CUSTOM APPLICATION OF BIOFERTILIZERS FROM RECYCLED ORGANIC WASTE

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PROJECT ACCOMPLISHMENTS:

This project accomplished several goals in increasing the marketability of compost from recycled organic waste. In particular, it demonstrated several value- added markets and applications for local poultry litter compost that could be accessed by area landscape or farming enterprises.

The primary purpose of the project was to evaluate new distribution technology to better access existing markets. It became increasingly clear that there is tremendous potential to use existing technology in a system that accesses lucrative new markets.

In an area like Chatham County, North Carolina there is a huge natural resource in the form of several types of poultry waste. As current environmental concerns make way for new waste management regulations, this resource is often thought of in terms of liability. With the application of fairly simple technology and astute marketing strategy, this resource could provide significant additional revenue to farmers and allied operations.

Individually, the three areas of evaluation for the project provided significant successes, as well as some frustrating setbacks. The greenhouse component was by far the most successful in economic terms. The hydroseeding and dry material delivery components, however, each yielded information indicating that they could be profitable enterprises. A combination of the two technologies in a total soil management operation offers even more potential.

GREENHOUSE TRANSPLANT PRODUCTION

- Evaluated numerous potting mixtures, arriving at an excellent media containing over 50% local poultry litter compost.
- Marketed over 10,000 wholesale organic vegetable transplants in the Triangle area through conventional nurseries and specialty retailers.
- Produced a wide variety of bedding plants, both edible and ornamental, including hanging baskets, all under certified organic conditions.
- Introduced local producers and consumers to the value of composted waste as a plant growing media and soil amendment.

HYDROSEEDING

- Used public and private trials to evaluate numerous composted materials for suitability in hydroseeding turf and other potential crops.
- Determined application ratios and limitations on using compost to amend or replace conventional wood and cellulose hydromulches.
- Discovered two interesting new materials to enhance the performance of compost based

hydromulches.

- Promoted the use of compost by successful seeding of turf at public school and private sites in the area using poultry litter as a primary fertilizer and soil conditioner.
- Successfully produced specialty crops (lettuce, spinach, various organic greens) in an innovative system that provides an excellent economic return..

DRY MATERIAL APPLICATION

- Evaluated several components that could be included in the handling, transport and application of dry compost material
- Completed time study and cost comparison of different methods of application.
- Demonstrated how compost applied at agronomic rates can improve soil quality under different cropping systems, including turf.

ORGANIC TRANSPLANT PRODUCTION

As a result of this project, a readily expandable niche market exists for a similarly produced vegetable transplant in the Triangle area. Our transplants were marketed under the name Hungry Mother Organic Transplants, with labels and signage indicating the use of 50% recycled poultry litter. (See attached documents.) A similarly produced product could likely capture the same market, even if produced without the benefit of organic certification.

LOWER COST OF PRODUCTION

Commercial potting media (peat, perlite, vermiculite, fertilizer) can be reduced by at least 50%. We achieved our best results using a 4:4:1, Peat/Compost/Worm Castings Mixture. This comparison based on actual project costs.

Example: Using 1801 flats (3" biodegradable peat pots)
Commercial Mix -$72.00 cu.yd. yields 108 flats @ $0.66 per flat.
Compost Mix -$37.00 cu.yd. yields 108 flats @ $0.34/flat
Result: $.32 net savings per flat on production cost.
Net per year based on 3000 flats = $960.00

INCREASED RETURN

This is where the most significant economic gain is made by selling value-added compost in the form of bigger transplants. We discovered early in our spring season that the retail market preferred a larger transplant. One of the major regional growers, Bonnie Pant Farm, markets all of their vegetable transplants in single cups, and has started to market a larger transplant called their "Miracle Grow Select**".** We found that by potting up our smaller 1204s (48 cells per tray) to an 1801 (18 individual 3" peat pots), we could greatly increase profitability.

Example: 1204 Wholesale Price - $8.50 -2.80 (cost) = $6.70 Net Return/flat
1801 Wholesale Price - $22.50 - 2.80 (cost) = $19.70 Net return/flat
* Additional cost of media in larger pot was offset by reduction in labor and # of seed or plug per flat.

