Wood 'N Fish Composting:

Small Industry Waste Management in Alaska

A Workshop on Utilization Opportunities for Fish and Wood Waste
April 11, 2001

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"What Do You Need To Know To Get Started With Wood and Fish Waste Composting?"

A project leader for the Center for Forest Mycology Research, Dr. Micales has spent 15 years doing research into the fungal degradation of wood. Her current research includes using fungi to accelerate the decay of slash and woody debris in many of the Western States to reduce the fire hazard.

What are we going to do with all that wood waste?

Mountains and mountains of sawdust, hog fuel and wood chips have been generated by wood-processing mills and accumulated in large mountains in the past. But because of today's environmental constraints, simply accumulating waste in piles is no longer acceptable.

Landfilling may not be an option because of high tipping fees and the high costs of transportation to the landfill.

Wood waste can be used as a biomass fuel to generate energy and produce alcohol as a by-product. For simple incineration, new technology smokeless burners can operate with very little amounts of smoke. The heat can be used for mill tasks such as drying lumber or to generate electricity.

But you can also turn the wood waste into value-added products:

- **Animal beds:** usually the material has to be kept dry and in clean condition.
- **Commercial mushroom-substrate:** Especially for hardwood wood waste. Most mushrooms dealt with in commercial production will not grow on conifer waste.
- **Mulch:** Unprocessed wood chips, marketed in different sizes from discrete pieces of bark to near sawdust. Usually, mulch particles are of a generally uniform size. May be clean or aged. Aging gives a uniform grey look to the product. Several companies have been experimenting with dyed mulches to match the color of suburban houses, garages or driveways, but there have been reports of dye leaching out of the mulch and staining the driveway.

Mulch is a very high-value product.

To successfully market mulch, you must find your market. And costs, such as for bagging or for transportation, must be factored in.

Now we get to compost

Unlike mulch, the wood waste in compost has actually been degraded by microorganisms into a humus-like structure.

Unlike mulch, where you can pick out individual wood chips, compost is more akin to what you might think of as organic soil.

Compost generation is really a microbial process — so all the efforts are trying to keep the microbes happy so that they will do their work.

The production of compost reduces the volume of wood waste by 50 to 70 percent — so composting is valuable to save space, even if the compost is not used.

Why not use it? Compost makes a wonderful soil amendment, rich in nutrients. Be advised, though, that compost may not be as high in nutrients as commercial fertilizers.

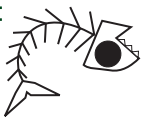
But compost adds organic matter to the soil and this is very important for how the soil retains nutrients.

Using fish waste in conjunction with wood waste is an ancient technology. Native Americans used to plant fish with their corn seeds. The principles of using fish and wood waste together are well-understood and all that will be required is tinkering for the precise recipe for your particular ingredients.

Composting can be done for personal reasons, as a cottage industry or on a large industrial scale.

As with any large-scale operation, industrial composting would require investment in some expensive machinery. But a composting operation of an intermediate size could probably get by with not much more than a front-end loader.

Requirements for Compost



Compost requires a source of carbon and a source of nitrogen. The wood is the carbon and the fish is the nitrogen. Other nutrients are also required for living things to grow — phosphorus, calcium, magnesium.

Compost generation is really a microbial process — so all the efforts are trying to keep the microbes happy so that they will do their work.

- Water — 60 percent water
- Oxygen is needed of at least 10 percent. As a note, the air is 20 percent oxygen.
- Temperature will self-generate in the pile.
- A pH of 6-8.5 is required. Not extremely acid or basic.
- Particle size of the stuff should be about 0.1 to 2.0 inches. Material that is larger than this will take a significant amount of time to break down. If the material is too fine, as in sawdust, the material will become compact, so there will not be enough air movement.
- Carbon and nitrogen — the basic building blocks of life — we are all made of carbon and nitrogen — as are all living creatures. Carbon provides energy and a source of structural material. Nitrogen is a major component of protein — both enzymatic and structural proteins, and also nucleic acids.
- The ideal ratio for composting — the ratio for bacteria to grow — is basically

25 to 35 parts carbon for every part of nitrogen. So we deal with carbon-nitrogen ratios of about 30 to 1.

Carbon-nitrogen ratios of components that go into compost mixtures

- Wood chips - 500-600:1, very low in nitrogen, which is characteristic of wood in general.
- Lumber mill residues - 200:1.
- Freshly-fallen leaves - 50:1.
- Biosolids from sewage plant - 15:1.
- Fish waste - 4:1. It's still mostly carbon, but has a lot more nitrogen in relation to other materials.

