%				6%
9			25%	75%				
10							100%	

Monitoring results

Windrows were turned from 5 -17 times in the first 6 weeks of production. Piles 1,2 & 3 were turned more frequently than others because with these piles our goal was to mix ingredients each time they were added to the windrow. This worked well with with the sheep bedding which broke down quickly and held onto water. However, once we changed over to horse bedding and longer rows (Rows 4,5,6); this strategy no longer worked. With rows 7,8 turning frequency was increased when piles became water logged. With perfect pile structure (due to high amount of silage) windrow #9 required less turning than others. Windrow #10 had very high moisture and required frequent turning in the beginning to lower moisture content. To determine turning frequency , piles were monitored for temperature and moisture on a daily basis for a minimum 30 days. Carbon dioxide readings were also taken during this time to get an idea of biological activity. Once windrows reached the required 15 days above 132° F, temperatures and CO_2 were measured less frequently .

Composite samples of compost windrows were taken as piles were combined and moved to curing areas (on-site or in bins located near the dairy barn). In all samples less than 6% man made inerts were found in final product. Inert materials testing was accomplished by hand screening a 2 gallon composite sample through a 1/4 mesh screen. Although food waste did have small amounts of contaminants, each time windrows were turned, contaminants were hand picked out of piles. As required by regulations, pathogen testing was done on composite samples prior to distribution or use. All compost produced passed pathogen and waste analysis tests as required by NC Dept. of Environment and Natural Resources. A total of 259 yards of compost was produced from 652.5 yards of feedstocks. 23 yards of this compost was added back in during active composting to increase biological diversity and hold moisture. By the end of compost production 55 yards of compost was used for on-farm applications, 159 yards were sold and 5 yards were stored for use in bioassays, potting soils and compost teas.

Site Limitations

The site that was chosen for this project was in a horse pasture with good buffers from roads, neighbors and streams. It's clay base drained well and allowed for as much as five, 120 ft' rows with room for curing and storing some carbon source. The farm was concerned about giving up valuable hay and pasture land, but was willing to take a look at how it could work. One of the biggest problems of this site was access during rain or snow events. Using the tractor to transport the food materials, we were able to put food into rows as needed (3 days per week). We were fortunate to have had a very dry spring when we started this project, otherwise we may not have been able to build windrows. The steepness of the site (4-5% slope) and the unimproved dirt road made travel impossible during much of the winter months. This would have to be changed if a year round site were to be developed.

Water Problems

Another problem that was not anticipated at the beginning of this project was the amount of water that could be supplied. The gravity fed spring which we used to fill the 425 gallon tank had a daily capacity of about 650 gallons during good weather. When dry weather set in, it's capacity lowered to about half that amount, not counting the amount of water that was used on the farm. We had several events where the spring water storage was run completely dry, and water had to be transported from other parts of the farm. This severely limited the amount of compost that could be manufactured at any given time.

Labor

Hand collection of food waste from the supermarket was very labor intensive. One of the goals of this project was to provide a tip fee to Sugar Hollow Farm (SHF) that would be able to cover labor costs and sustain a long term composting operation. This was not able to be attained. Also, extra labor is in very short supply at the farm, and without a guaranteed 40 hour work week; food collection was not very attractive as a source of employment. Workers at SHF have their hands full with other farm projects and therefore could not dedicate many hours to this project. The amount of compost produced would have to be much larger to sustain a full time operator.

Economics

Throughout the project there was difficulty in accessing waste collection cost savings. This was due to the fact that Food Lion dumpsters were being used by local residences to dump residential trash. To resolve this problem, ECC created signs for the dumpsters and added locks so that only Food Lion employees could open them. Using standard Waste Management costs for removal of dumpsters, the compost facility could save as much as $170 per month for the Fairview Food Lion. Using these figures and dividing by 4 weeks per month, SHF could provide a break even situation for the store with a collection fee of 42.50 per week. With a pickup of 3 times per week this would provide $14.16 per pickup. Although they would probably not cover all the labor and transportation costs, SHF offered a rate of $160 per month to pickup the food residuals. This fee was not accepted and collection was discontinued the first week of Dec. 2000 (windrow #9).

Negotiations with Food Lion continued till Jan. of 2000 to try to create a reasonable fee that could be charged to the Fairview store. Unfortunately we were not able to see the actual fees that Food Lion was charged by Waste Management. Under a bid process, Waste Management bids for collection services for all Food Lion Stores. The actual fees that were charged were probably much lower than the standard rates we were told and therefore even at a $40 per week fee (to cover the costs of 3-4 hours of collection, transportation and mixing into windrows), we were probably not competitive. In order to receive such a contract, Food Lion explained that we would have to provide significant savings.

In talking this over with management of Sugar Hollow Farm, the consensus was that unless we could provide a good 40 hour wage for someone at the farm (which is already short handed), compost production would not be cost effective. Because the farm does not want to take valuable pasture lands out of production, the development of a new site is difficult. The issue of good road access and water supply continues to be a problem toward future planning. There is also the issue of what size of facility would be required in order to be competitive with Waste Management dumpster fees. At present, it is probably cheaper to make compost from manure, spent hay and silage that is locally available. The farm is continuing to look at less costly ways to make compost (perhaps vermicomposting) but at present has decided to discontinue the operation. The bedding materials from the Ag Center in Fletcher continue to be used by the farm as beef cattle bedding and the farm is grateful that this material will continue to be available.

TASK #2
COMPOST QUALITY STANDARDS

Lab Analysis of Final Compost Products

Once compost is fully matured, there were 5 main criteria which we looked at in choosing composts for use in potting soil or other applications. These criteria include: 1) C/N Ratio, 2) nutrients 3) conductivity 4) maturity and 5) pH. These criteria can then become the basis of our quality guidelines we use to choose how compost could be utilized in different applications. A complete analysis of the the compost recipes described earlier is shown below. Piles 4,5, and 6 had very similar consistency and therefore were blended together for curing. Piles 7 and 8 were also combined for the same reason. Combining these piles also created more space on the compost site for new materials. Compost age is expressed as the amount of months product cured following active composting.

Analysis of compost mixes - (NCDA LAB)

Compost Pile #	Date of Report	Compost Age (in months)	C:N Ratio	pH	Soluble Salts (mmhos/cm)	N	P	K	Ca	Mg
						(expressed as a percent of dry wt.)				
1	1/10/01	7 mo.	10.41	8.07	3.26	0.92	0.35	1.70	0.88	0.41
2	1/10/01	6 mo.	9.34	8.01	5.46	1.28	0.37	2.06	1.15	0.54
3	3/7/01	8 mo.	9.69	7.87	6.65	1.12	0.44	1.86	0.89	0.45
4/5/6	2/14/01	4 mo.	9.87	7.84	3.78	1.28	0.41	1.72	1.08	0.43
7/8	1/10/01	3 mo.	10.05	7.87	3.75	1.58	0.36	1.72	0.82	0.35
9	1/10/01	1 mo.	10.49	7.21	2.40	1.48	0.30	1.43	0.62	0.27
10	1/10/01	1 mo.	12.69	8.30	1.69	1.36	0.22	0.64	1.67	0.41

Carbon : Nitrogen Ratio

The Carbon:Nitrogen Ratio (C:N) in composting is often used as an indicator of compost maturity. In keeping with existing research compost may be considered fairly well cured, and hence stable, when the C:N ratio has dropped to about 1/2 of the original value, and has satisfied other maturity tests such as lack of heat and odor generation.