Production time was increased by 7 to 10 days, but the other benefits of "potting up" more than compensated us for the extra time. Benefits included:

- Larger, healthier looking transplants.
- Ability to grow transplants organically without fertilizer.
- Enhanced shelf life and resulting marketability.*

*** Table 1.**
All of the transplant mixes in the following table were combination of commercial growing media (peat, perlite and vermiculite), mixed with poultry litter compost and worm casings, in various ratios. The numerical designations represent ratios of each ingredient in the order of commercial mix, compost and orm castings, respectively. For example, the 101002 represents 10 parts commercial mix, 10 parts compost and 02 parts worm casintgs.

Average Shelf Life of Transplants								
Treatment	wk 2	wk3	wk 4	wk 5	wk 6	wk 7	wk 10	wk 12
Control	2	2	3	3	2	1	1	1
21800	2	2	2	3	3	3	2	1
61402	2	2	4	5	5	5	3	3
101002	2	3	5	5	5	5	4	3
101000	2	2	4	5	5	5	3	3
180002	2	3	4	4	4	4	3	2

This table shows the average quality scores of six plants in each treatment Quality Scale:
5 - Excellent 4- Above Average 3 - Market Ready 2 - Marginal 1- Unmarketable

In order to determine the amount of greenhouse time to market transplants, we set up this trial using tomato plugs (v. Better Boy) planted in six different potting mixes. The control was our commercial peat based mix, 200000, and 180002 was the same mix with two parts worm castings added. The other treatments had different ratios of peat/compost with worm castings added

At 14 days, all six plants in each treatment were given a supplemental dose of 3/4 tsp.of organic fertilizer (4-2-2) for three consecutive weeks. The trial was initially scheduled to go through week 6, at which point fertilizer application had been stopped. Observation continued through week 12, with many of the plants still in saleable condition after 5 to 6 weeks of watering only. The control group, having no slow release nutrients in the form of compost, declined in quality within 3 to 4 days of being taken off of supplemental fertilizer.

The increased shelf life of our transplants was a major marketing advantage. It meant fewer flats returned or written off by the retailer. The high quality of our plants was also evident to consumers, as our product was placed in close proximity to the conventionally grown

transplants, which rapidly declined in quality.

CUSTOM COMPOST APPLICATIONS

Numerous seeding operations were performed on several sites in the area using a variety of custom applications. The following information summarizes some of the more useful information generated from these trials.

SOIL IMPROVEMENT THROUGH APPLICATION OF COMPOST

The project initially focused on two types of compost application, comparing the advantages and disadvantages of both. It was assumed that one or the other would prove more feasible, or at least more profitable. In reality, it was found that bulk application of compost could be combined with an ongoing system of hydroseeder applications to improve and maintain soil fertility and structure.

BULK APPLICATION

Two major challenges in promoting the use of compost are demonstrating that:
1. an appropriate rate of compost application can substitute for the use of chemical fertilizers in lawn or landscape establishment..
2. Composts will not adversely affect the soil when used at agronomic rates. (In particular, copper and zinc levels have been a concern with the use of animal manure compost.)

A seeding demonstration was conducted at Central Carolina Community College in Pittsboro, to demonstrate the benefits of applying compost at agronomic rates. Officials in the Sustainable Agriculture Program there were interested in establishing a cereal rye cover crop on a half acre plot. The following tables include NCDA Waste Analysis for composts used, and a table showing the difference in soil analysis before and after crop was grown.