So you want to mix a high source of carbon — wood waste — with a high source of nitrogen — fish waste. But you have to take into account the bioavailability of the carbon.

Carbon in wood occurs primarily in the form of cellulose, a polymer of simple sugar whose glucose units are linked together into long, thin threads. Cellulose is very digestible by microorganisms.

The problem is that the strands of cellulose in wood are imbedded in a matrix of lignin —which is a complex structure composed of rings of carbon molecules.

Lignin rings are of a non-repeating structure, which thwarts microorganisms' efforts to identify and digest the molecules. This limits the amount of carbon that is available. The amount of lignin affects the amount of carbon available. Lignin is not digested, but retains its structure into the finished compost.

Of all the microorganisms, the ones you most have to worry about keeping happy are the bacteria, since they do the bulk of the composting.

Another organism that eats fish and wood waste is earthworms, and so-called vermicomposting is a subscience of composting. Generally, earthworms are cultured in troughs. For vermiculture, temperatures must be maintained between 50 and 70 degrees F.

Vermiculture does not generate the high temperatures associated with regular composting.

Temperature is critical

Initially, when you mix compost it will be of ambient temperature and will stay that way for a few days. This is termed the "mesophilic"phase. But once decomposition begins, the temperature rises due to microbial growth. The compost will then attain a high temperature phase — 130-150 degree F. – termed the thermophilic phase. This phase may last for several weeks.

When the decomposition is completed, the compost cools and eventually returns to the ambient temperature.

One of the ways that you know compost is ready to use is that it has returned to the ambient temperature.

Decomposition of organic matter creates heat, and conversely, microbial growth generally occurs faster at higher temperatures.

As the compost pile heats up, it throws off moisture — and can lose up to 60 percent of its moisture volume that way.

It is vital to measure the moisture of the compost. Too wet a pile can retard microbial growth, resulting in lower temperatures.

Compost must be kept at 130 degree F. or higher for at

least three days to kill the pathogens and weed seeds in the compost pile. New research is showing that lower temperatures for a longer period of time also kill pathogens and seeds.

It is important to keep moisture and temperature levels consistent. Temperatures of 150-165 degrees F. will kill the microorganisms that do the composting.

Temperature is largely determined by the size and shape of the compost pile.

Too flat and wide a pile will result in temperatures too low for efficient decomposition. Too high and wide a pile can result in too hot a temperature, killing microorganisms that do the composting. A critical mass of material is needed to self-sustain the composting process.

High temperature may also be related to the proportions used in the compost mixture — the addition of too much nitrogen may result in microbial growth erupting, causing temperatures to spike. Too little nitrogen may result in too little decomposition occurring, causing temperatures to remain too low to kill pathogens and weed seeds.

Moisture is another critical factor

The optimal level of hydration of a compost pile is 60 percent, which can be measured with a hydrometer. You can also check the compost manually — it should feel moist, but water should not drip out of your hand if you squeeze the material. Too much runoff can also mean leachate problems.

A compost pile that is too wet can become anaerobic, causing the growth of anaerobic organisms which cause extremely bad odors.

The oxygen level of the compost pile is also dependent on moisture, as well as the size of the particles being decomposed. Bacteria live in a thin film of water that surrounds compost particles. Too much water in the compost keeps the bacteria from diffusing oxygen through the thicker layer and results in the generation of bad odors from the anaerobic organisms.

It is important to keep the pile oxygenated. Start with a proper particle size, 0.1 to 2.0 inches. Too big a particle and decomposition takes too long. Too small a particle does not allow oxygenation.

Ammonia smell may be present under both aerobic and anaerobic conditions. The smell is caused by an excess of nitrogen. Fortunately, the ammonia smell is easily dispersed through the top of the pile. Many noxious odors are heavier than air and will linger at the bottom of the pile — where people's noses are.

The best odor control is to maintain the proper ratios of carbon and nitrogen, oxygen and water.

To remediate odors, there are commercial additives available. But a better method is the use of a biofilter. One way to form a simple biofilter is to place a layer of organic material on top of the pile. Other finished compost, peat moss, chips, brush, bark and also inert material can be used as a biofilter.

Leachate Issues

Control problems with leachate by keeping the proper amount of nitrogen in the mix, and protecting the pile from excess amounts of rainwater. Some operations use sawdust to blot up excess water and then

add the sawdust back into the composting pile. Others use catch basins, then re-use the water.