Nutrients

Another important way to determine the quality of compost is through nutrient testing. Although there will be some variability within any compost pile and between individual compost batches, these types of numbers provide good "ball park" measurements for making management decisions. When making potting soil we can compare these nutrients to what we achieve in our final potting mixes.

This data can then be compared to known standards for nutrients in potting soil such as those published by A and L Laboratories of Richmond, VA . More detail on compost nutrients and standards for potting soil is shown under TASK 3 - EXAMPLES OF POTTING SOILS.

Conductivity

As described earlier, electrical conductivity is a measure of salinity. While peat moss has an advantage in that its salt content is generally very low, when nutrients are added to peat, conductivity often increases. The nutrients in compost can partly offset this because nutrients do not necessarily have to be added to the mix. In planting mixes, generally the more mature the crop the more tolerant it is to salts. For example, plants that are grown from seed in germination mixes would be much more sensitive than shrubs that are transplanted into container mixes. If the compost were to be used as the principal component (50%) of a potting soil or germination mix, we would like to see the conductivity as low as possible, or at least below 4.0. If it is to be used as a fertility amendment in planting mixes or is to be soil applied, higher levels can be tolerated.

Compost Maturity

Much research is currently being conducted on standards for composts that include indicators of maturity, but as yet no one system has been agreed upon. Indicators such as respiration, ammonia and nitrate levels, C:N ratio, heat generation, growth trials, odor and direct spectroscopy are among many that have been suggested for making maturity determinations. A combination of heat generation, odor, C:N ratio, and germination tests can be used at most operations with good results. Which tests are most appropriate depends on the particular circumstances and product .

One of the simplest ways to assess the maturity of a compost windrow is to turn or screen a windrow and take temperature readings. If the compost heats up again or produces ammonia smells, it probably requires more time to cure. However, this test can be misleading, particularly if piles are over dry, have excessively high pH or excessive moisture. It must be carefully weighed in combination with other factors. By measuring temperature changes over specific time intervals an assessment of compost maturity can be made. In general, a mature compost should not have any objectionable odors and a "sour" smell or the smell of ammonia should not be detectable. As the compost ages it should begin to take on a musty odor which later develops into an earthy odor such as that of freshly plowed soil.

One of the easiest and most fail-safe tests for maturity is the germination test. Two plants which are are easy to find and which are suitable for germination tests are curly cress and green beans (we prefer curly cress over other varieties such as water cress because it matures more quickly than others and has larger seeds). To perform this test, compost is placed in a shallow, flat bottomed container (for cress) or a regular flower pot (for beans) and seeded. By observing how quickly seeds germinate we can determine whether or not they're growth has been hindered by immature compost or any phytotoxic properties that may be present. By weighing or simply counting out seeds and recording the percent that have germinated it is easy to make comparisons. With cress, germination should be completed within 2-3 days after seeding. After 7 days seedlings should still be green with healthy roots. Green beans should germinate after 5-7 days and should have a well developed root system within 10-14 days after seeding.

As a check on the viability of the seed being used it is advisable to germinate some of it on paper towels and make counts. If compost is not able to germinate seeds as well as that of the wet paper towels, it is reasonable to assume that it may not be fully matured or contains something which is hindering plant growth. Be sure not to over water samples when germinating seeds as this can cause rotting, and make sure you have good seed. In most cases the compost will not dry out nearly as quickly as the paper towels. Some of the factors which can affect germination include: salts, ammonia, or a high level of organic acids.

pH

Ideally a good compost should be slightly acidic with a pH in the range of 6.0-7.5 . While this is much higher than peat moss, this is an area where the pH of peat mixes must often be adjusted, so high pH is usually not a disadvantage. If a lower pH is desired for certain applications such as acid loving nursery stock, it can be easily adjusted through the use of peat moss or other acidifying materials.

Quality Guidelines for Compost

Using these criteria as well as our own experience in compost use, we developed the following guidelines for choosing compost for various applications and markets.

GRADES OF COMPOST

Quality Parameters	Potting Soil	Germination Mix	Soil Amendment	Topdress	Mulch
NUTRIENTS	good verify with lab tests	good verify with lab tests	good verify with lab tests	good verify with lab tests	not as important
SOLUBLE SALTS (mmhos/cm)	< 3.0	< 2.0	< 12.0	< 4.0	< 12.0
MATURITY/ STABILITY	Well aged Mature	Well aged Mature	Less aged Mature	Well aged Mature	Less aged Mature
C/N RATIO	Low C/N	Low C/N	Low C/N	Low C/N	higher C/N ok
pH	6.5-8.5	6.5-8.5	6.5-7.8	6.5-8.5	6.5-8.5

These guidelines become very important when examining how compost can be used in value added mixes and can significantly effect potting soil performance. Using these guidelines in our project, we tested several of our composts in potting mixes to see how they would perform. (see Task 3 - EXAMPLES OF POTTING SOILS.

TASK #3
EXAMPLES OF POTTING SOILS

In this part of the project we tested various compost mixes in potting soil applications. Potting soil formulations were determined by organic growers who all had experience in using compost in their potting media. The goal was to to see how close we could come to the A and L standards for potting media with these " organic ingredients" and what the plants would tell us as they reached maturity in these mixes. (see APPENDIX 1 for the A and L standards on the table entitled EVALUATION OF POTTING MEDIA ANALYSIS). All mixes in these trials were wither blended by hand or blended through a conventional feed mixer that was leased through a dairy farm that cooperated in this project. By trying different mix recipes with the same composts, we can begin to learn how to develop the ideal mix. Because compost weight varies with moisture content, potting soils were mixes on a volumetric basis. In this manner, it was easier to compare recipes.

EXAMPLE NO. 1

The first grower we worked with in this project was Joe Allowas of Sugar Creek Farm in Leicester, NC. His first mix recipe with Compost No. 2 was as follows:

JOE ALLOWAS #2A
2 parts PEAT
1 part COMPOST #2
1 part PERLITE
1 part VERMICULITE
plus: 20 cups of = parts Blood Meal, Calcium Phosphate, Green Sand and 4 cups high cal. lime per every 150 gallons of mix

The analysis of this compost and some comments are shown below. All numbers except pH and conductivity are expressed in parts per million. The comments are based on the A and L standards from the laboratory based in Richmond , VA.

pH - 6.3
Conductivity 3.92 (should be less than 3.5 for mature plants and <2.0 for young plants)
NH4- 16
N03- 113
total avail. N = 129 (very good)
P- 130 (too high)
K- 1200 (too high)
S- 104 (good)
Ca- 88 (good)
Mg- 73 (ok)
Na- 89 (high)

This first mix showed excellent results in term of plant growth, but we suspected that with high conductivity we could have some problems. The main comment from Joe was that the plants seemed to be too lush and that maybe we had a little too much nutrients. Therefore, the volume of this mix was essentially cut in half by adding 2 more parts peat and 2 parts perlite, to 4 parts of old mix + .75 cups lime to get the calcium level back up. This became mix No. 2B which had this analysis.

JOE ALLOWAS #2B

pH - 5.5 (ok)
Conductivity 2.26 (good)- (should be less than 3.5 for mature plants and <2.0 for young plants)
NH4- 5
NO3- 66
total avail. N = 71 (good)
P- 109 (high)
K- 619 (too high)
S- 58 (good)
CA- 65 (good)
Mg- 50 (good)
Na- 63 (good)

Overall this mix showed good plant growth. We would have expected the phosphorous to be a little lower. The plants definitely seem happier in this mix generally. We were still a little concerned about the high K level, but after talking with the lab we found out that K is generally not a problem unless the conductivity is too high.

In Joe's next mix , we essentially cut out all the blood meal as we were seeing good nitrogen supplied by the compost in the previous mix and we anticipated we would get similar results using Compost #1 .