Table 2.
NCDA Waste Analysis of Composts Used in Greenhouse and Seeding Production

Nutrient Availability			**lbs/ton**							
Sample	**pH**	**SS**	**C:N**	**N**	**P2O5**	**K2O**	**Ca**	**Mg**	**Zn**	**Cu**
Steer	**7.07**	**170**	**10.7**	**12.1**	**7.2**	**10.6**	**40**	**4.3**	**0.12**	**.09.**
Breeder Hen	**7.3**	**305**	**17.6**	**4.6**	**20.2**	**9.9**	**44.6**	**3.7**	**0.23**	**.05.**
Broiler	**6.3**	**695**	**12**	**8.6**	**24**	**12.6**	**22**	**4.2**	**0.51**	**.05.**
Turkey	**6.11**	**117**	**21.9**	**5.3**	**10.8**	**4.2**	**18.3**	**1.5**	**0.19**	**.07.**
VO Worm	**5.23**	**210**	**13**	**5.9**	**31.2**	**0.76**	**36.9**	**1**	**0.4**	**0.2**
Cult Worm	**6.07**	**75**	**17.2**	**6.9**	**9.6**	**1**	**22.5**	**6**	**0.31**	**.06.**
Eggshell	**6.79**	**113**	**13.6**	**5.5**	**6.8**	**3.5**	**166**	**2.7**	**.04.**	**.03.**

All of the composts, except for the two worm casting products were made outdoors in windrows, using a front end loader for turning. Had they all been subject to controlled conditions and made at the same time, it would be possible to do a more accurate comparison of quality.

The turkey litter product was used for the bulk of our transplant production, primarily because of the relative N-P-K balance, which was roughly 5-10-4, combined with a low soluable salts level of 117. The broiler litter was very similar, except that it was very high in soluable salts, which could be harmful to young transplants. The reason for such a pronounced difference in salts levels could be that the broiler litter had nearly as long a curing time as the trukey litter.

For field application, we chose the three products that were readily available at trial time. Soluable salts are not so much of a concern, as they will be subject to leaching in the soil. In most situations, a farmer or landscaper would choose the product that provided the most nitrogen for plant growth, in this case, the steer manure compost.

RESULTS

The following chart shows a comparison of soil analysis from demonstration plots at Central Carolina Community College in Pittsboro, NC. The top number is an indication of soil fertility tested before any treatment was applied in October 1999. The lower line is from an NCDA soil analysis 6 months after applying 3 different compost treatments at the rate of 15 tons per acre and seeding with cereal rye.

Physical indices, including pH and CEC, are significantly improved on all plots. This indicates an increased capacity in the soil to hold and exchange nutrients with plant populations. This is a benefit, even if chemical fertilizer was applied, as it would be used more efficiently by the soil and plants. Slight improvements, even on the control plots, could be associated with the plow down of plant residue on the plots prior to treatment and planting.

Another significant result of compost application is in the increase of indices for Phosphorous and Potassium. At the beginning of experiment, the indices for all plots except for #2 fell in the low to moderately low range. Post-treatment indices, except for the control plot, are all in the moderately high to high range. This indicates that residual potassium and phosphorous are adequate to supply the following crop.

One of the potential problems associated with this bulk application is the high index for phosphorus on the Turkey Litter Compost treatment. Under pending NRCS rule changes pertaining to phosphorous, such an index would more than likely limit further applications of manure, at least in the short term. There are two possible management solutions, depending on the cropping system. One would be to decrease the initial application of compost in order to maintain a lower phosphorous level in the soil. With the increased biological activity assumed from the addition of organic matter, the following crop would help to lower the P-Index. An alternative strategy, especially where one encounters a potential problem, would be to apply smaller amounts of compost over several seasons, as is possible with the hydroseeding method of soil amendment.

Copper and zinc levels, while slightly higher after compost treatment, should not be a concern. It would require repeated applications over several years before these two metals would reach a level of toxicity in the soil.

Table 3.

Treatment	CEC	pH	P-I	K-I	CA	MG	Zn-1	Cu-I
1. Pre-treatment	8.3	6.4	5	42	60	30	105	66
1. After Eggshell	21.6	7.2	69	86	84	14	213	82
2. Pre-treatment	9.2	6.3	65	70	58	29	163	73
2. After Turkey	14.6	6.6	124	114	67	25	332	80
3. Pre-treatment	8.5	6.2	28	46	56	30	82	63
3. After Steer	17.1	6.9	72	178	66	27	179	97
4. Control	9.1	6.3	34	47	59	29	122	64
4. No Compost	13.2	6.6	20	69	57	32	162	67

DRY MATERIALS APPLICATION METHODS

One of the major objectives of this project was to develop a blower assisted application method for applying bulk compost. Various applications afforded the opportunity to trial several pieces of equipment, including:

1. A chipper/shredder with 9 hp engine, retrofitted with a custom hopper and delivery hose.
2. A 14 hp bale chopper/straw blower.
3. A 24 hp brush chipper, retrofitted with 30 ft. of delivery hose.