Compost pile leachate has a high organic content, so you would not want to flush it into a river or down a storm drain. If you have a very wet nitrogen source (fish) you may want to use a drier carbon source — (drier wood waste.)

Getting the Right Mix

The basic mixture is 3 parts carbon to 1 part nitrogen — assuming a proper moisture content. Three or four parts wood waste to one part fish waste by volume is a good start.

Excellent spreadsheets are available at http://www.cfe.cornell.edu/compost/download.html *and* http://www.cfe.cornell.edu/compost/calc/1a.html.

Unusual materials, such as crab legs or sea urchins may need a slightly different mixture.

Mixing the Compost

How much material do you have? Garden-sized amounts or massive amounts? How are you going to aerate?

In static piles, air just approaches from the sides and then is diffused through the pile. Another passive method is to insert drainage perforated pipes into the pile. For a more active method, air can be blown through the pipes. The airflow can be maintained with exhaust fans for negative pressure, as well as blowing air in for positive pressure.

The shape of your compost pile is vital to success.

Windrows is the term used for long, tall piles of compost — one of the most common methods.

Fully containerized systems are available, but are capital intensive. Container systems may be fully automated, through — with raw material coming in one end and processed, finished compost emerging from the other. This processed compost generally still requires an extensive curing period.

Start your compost pile with a somewhat fluffy base layer, that should be about 1 foot deep. This will help the pile drain, provide aeration and intercept leachate. Could be peat moss or bark.

Then comes the compost layers. Some people also add finished compost to the active layers. One recipe is 3 parts wood waste, 1 part fish and then a layer of finished compost.

Large-scale mixing is often done on a concrete pad, using a front-end loader. They will then add the cover layer, composed of 6 to 12 inches of wood chips, recycled compost, peat, etc. to act as a biofilter. This will intercept odors and act as a barrier against flies and vermin.

While dimensions of the compost pile are variable, about 10 cubic feet (3 feet x 3 feet x 3 feet) is considered the absolutely minimum critical mass need for successful decomposition.

The base of windrows are often about 8 feet across. Height is often about nine to 10 feet, although some operations will go up as high as 14 feet. A lot depends on the kind of machinery you have.

After the first period of decomposition, piles may be turned to aerate and bring fresh nitrogenous material against fresh nitrogenous carbon material. The amount you need to turn depends on the shape and size of your pile and the amount of moisture. There are several types of commercial turners. There are expensive self-contained units or ones that attach to an external power head.

Another composting strategy for aeration is passive — taking PVC pipe and putting holes in it and placing it in the base. This can be done length or width depending on the size and shape of the pile. As heat is emitted from the top of the pile, new air is pulled in on the sides and bottom.

An active system can be rigged with sensors, so if the pile gets too hot, it can be cooled down by fans throwing air through the pile. An active system using negative pressure is often coupled with a biofilter.

Fish waste will decompose in two weeks under proper conditions. All that will be left are the gill plates. A 36 lb salmon would decompose to nothing but gill plates in two weeks.

Carbon sources are much slower to decompose, and can take one to two years, so particle size is important.

Curing

Just because compost has dropped in temperature doesn't mean you are ready to put it on plants. It must first be cured, which results in certain organic acids and other chemicals breaking down. If the compost is used too early, these chemicals can be harmful to plants.

Compost maturity can be judged by its return to ambient temperature.

The carbon to nitrogen ratio in finished compost would be about 15:1, and it would contain no pathogens, and no toxic chemicals

To determine if the compost is ready, look at it. Do you notice odors or not? Does the compost still have a sulfury or ammonia smell? You can also order or perform a chemical analysis.

A good check is to throw a handful or radish or cabbage seeds onto a small pile of compost and see if they grow and if they appear healthy.

Financial Considerations

Is composting going to pay? Profitability depends on your strategy in producing compost. Are you just using compost for waste reduction or disposal? To take care of your wood waste or fish waste? Are you trying to make a profit from composting?

To make money, there is a whole range of considerations.

Do you want to do it on a large scale or a small scale?

Do you want to become a central place where people bring you their waste and you charge them to take it?

A market analysis is a great idea before beginning a commercial composting enterprise. Different markets may require modifications in the product — uniformity of particle size, for instance, or the size of the bag.

Transportation will be the major expense.