<u>JOE ALLOWAS #1</u>

1 part PEAT
1 part COMPOST #1
1 part PERLITE
1 part VERMICULITE
plus the following to every 120 gallons of mix: 2 cups of lime
4 cups Colloidal Phosphate
4 cups Green Sand

The analysis showed lower nitrogen and in general the rest of the nutrients were in pretty good shape.

pH - 6.1
Conductivity 3.38
NH4- 1
NO3- 1
total avail. N = 2 (very low)
P- 75 (high)
K- 1050 (high)
S- 103 (good)
Ca- 68 (good)
Mg- 78 (ok)
Na- 116 (high)

In this mix we had no germination inhibition which we were concerned about in mix 2A, but now we were worried about how long the nitrogen would last. One of the things that is hard to estimate with compost is just how much nitrogen is released . Lab tests show us soluble nitrogen but this may not reflect the total available nitrogen that would be present during the growing period. Since different plants react in different ways, this remains one of the unsolved mysteries in use of compost. One of the other factors in Joe's production is that he waters his plants pretty frequently in his greenhouses and therefore there is some leaching of nutrients. This may explain how even with the high salts in his first mix , he didn't see any germination or toxicity problems.

EXAMPLE NO. 2

The second grower in our testing was Robert Morningstar of Rose Creek Farm. Robert tested 3 composts in 3 separate mixes which used the same formula. He grows cut flowers and in the past has used various composts without much addition of nutrient amendments. The formula for Robert's 3 mixes which we tested on Composts No. 1, 2 and 10 is shown below.

<u>ROBERT MORNINGSTAR #1, 2, AND 10</u>

1 part COMPOST
2 parts PERLITE
2 parts PEAT MOSS
plus a 1/8 cup of lime for every 6 gallons of mix

The results of Robert's mixes are shown below.

ROBERT #1	ROBERT #2	ROBERT #10
pH - 5.1	pH - 5.5	pH - 6.2
Conductivity 2.71	Conductivity 3.18	Conductivity 0.72
NH4- 4	NH4- 4	NH4- 3
NO3- 54	NO3-76	NO3- 8
total avail. N = 58 (good)	total avail. N = 80 (good)	total avail. N =11(low)
P- 63 (high)	P- 99 (high)	P- 25 (high)
K- 875 (high)	K- 1020 (high)	K- 158 (slightly high)
S- 69 (good)	S- 77 (good)	S- 11 (good)
Ca- 35 (low)	Ca- 35 (low)	Ca- 18 (low)
Mg- 29 (ok)	Mg- 33 (ok)	Mg- 11 (low)
Na- 79 (good)	Na- 74(good)	Na- 58 (good)

The main comment Robert had was that mix number 10 had shorter plants and slower growth in the early stages of growth. With these side by side comparisons, we can see that the more aged No. 1 and No. 2 composts had more total available nitrogen, while the younger No. 10 had much lower conductivity than the others. Looking at our test data, we can see that the lower conductivity of No. 10 was probably due to lower nitrate (NO3) and lower potassium (K). Also the younger compost No. 10 had generally less nutrients than the other two. Using this data we could deduce that the more aged compost would be best for the planting mixes and that addition of lime will help get the pH and calcium levels up. Looking back at our original NCDA tests (on page 6) we can also see that compost No. 10 had a higher C/N ratio. This means that with more carbon in the final compost we will have less nitrogen availability. As his plants matured, Robert saw less differences in plant growth. However, if we were making potting soil we would definitely want to select the older more aged composts to get good early plant growth and vigor. Lab tests with grow out trials off this kind allow us to " fine tune" our mixes.

EXAMPLE NO. 3

The third grower in our trials was Patryk Battle of Pat and Karl's Organics of Burnsville, NC. Pat used a similar mix as Robert Morningstar with vermiculite replacing 1/2 the perlite.

PAT #1 and #2

1 part COMPOST
1 part PERLITE
2 parts PEAT MOSS
1 part VERMICULITE

His results were similar to Robert's, with the exception of higher conductivity especially in mix No. 1 and lower overall calcium in both mixes.

PAT #1	PAT #2
pH - 5.9	pH - 5.4
Conductivity 5.9 (high)	Conductivity 3.91 (high)
NH4- 4	NH4- 2
NO3- 119	NO3-92
total avail. N = 123 (good)	total avail. N = 94 (good)
P- 127 (high)	P- 96 (high)
K- 1400 (too high)	K- 1070 (high)
S- 116 (good)	S- 100 (good)
Ca- 83(ok)	Ca- 72 (low)
Mg- 93 (good)	Mg- 96 (ok)
Na- 120 (too high)	Na- 142(too high)

In his mixes, Pat found that mix No. 1 had slower growth and some yellowing in the initial stages of growth following germination. Looking at the potting soil test data, this could certainly have been due to higher conductivity which at the level of 5.9 could definitely have reduced growth. What was also interesting in Pat's case was that the plants seem to grow out of the condition and grew better as they matured further. Perhaps as he watered each time, he may have actually flushed out some of the salts with each watering. Also, as seedlings get larger they are generally more resistant to salts. As of this report, Pat has seen good growth in these plants for 6 weeks without any added amendments.

TASK #4
COMPOST FOR SUPPRESSION OF DISEASE IN COMMERCIAL APPLE PRODUCTION

In the beginning of this project it was expected that a spray program would be developed in spring of year 2000. However, with time constraints of composting and need to gather feedstocks in March through April, compost product was not yet available. Therefore, the decision was made to move the spray project to spring of 2001. A 6 month extension of the project was granted for this purpose.

Sugar Hollow Farm is interested in organic apple production if it can be economically feasible. One of the most important tools in organic apple production is a good organic spray program. The first step in developing the use of compost tea on the orchard located at Sugar Hollow Farm was to to test compost for their ability to suppress diseases of apples. As of yet, no lab in the country has the ability to do this kind of bioassay with " off the shelf" materials. One lab that has been successful in verifying growers success of compost teas in suppressing apple scab disease is Soil Food Web in Corvallis, Oregon. While they do not have a specific bioassay test, such as the one we used for potting soil, they have identified that good compost can have a suppressive effect. They determine compost quality not only with maturity testing but also by measuring the ratio of total and active bacteria and fungi. What they have learned is that if a healthy compost has good ratios of these microorganisms, it is highly likely to suppress disease. Samples of combined compost piles 4/5//6 and 7/8 as well as pile number 10 were set to Soil Foodweb for biological testing. In conversations with growers that have used compost teas, ECC learned that young composts (ie. not cured very long) that have high biological activity yet, that were fully finished, have achieved the best results. This is different from the potting soil compost in which we wanted to make sure that compost was well aged.

In addition to using this data , with visual scouting in our trials, we felt that we would be able to see a visual effect of less disease if we were successful. The results of the Soil Foodweb testing is shown in Appendix 1. What we learned from this test was that composts No. 4/5/6, 7/8 and 10 all had good biological activity. These three composts were chosen because they were much less aged that others, and previous experience has show that relatively young composts will have higher biological activity than well aged composts such as composts No. 1 and 2. As we looked closer at the Soil Foodweb test we could also see that of the 3 composts, No. 4/5/6 had the highest active bacteria as well as fairly good levels of active and total fungi. In talking with consultants that are working with apple growers we learned that high bacterial activity is what has been most successful in providing disease control. Therefore compost No. 4/5/6 was selected as the best candidate for the spray program.