Table 4.

Component	Flow Rate (cu. ft./minute)	Delivery Distance from machine	Material Density W/V Ratio
Straw Blower	18 to 27	80 -100 ft	<.75 @ 30% Moisture
24 hp Chipper	15 to 20	40 - 50 ft	<.75 @ 30%Moisture
9 hp Chipper	4 to 6	15 - 20 ft	<.6 at 30% Moisture

There were several unexpected difficulties in utilizing this type of application, which may explain the high cost of mulch blowing units currently on the market. The following summarizes problems encountered on this project.

1. Moisture content - All the machines used operated much more effectively with moisture content below 30%. At higher moisture levels, material would clog machine at intake, or in the hose line just past machine outlet.

2. Dust and Debris - At moisture levels low enough to facilitate good flow, there was a constant problem with small particles escaping both from the hopper and through joints in machinery sheet metal. Low moisture also resulted in significant reduction in particle size resulting in excessive wind borne particles at hose end.

3. Labor intensity- Trying to convey materials from spreader body to machine and then to the end of the hose required three workers. It wasn't possible for one person to regulate flow from the truck/trailer and keep the blower unit operational at the same time.

SUCCESSES

One discovery made in the process of evaluating machinery was the increased efficiency brought to all applications by the use of a spreader body. Two types were used on the project, a conventional litter spreader truck, and a PTO-driven Farmhand trailer (originally a grain trailer).

The following are some of the advantages realized:

- Elimination of all hand labor where vehicle access allowed mechanical spreading
- Controlling flow from the unit, so that material could be loaded directly in to wheelbarrows, cutting manual labor in half.
- Elimination of mess associated with dumping loads of material on driveways, sidewalks, turf, etc; savings in clean-up cost.
- Used as a mobile hopper, it facilitated other operations, such as processing material through grinder or screens for use in hydroseeding and greenhouse operation.
- More precise placement than a dumptruck for bulk compost deliveries.

Table 5.
Time Study of Compost Application Methods assumes a manual labor rate of $10.00/hr x two persons and equipment rate of $40.00/hr. Calculations based on 6 cubic yard application, which was the standard capacity of equipment used.

Application Method	Total Time to Apply (From arrival)	Labor/Equipment Charge per Appl.	Additional Cost per Yard of Compost
Dumped/Hand Spread	3.5 hrs @ $20.00	$70.00	$12.00
Skid/Front End Loader Assisted	1.5 hrs @ $40 1.5 hrs @ $10	$75.00	$12.50
Spreader Assisted w/Hand Labor	1.0 hrs @ $40 1.0 hrs @ $20	$60.00	$10.00
Direct from Spreader	0.25 hrs @ $40	$10.00	$1.70
Mulch Blower	0.15 hrs @ $40	$6.00	$1.00

HYDROSEEDING APPLICATIONS

The most promising aspect of this technology is the feasibility of using recycled material combined with numerous other fertilizer and or soil amendments in one procedure. Custom slurries can be mixed to provide whatever nutrients needed for a given situation. This means that after initial bulk application of compost, the hydroseeder can be used to deliver a slurry or solution that is custom blended to supply whatever macro or micronutrient needed, along with supplying a carbon rich organic matter source in one step.

We determined that it is possible to apply almost any composted material through this slurry method with proper processing and handling. Both wet and dry materials will work, but amount of material that can be used varies depending on moisture content, weight, and volume.

All of the compost materials used had the tendency to separate in the water, with larger bark pieces staying afloat, heavy finer material concentrating on bottom. The result was a thin slurry that did not form a film on ground. This problem can be eliminated by first making a thin slurry with the commercial paper mulch, then suspending the other materials in the slurry.