The spring of 2001 was very warm and dry and as a result spray for apple disease was not necessary for the first few weeks of the season. A late frost in late April resulted in as much as 75% loss of apple blossoms which further set back spray needs. B y the first week of May, moisture and temperature conditions were conducive to apple scab disease. Jamie Oxley an independent apple consultant, was hired for an afternoon to go over cultural and spray practices in the orchard block that was selected for the trial. The orchard was divided into 4 rows which would receive an Oxidate spray and 3 rows which would receive compost tea. Oxidate is a relatively new organic fungicide which is a dilute solution of hydrogen peroxide. Growers describe it's activity as essentially 'cleaning up' the orchard as it kills all fungi and bacteria. In our trial, it was used as comparison to see which material would get the best control. As of May 30th, the orchard has received 4 compost tea sprays in 7-10 day intervals. Results so far have show little disease in either of the 2 plots. The farm hand that has been doing the sprays has seen more vigorous growth in the compost plots and as a result tissue testing will be done to access nutrient levels in compost tea vs. oxidate sprayed leaves. By the 5th spray he saw much lower vigor in the oxidate rows and was beginning to see spotting of the apples in the oxidate area. As of June 8th, disease suppression has not yet been verified. To judge overall plant vigor, leaf tissue samples will be taken and sent to NCDA labs for nutrient analysis. Because compost tea also acts as a foliar feed we expect that we will see differences in leaf nutrients.

TASK #5
SHORT TERM BIOASSAYS

Short term bioassays were conducted on selected compost to determine their ability to suppress damping off (*Rhizoctonia solani*). These tests were conducted by Judith A. Kipe-Nolt, Ph.D. Soil Microbiologist and Barry L. Nolt, Ph.D. Plant Pathologist from Bloomsburg University, Bloomsburg, PA. Bioassays were completed in May of 2001. A full report on these tests are shown below.

MATERIALS AND METHODS

Composts

Three composts were provided by Mr. Jon Nilsson of East Coast Compost. These had been prepared using food waste or dewatered diary manure and were labeled #1, #9, and #10. Compost #1 was a very well aged food compost which was cured about 6 months. Compost #9 was a much younger product and while still made from food waste was cured only 1 month. Compost #10 was used as a comparison of what could be achieved without food waste in a compost made from diary manure which was also cured just 1 month. In the first experiment these composts were used as provided, but for subsequent trials the composts were screened through a 0.5 cm pore sieve prior to preparation of the potting mixes.

Pathogen Preparation Using a Potato Peat Method

Sphagnum peat was screened through a 2.8 mm pore sieve, limed to a pH of approximately 6.5 with dolomite limestone, and moistened with water to approximately 70%. One hundred grams of chopped potato pieces (1 cm^3) were added to 1 liter of peat. Distilled water (100 ml) was then added to the potato-peat blend. The moist potato-peat blend was autoclaved at 121° C for 1 hour on three consecutive days. The mixture was allowed to cool to room temperature and three 5 mm plugs of fungal pathogen (*Rhizoctonia solani*) were added from agar plate cultures. After 14 days growth, the mixture was dried at room temperature. Potato pieces were removed and then the mixture was ground with a mortar and pestle, sieved through a 2.8 mm screen and stored in air-tight plastic bags until use in the growth chamber trials.

Preparation of Potting Media

Sphagnum peat was screened through a 2.8 mm sieve to remove larger particles. Dolomite limestone was added to yield a pH of 6.5. Water was added to approximately 70% moisture content. An equal volume of horticultural grade perlite was added to the peat. The peat:perlite mixture was autoclaved for 1 hour at 121° C on three consecutive days. The mixture was stored in plastic bags until use in the growth chamber trials.

Growth Chamber Trials

Bioassays were performed in a growth chamber where night to day temperatures ranged from 60° to 80° C. Pathogen inoculated and non-inoculated pots of each of 3 compost mixes and a peat:perlite control were included. Composts were combined with the peat:perlite mixture yielding a 1:1:1 ratio (33% v/v compost). Pots were filled with 400 ml of each respective potting medium to evaluate disease suppression. Pots were arranged using a completely randomized design, inside the growth chamber. The growth chambers were constructed locally and were essentially light boxes that received 16 hours of illumination and 8 hours of darkness *per* day. Full spectrum bulbs were utilized. All potting media were mixed in plastic bags and distributed into plastic pots. Fungal pathogen inoculants were added to the bags prior to mixing, in positive inoculation treatments. Pots were sown with cucumber (*Cucumis sativus* L. "Straight Eight") seeds, watered, and covered with plastic lids for the first three days to maintain moisture and speed germination. Pots were observed daily and watered every other day after emergence. Pots were washed and soaked in 50% Clorox solution after each trial to ensure disinfection.

All composts and the peat:perlite control were evaluated for suppression of *R. solani.* Following a preliminary calibration experiment in which various inoculum doses were evaluated for their effects on seedling emergence, inoculum doses of 0.5 g and 1.0 g per 400 ml of media were selected. Eight cucumber (variety Straight Eight) seeds were sown in each pot. Seeds were buried approximately 1 cm in the media. Three to six replications of each inoculated treatment were evaluated in three different trials. Non-inoculated control pots of each medium were also included in the first experiment to ensure no adverse effects of the composts on seed germination.

Disease Scoring

Observations and recording of germination and disease-affected seedlings were done on day 7 and again on day 14 after sowing. Differences between treatments were evaluated using analysis of variance and when the F-test was significant, means were separated using Duncan's Multiple Range Test.

Fungal Cultures

The fungal isolate (*Rhizoctonia solani*) was provided by Dr. Chloe E. Ringer of the USDA-ARS, Beltsville, Maryland. *R. solani* was cultured on potato dextrose agar.

RESULTS AND DISCUSSION

The first experiment was conducted using compost as received from East Coast Compost. This compost contained clumps up to 2 cm in diameter (some appeared to be composed of clay/soil). There was a great deal of variability between replicate pots in this experiment and no significant differences between treatments were detected. It was hypothesized that this was a result of the small pot size used in these experiments and the lack of homogeneity of the composts. The following two experiments were conducted using sieved composts. Seedlings in non-inoculated control pots germinated and remained healthy. This confirmed that all the mixes provided good growth conditions for the cucumber seedlings in the absence of the fungal pathogen.

The results of % healthy seedlings at the 14-day evaluation of an experiment in which the inoculum dose was 0.5 g/pot are shown in Figure 1. The peat:perlite control pots showed the greatest disease, and Compost #1 showed significant levels of suppression when compared to it. Disease pressure in this experiment was not as severe as had been observed in the preliminary calibration experiment. Slight changes in room temperature and humidity appear to have a profound effect on disease intensity. The simple light boxes used for these trials unfortunately do not provide for precise control of temperature and humidity.

A third experiment was conducted in which 1.0 g of inoculum was added to each of the pots. The results of % healthy seedlings at the 14-day evaluation are shown in Figure 2. Again the peat:perlite control pots showed the greatest disease with only 58% of the seedlings remaining healthy. In this experiment both Compost #1 and Compost #10 mixes provided significant control of *Rhizoctonia solani* when compared to the control. Disease pressure was a little more severe in this experiment than in the one in which 0.5 g of inoculum was used.

Compost #9 appeared to show the poorest disease suppression of the three composts evaluated. However the differences between the composts were not significant at a level of P<0.05. The interaction between treatment and experiment was not significant, so the results of a combined analysis across the three experiments are presented in Figure 3. As has been observed in previous studies, there were significantly more healthy seedlings in the compost mixes than in the peat:perlite control mix.

Figure 1. Percent healthy cucumber seedlings in different compost mixes inoculated with Rhizoctonia solani (0.5 g inoculum/pot) Means labeled with a different letter are significantly different at P<0.05

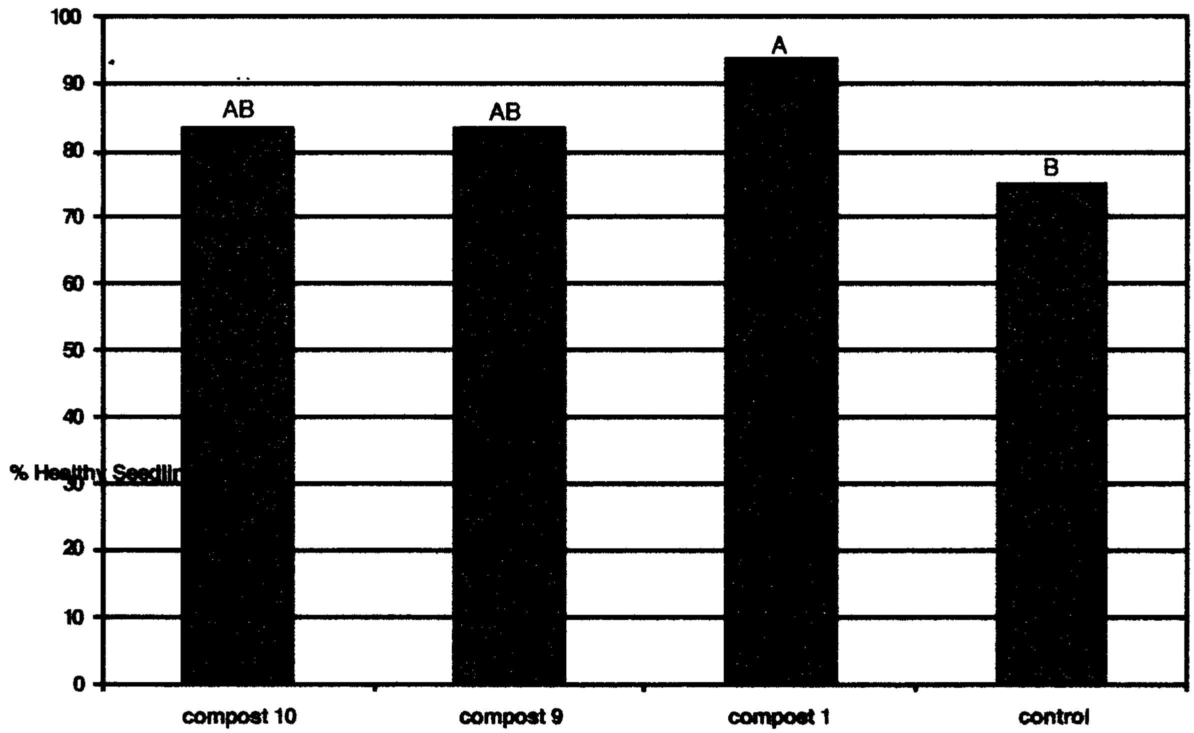
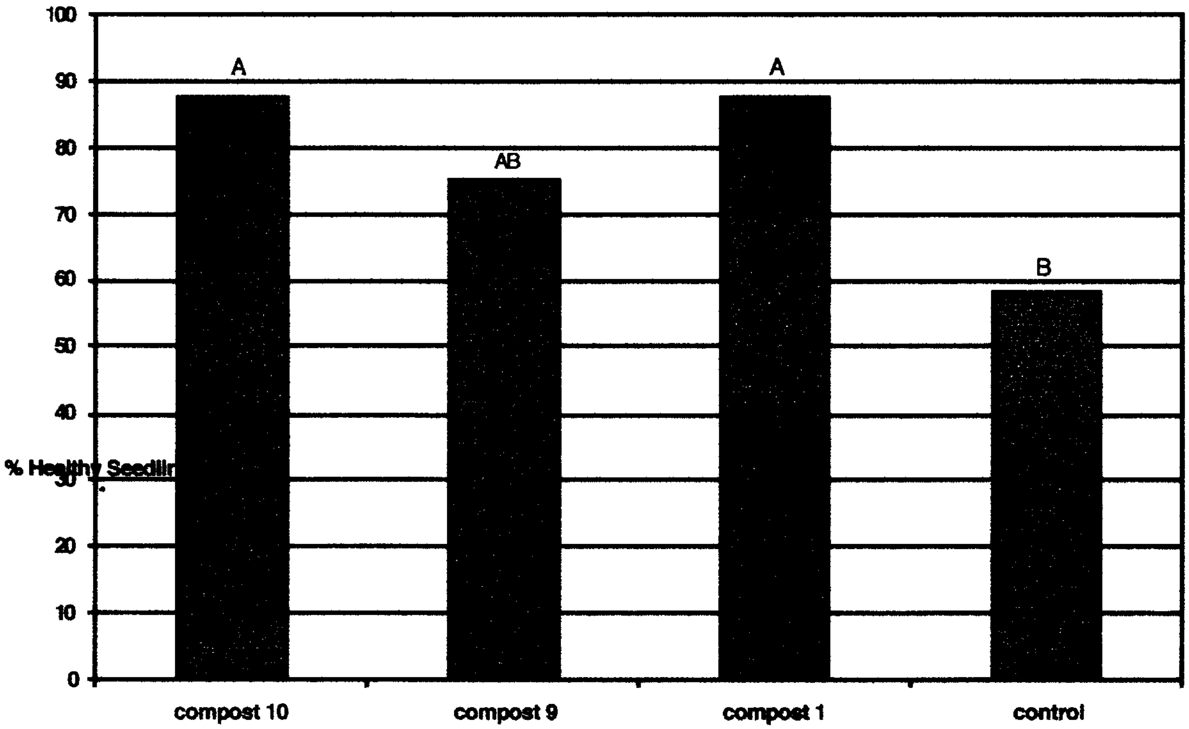


Figure 2. Percent healthy cucumber seedlings in different compost mixes inoculated with Rhizoctonia solani (1.0 g inoculum/pot)

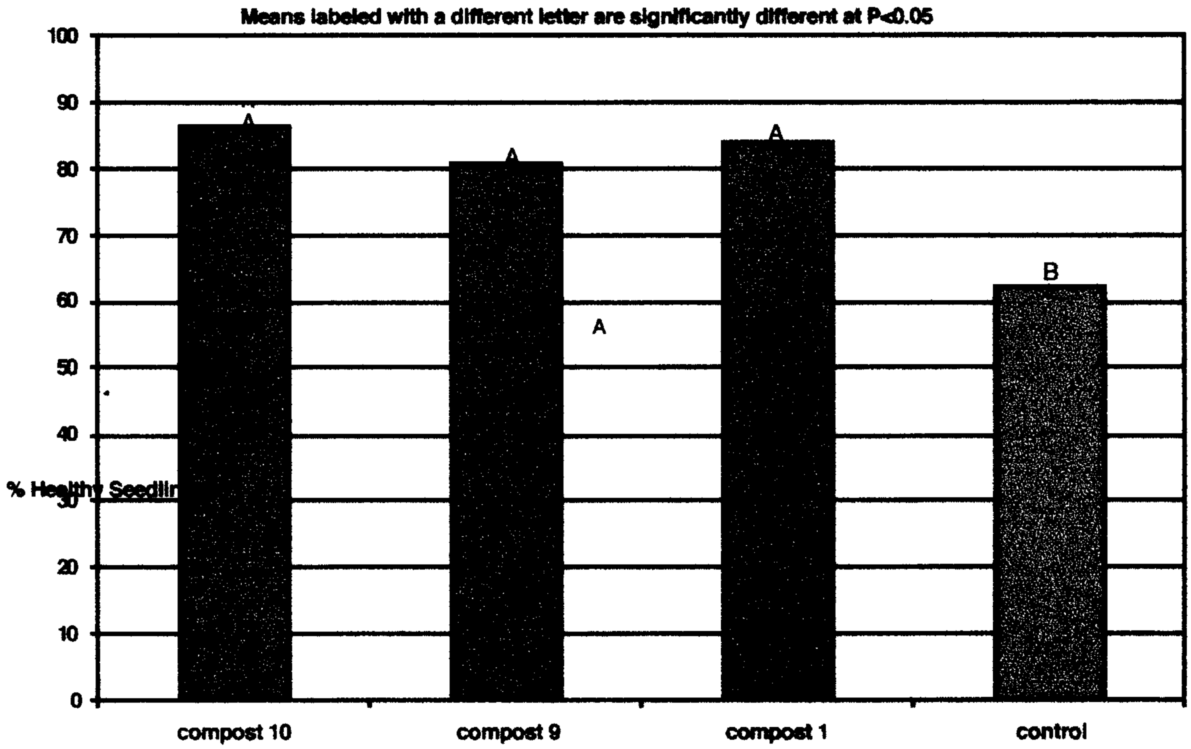
Means labeled with a different letter are significantly different at P<0.05