This technology makes it feasible to use recycled material combined with numerous other fertilizer and or soil amendments in one procedure. Custom Slurries can be mixed to provide whatever nutrients needed for a given situation.

Specialty crop trials demonstrated the ability to use hydroseeding technology to produce difficult to manage crops such as carrots, salad mix, spinach and various greens, eliminating the need to cultivate growing beds.

Completed preliminary investigation of new materials for hydroseeding, including plantago for suspension and bonding enhancement, and corn gluten for natural weed suppression.

ALTERNATIVE MATERIALS FOR HYDROSEEDING

It is important to note that all materials were tested using a 300 gal. jet-agitated hydroseeder. Paddle-agitated machines are much heavier duty and could handle the heavier materials at higher rates with fewer suspension problems. Paddle agitation provides the agitation needed to lift heavier particles off of the bottom of tank and pull lighter weight materials floating on the top into the slurry.

There are three major factors to consider in the selection of materials for hydro seeding.

1. Weight/Volume Ratio < .60 g/ml

Another way to express this ratio is bulk density. The density of material has a direct effect on how well it will suspend in the slurry. Materials with a W/V greater than .60 tend to be too heavy to stay in suspension. Compare to commercial cellulose fiber mulches which weigh in at less than .10 W/V. In certain circumstances where the material is very absorptive, it may be possible to go higher, but it will require a lower volume of heavy material, with the addition of more light weight cellulose fiber.

Sample W/V for composts used in project slurry:

Poultry Litter Compost	.25 to .45 g/ml
Worm Castings	.42 to .53 g/ml
Hen Manure Compost	.56 g/ml

2. Particle size <.125 " (recommended) <.25"(maximum)

Perhaps the most important factor because it determines both how well material will suspend in the tank, as well as how it will flow through orifices. We found that any material not screened through 1/8" mesh had a high portion of floating material and greatly increased the risk of clogging.

3. C:N Ratio Depends on Application

This ratio determines how fast or slow the material will break down on the soil surface, as well as how quickly nitrogen will be released for plant absorption or possible leaching. Paper and wood fiber have a C:N ratio greater than 200:1, whereas all composts used on the project were less than 40:1. High C:N materials persist on the soil surface for long periods (several weeks) in the absence of supplemental Nitrogen. Low C:N materials have a tendency to break down quickly (several days). Ratio of materials added to slurry can be adjusted depending on intended use, as very high and very low ratio materials can balance the overall C:N ratio of slurry.

4. Nutrient Analysis

One major benefit hydroseeder applications is the ability to adjust nutrient levels in the solution. Almost any source of fertilizer can be used, from pelletized to liquid, organic or chemical. We

frequently used a dehydrated poultry manure product with a 4-2-2 analysis in order to put out more nitrogen, as most of the composts were very high in Potassium and Phosphorus, with a fairly high C:N ratio after mixing with cellulose mulch.

Table 6.
Examples of Slurry Formulations
Mixed in 300 g. Water

Application	Materials	Coverage/Tank	Comments
General Turf Seeding	40 # Cellulose Fiber Mulch 160# Poultry Compost	3000 sf	good all purpose hydroseeding blend
Erosion Control	50-60# Cellulose Fiber Mulch 150 # Poultry Compost 10# Plantago	2000 - 3000 sf	Very tacky, good persistence on soil, resistant to water
Weed Barrier	250 # Poultry Compost 35# Plantago 25# Corn Gluten	1000 - 1500 sf	Very tacky, resists water, acts as weed barrier if applied heavily

WASTE DIVERSION

A total of 380 cubic yards of compost were applied throughout the project. Of that amount, approximately 250 yards were made from local waste sources here in the county during the project. The plan was to buy ready made compost, but compost of consistent high quality proved difficult to find.

We had an estimated demand from local consumers for approximately twice the amount we actually applied. We were not set-up to do a large volume of bulk compost, so at times we either didn't have equipment scheduled or didn't have enough compost on hand to accommodate all of the requests.