Combining these bioassays showed the following results **(summarized in Figure 3.)**

Compost #	Percent Healthy Seedlings
1	84.1
9	80.7
10	86.4
control	62.5

Figure 3. Combined analysis over all experiments showing percent healthy cucumber seedlings in different compost mixes inoculated with Rhizoctonia solani



What we can learn from this bioassay is that when we make a good quality compost using the feedstock ratios described for pile numbers 1, 9 and 10 ; and when we use these composts in a potting soil at 33 % of the volume of that mix, we can expect to suppress *Rhizoctonia solani* (damping off) over 80 % of the time. Also as the disease pressure was raised from .5 grams to 1 gram per pot we got even higher suppression from composts 1 and 10. These kinds of results have been verified by East Coast Compost in other bioassay trials and in some cases with higher amounts of compost in the potting soil we have seen as much as 98 % suppression while the control showed 0 % healthy seedlings.

TASK #6
GUIDANCE DOCUMENT FOR FOOD WASTE COMPOSTING

--ABSTRACT--

Manufacturing High Value Products From Commercial Food Waste

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101 Woodhaven Road
Asheville, NC 28805

Through a joint venture agreement of Sugar Hollow Farm, Food Lion Inc. and East Coast Compost, this project demonstrated the diversion of food waste (produce, baked goods, floral and deli waste) to the manufacture of high quality compost.

PROJECT ACCOMPLISHMENTS:

A. methods for successful diversion of supermarket and residential food waste and
B. the production of value added compost products that can receive a premium price in the marketplace.

Demonstration of product manufacturing techniques and compost applications include:

1) Source separation, collection, transportation and production methods for composting of commercial & residential food wastes **2)** Compost quality guidelines for various value added products with regard to feedstock recipes and final product analysis **3)** Examples of potting soil planting mixes **4)** Use of compost for suppression of disease in commercial apple production **5)** Short term greenhouse trials for assessment of disease suppressive quality of compost in potting soil **6)** Creation of a guidance document to aid others in foods waste compost production and use

------------------------------------ GUIDANCE DOCUMENT ------------------------------------

1. GETTING STARTED WITH A FOOD DIVERSION PLAN

The first step in starting our food compost project was to secure a good compost site. We started our composting at a site at Sugar Hollow Farm. This location was close to the FOOD LION store, had good drainage and access and was fairly easy to get fully permitted for receiving food residuals. The next step requires establishing good communication with store management and staff. It is important that they "buy into" the compost project and develop a strong commitment. The way we got good cooperation in our project was through a good presentation, providing regular feedback and providing good educational materials.

2. EDUCATE THE FOOD SERVICE STAFF ON SOURCE SEPARATION

The next step was to provide the store with some information on how and why we make compost from food and just how they could do their part to make this a successful project. The following is the handout we supplied to the food service workers at the college cafeteria during our first source separation meeting (see" What is Compost"). On the of the biggest
questions we get is "How do you make sure that the garbage is staying out of the food you pick up? ". What we found to be best is not only tell them if you are getting garbage in the compost ingredients, but actually take it back to them. Meet with anyone you can (and preferably the manager) and say here's what came in on the last load. We can't compost this stuff!!!" You can also get them to sign a right of refusal contract but a contract is only as good as the people who sign it. Bringing back the garbage let's everyone know that you are not going to put up with this stuff and yes they will have to take it back.

3. CHOOSE PROPER CONTAINERS AND SET UP A COLLECTION SCHEDULE

In researching containers for this project we decided that a 35 gallon container with a can dolly would be our best choice. These were easy to roll to the end of the loading dock where they could be rolled into the pickup truck we set up for this project. If the cans were light we could simply lift them down into the truck. If they were heavy, which was often the case, we used a small plywood ramp to roll them down with. In hindsight I would say that a truck with a lift tailgate or with that was high enough to match the loading dock height would have been better.

To make the process as simple as possible was certainly one of our main objectives. To avoid questions about just what could go in our compost cans we made posters (shown below) that were hung in the food processing area. The same poster in a smaller form was also attached to the lid of our collection cans as a further reminder of just what we were looking for.

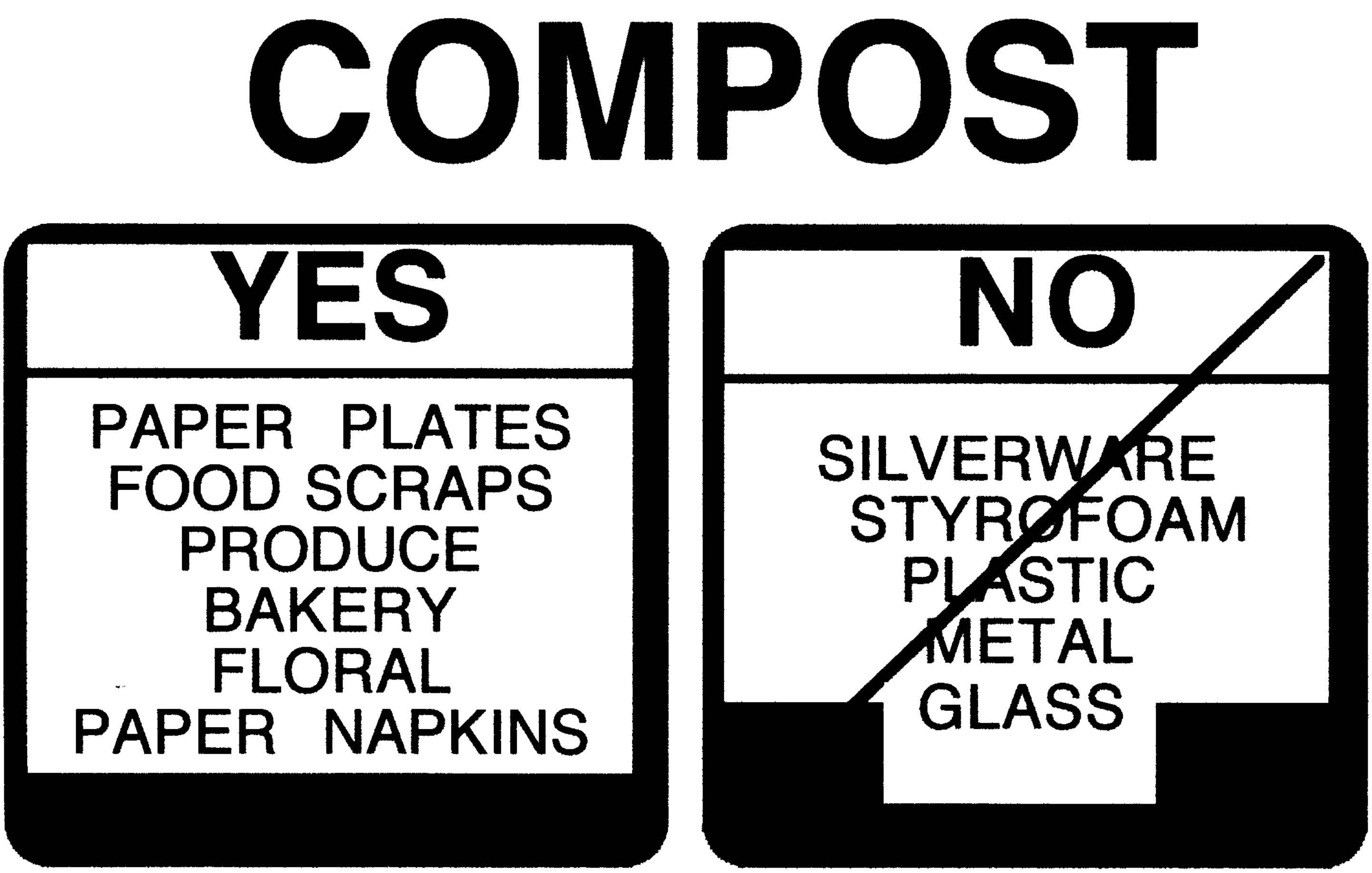
To determine our collection schedule we met with the manager of the store. We started our with 4 cans located in 2 food prep areas; the deli and produce sections (1 in the deli and 3 in produce). As time went on we learned that we needed additional can as a backup for when there was additional food waste (holidays, etc.). Because the food would be simply sitting in the back of the store once the can was full, we decided to make our collection time 3 days a week. This meant that we had to have an additional 4 cans to exchange with the full ones each time. In our situation where e would agreed to handle the washing of the cans, we found that it was best to go ahead and use a plastic can liner which we removed when we put food waste into windrows. This made for easier handling and less cleaning. In some collections, all we had to do was wipe out the container with a wet cloth to get it clean again.

4. MAKE A GOOD PRESENTATION

Be able to fully explain what you are trying to accomplish in your food diversion. In our case, we gave a copy of our entire grant proposal to the store manager, the regional manager and the corporate food safety officer so that they all would know where we were starting from and what we hoped to accomplish. We also showed a film on composting of food waste that was put together by Cornell University. As an introduction to the film we made a poster from the Cornell handouts and then provided examples of the signs we would use to direct workers on how to choose what ingredients to put in the cans. Below is the sign we placed in the food collection areas.

5. PROVIDE FEEDBACK

As you begin to pick up food waste on a regular basis, you will get to know the various workers that are at the store. Encourage them to tell you how things are going from their prospective. Did they have any problems, Do they have any questions. These are the types of things you want to be asking. Then you let them know how it's going from your prospective. If your still getting contamination of food with plastic, glass or metal, let them know. Tell them that you can't take the packaged items because you just can't take the time to get the food out of the packages. If you've got garbage in your food materials that you take to the compost site, bring it back. Show them exactly what you took out and either hand it to them or put it in their trash cans and remind them that this is just not acceptable. Be firm and diplomatic. You don't want to have to discontinue collection, but you will have to if you can't get clean ingredients. By removing food waste from the store dumpsters, you're actually taking out some of the heaviest materials that will go in that dumpster, so if everyone works together, those workers at the store won't have to be lifting those heavy cans like they used to.



6. PROVIDE EDUCATIONAL MATERIALS

Providing good educational materials for store staff ensures that everyone has at least had a chance to understand what's going on. It helps answer questions and shows how we re all working together to get a good quality product. . In addition a poster was designed by the NC Dept. of Pollution Prevention which was put up in the front of the store for customers to see. The following is the handout we provided to all FOOD LION staff during our presentation meetings:

WHAT IS COMPOST?

Compost is a soil like material. It is dark brown, almost black in color and has a earthy smell most people find appealing. Compost is the product of decomposition when organic matter is broken down. In nature this takes place over a long period of time in forests and woodlands. At compost operations, we speed up this process. The difference between the natural way and the composting process that we do is people. It takes people to manage organic waste correctly so that we can produce a high quality product that has many beneficial applications. Environmental factors such as oxygen, temperature and moisture must all be controlled in order to make the decomposition process as efficient as possible. Healthy compost, like healthy soil, is a living structure that is ready to support vigorous plant growth.

WHY SHOULD WE MAKE COMPOST?

Current research on horticultural and agronomic crops has shown that the benefits of composted organic matter can be both cost effective and often, superior to conventional fertilizers. In California,comparison trials on broccoli indicated that compost/fertilizer blends scored highest in both marketable yield and in all measures of nitrogen use efficiency. Research conducted in Germany has demonstrated that compost applications positively affect food quality, improve storage performance and slightly reduce nitrates in tomato crops. Greenhouse trials have shown that certain composts can biologically suppress plant diseases such as Phytophthora, Fusarium, Damping Off and Pythium Blight.

Research conducted at the University of Connecticut has also shown that compost was resistant to leaching when applied at rates as high as 50 tons per acre per year on vegetable plots. This means that compost is also a very stable source of fertility when compared to soluble fertilizer.

<u>In addition composting also has environmental benefits. A well run compost operation can</u>:

1) divert valuable resources from landfills while enhancing the sustainability of agriculture

2) reduce greenhouse gas emissions by sequestering carbon in the soil

3) curtail methane and nitrous oxide emissions and

4) reduce nitrogen pollution in groundwater.

WHAT IS ORGANIC WASTE?

Organic material is anything that started out as a plant or animal. It becomes waste when it is no longer usable in it's present form. Examples include: food, leaves cardboard and paper. It is estimated that 60% of municipal waste is compostable organic matter. Not all materials are best managed through composting. For example, high quality office paper and cardboard is valuable for recycling.

WHAT CAN A FOOD COMPOST PROJECT ACCOMPLISH?

Food composting can help reduce the amount of trash that enters landfills and turn it into a valuable product that can improve soil quality. This will save valuable landfill space, reduce disposal costs to FOOD LION, and can save tax dollars by reducing demands on disposal facilities.

To be an effective management tool, each member of the food compost project must understand that composting will make a difference. This is very important for the success of the project. The organic waste that will be composted must be kept separate from trash. Each individual must make a conscious decision every time something must be thrown away. It is critical for all employees to understand that they are an important part of the process. At the moment of disposal, the decision must be made whether the materials go in the the regular trash or into the compost cans. Once the practice becomes habit, it should not create a significant burden on the individual employees. Clean, separated organic materials make the best quality compost. Organic material that has been contaminated with non-compostables requires additional separation and processing. This drives up the cost of compost production and ruins compost quality. This in turn can make the whole process so expensive that it is no longer feasible.

HOW IS WASTE SEPARATED?

Separate containers will be located in various parts of the food preparation area. They will be clearly marked with signs that say exactly what can be put in the containers. It is extremely important that organic materials for compost be kept separate from all other waste. The size and number of containers will be based on the amount of compostable waste that is generated. The containers for composting are bright yellow so that they will be easy to distinguish from trash cans. Signs will be provided to remind personnel of the types of materials that can be put in the compost cans. Spot checks should be carried out throughout the day to catch contaminants before cans get sent out to the loading dock. Department managers need to be fully acquainted with targeted compostable wastes in order to answer questions about different wastes materials when they occur.

WHAT DO WE DO WITH THE COMPOSTABLE MATERIALS ONCE THEY ARE PLACED IN THE YELLOW CANS?

Compost containers will be taken to the loading dock where they will be picked up on a regular basis. These containers will then be cleaned using the cleaning system that is located there. Clean cans will be exchanged for the old ones and the process will start again. The compostable materials that are removed from the loading dock will be delivered to the compost in a truck that will be specially designed for this use. If any contaminants are found in the cans prior to dumping in the truck they will be dumped into the normal trash dumpster. If materials received at the compost site are found to be contaminated, they can be refused and sent back to the trash dumpster. To make this project successful it is important that we all work together to insure that only good organic waste is being taken to the composting site.

WILL THIS BE MORE WORK FOR THE EMPLOYEES?

The amount of additional work for food service employees should be minimal. Efforts will be made to made to place compost cans in the most convenient locations. Employees will be responsible to monitor the waste in order to keep unacceptable wastes out of the containers. In addition, the containers will need to be cleaned periodically to control odors.

WHO WILL BE IN CHARGE OF MONITORING THE PROGRAM?

EVERYONE!!!!!! This is not a job for just one person. We all throw away trash. Each person must decide if something is trash, recyclable or compostable. If you are not sure ASK YOUR DEPARTMENT MANAGER. No one wants to sort through food waste later on to try to get out all the non-compostable material. If we all work together we can make sure that only good ingredients are heading for the compost site. In the end this pilot project can set the groundwork for high savings at the store and the county landfill.

This can be a great project, but it will be up to each individual to make sure the job gets done right from the start .

APPENDIX 1

SOIL FOOD WEB TEST RESULTS

AND

A and L LABORATORIES
EVALUATION OF POTTING MEDIA ANALYSIS

SFI

Soil Foodweb Inc.
1128 NE 2nd St. Ste 120
Corvallis, OR 97330
Phone: 541-752-5066
FAX 541-752-5142
E-Mail: info@soilfoodweb.com

Compost Foodweb Analysis

Client: Jon Nilsson
East Coast Compost
P.O. Box 120
Fairview, NC 28730

Sample Received: 01/09/2001 Date Mailed: 3-26-2001
Compost type: Manure w/ silage, food waste, other materials
Invoice #: 2851
Grower:

Organism Biomass Data

Sample #	Treatment	Dry Weight of 1 gram Fresh Material	Active Bacterial Biomass (µg/g)	Total Bacterial Biomass (µg/g)	Active Fungal Biomass (µg/g)	Total Fungal Biomass (µg/g)	Hyphal Diameter (µm)	Protozoa Numbers /g: Flagellates	Protozoa Numbers /g: Amoebae	Ciliates	Total Nematode Numbers (#/g)
87604	456	0.47	58.9	355	229	352	2.5	NR	NR	NR	NR
87605	78	0.48	8.5	325	62	361	2.5	NR	NR	NR	NR
87606	10	0.38	5.0	395	284	534	2.5	NR	NR	NR	NR
		606 too wet, highly likely that this will be or is anaerobic. Others a touch too wet as well. Need to reduce moisture, turn and make sure piles are covered, out of puddles	604 high bacterial activity, others too low or too old	All excellent - higher than minimum range	All above minimum range, but clearly 605 is less fungal dominated than others	All excellent! 606 much more fungal than others	OK				
Desired Range		Field capacity	See A 15 - 30	See B 150-300+	See A 2 - 10+	See B 150 - 200+	C	10,000+	10,000+	20-50	50 - 100

A - Immature compost can have activity ranging from 10 to 100%. Mature compost should have activity between 2 to 10%.
B - Fungal activity and biomass depends greatly on the plant being grown. Desired range given here is for a 1:1 compost.
C - Hyphal diameter of 2.0 indicates mostly actinomycete hyphae, 2.5 indicates community is mainly ascomycete, typical soil fungi for grasslands, diameters of 3.0 or higher indicate community is dominated by highly beneficial fungi, a Basidiomycete community.
Season, moisture, soil and organic matter must be considered in determining optimal foodweb structure. If sample information, such as pesticide, fertilizer tillage, irrigation are not included on the submission form, sender's locale is used. One report is sent to the mailing address on the submission form.

Organism Ratios

Sample #	Treatment	Total Fungal to Total Bacterial Biomass	Active to Total Fungal Biomass	Active to Total Bacterial Biomass	Active Fungal to Active Bacterial Biomass	Plant Available N Supply from Predators (lbs/ac)	Root-Feeding Nematode Presence
87604	456	0.99	0.65	0.17	3.88	NR	NR
87605	78	1.11	0.17	0.03	7.28	NR	NR
87606	10	1.35	0.53	0.01	57.2	NR	NR
		604 and 605 are well-balanced, 606 is on the fungal-dominated side, so best for any system low or lacking fungi	None of these composts are mature	604 not mature, but at least mature levels of bacteria in 605, 606	All composts are moving in a more fungal direction, 606 to a greater degree than others. This is good for ag soils		
Desired Range		(1)	(2)	(2)	(3)	(4)	(5)

(1) For the following plants, Grass:0.5-1.5; Berries, Shrubs, grape: 2-5; Deciduous Trees: 5-10; Conifer: 10-100.

(2) Active organisms in mature compost should be below 0.10. Compost is not mature, i.e., not stable, if greater than 0.10.

(3) For annuals, ratio should be 1 or less, for perennials, ratio should be 2 or greater.

(4) Based on release of N from protozoan and nematode consumption of bacteria and fungi. Often protozoa and nematodes compete for food resources. When one is high, the other may be low. Also, if predator numbers are high, the prey may have low numbers

(5) Identification to genus.

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EVALUATION OF POTTING MEDIA ANALYSIS

- BY MODIFIED (DTPA) STURATED EXTRACT MEHTOD -

Parameter	Unit	Low	Adequate	High
pH (less than 20% soil)*		<5.0	5.0-6.8	>6.8
pH (more than 20% soil)*	mmho/cm	<5.5	5.5-7.0	>7.0
Conductivity (mature plant)	mmho/cm	<0.7	0.7-3.5	>3.5
Conductivity (young plant)	ppm	<0.5	0.5-2.0	>2.0
Available Nitrogen (NH4-N + NO3-N)	ppm	<40	40-200	>200
Phosphorus (less than 20% soil)	ppm	<5	5-25	>25
Phosphorus (more than 20% soil)	ppm	<2	2-18	>18
Potassium	ppm	<50	50-150	>150
Calcium	ppm	<50	50-200	>200
Magnesium	ppm	<20	20-150	>150
Sodium	ppm		0-80	>80
Sulfur	ppm	<20	20-200	>200
Boron	ppm	<0.5	0.5-2.0	>2.0
Iron	ppm	<10	10-40	>40
Manganese	ppm	<5	5-30	>30
Zinc	ppm	<5	5-30	>30
Copper	ppm	<0.5	0.5-10	>10

*1:2 media:water
< (less than) > (more than) ppm (parts per million)

The above table is a general guideline. Values may change with different plant types and growth stages. For example, there is a wide range of values under "adequate." For young plants or to slow growth rate, keep nutrient levels at lower end of the adequate range. To "push" the plant growth, add nutrients to the high end of the adequate range.

To convert conductivity (mmho/cm) to soluble salts, multiply by 640 (theoretical value) or 700 (empirical value).

Saturated Extract Method was written by D. D. Warncke.
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