Dr. Thomas Richard
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"Practical Applications for Wood and Fish Waste Composting Facilities: Current Technology and Processes."

Make A Product

Often, what drives the creation of a composting operation is that a person has something that they don't want — a waste material. But just thinking about treating the waste will not necessarily lead to a product that someone else will want to use. *Unless you THINK THINGS THROUGH first.*

How do you organize your operation so it is not a waste disposal process, but a product manufacturing process?

If you are making a product, you will want to consider that end product goal in thinking about all aspects of your operation — from the feed-stock you use, onward. You will also, for instance, learn to avoid some potential feed-stocks because of their effect on the final product.

Different customers with different needs may require different feed stock, processing, or packaging — and these are all aspects to be considered up front.

In New York State, a 6 million lb. salmon fishery originates in Lake Ontario. Largely fished by recreational anglers on fall weekends, the fishing left New York State officials facing a mountain of fish waste being produced at about 40 small fish cleaning stations at harbors and bait shops. Rather than taking the noxious fish waste to the landfill, the material was mixed with wood and paper mill waste to make compost. These small-scale, simple bin systems were low-cost, simple to operate, and with one possible exception, trouble free.

The one problem, which ultimately turned out to be a benefit, was at one Upstate New York bait-shop with one of the first fish waste composting sites. At a visit about a month after the composting had started, scientists were shocked at the number of maggots that were breeding in the leachate where the passive aeration pipes had not been installed properly. But the scientists, rather embarrassed at the maggot situation, got a new insight when they apologized to the owner of the local bait shop. He pointed out a huge jar of

maggots on the counter and proudly reported that he sold them to fishermen for 10 cents each. ***It depends on what your product is!***

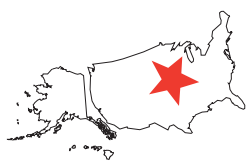
Windrow Systems

Windrows, elongated piles about 8 to 10 feet tall and twice that wide, are by far the most common type of medium-to-large-scale composting pile configuration used throughout the world.

Windrows are typically built outdoors, with enough space between them to maneuver the equipment needed to turn the piles and maintain air movement through the piles.

Turning the windrows can be done in different ways, some of them low-tech and low cost. Control of the process is largely determined by the initial mixture of carbon and nitrogen, and especially the presence of adequate porosity to allow air movement.

Windrows must not be too big or air will never reach the center of the pile. Ten (10) feet is the maximum safe height — piles 12 or 15 feet in height run the risk of spontaneous combustion.



Barns still burn occasionally in the Midwest because of hay being piled up too high. Once the temperature of a pile gets above 180 degree F. chemical oxidation processes can occur which push temperatures high enough to ignite. Spontaneous combustion can sometimes occur at composting sites, and fires once started can be difficult to put out. Avoiding large piles and keeping track of internal pile temperatures are the two most important means of prevention.

Dealing with Odors

Although ideally one would like to have the whole composting pile fully aerobic and never generate many odors, in practice that is nearly impossible, especially with high protein, wet ingredients like fish waste. The best way to deal with those possible odors is with biofilters. These can be separate units in forced aeration systems, but in windrow operations can simply be outside layers of the pile that don't have the high protein odoriferous materials and can absorb odors before they escape the pile. Finished compost, peat moss and sawdust are a few of the materials that would make an effective biofilter.

The coarser the material you have, the bigger the buffer layer you have to have over the pile. If you are working with large diameter wood chips or bark, you will need a thicker layer in your biofilter.

Thus, a biofilter of sawdust may be eight inches thick, whereas a biofilter of wood debris may need to be a foot and a half thick.

Porosity and Odors

Using fish means dealing with a high moisture substance, which is high in nitrogen, is very readily biodegradable, and does not have much structure. All of these things mean trouble.

If you are dealing with fish you cannot even consider producing marketable compost unless you can address those things. The easiest way to address them is to include some high carbon material that has some porosity and is a lot drier — and wood waste perfectly fits the bill.

But so do cornstalks, cardboard, and even newspaper, although newspaper alone doesn't have the structure to

provide good porosity and has to be blended with something else.

If you do not deal with the moisture, high nitrogen and rapid degradation, you will experience some very noxious odors. The resulting anaerobic reactions will also produce acids that are especially noxious in combination. In fact, the presence of such acids can be a good indicator of anaerobic conditions in the pile.

Noxious odors may be a sign you have too much nitrogen and not enough carbon in your compost pile.

These noxious odors can be detected in parts per billion and can travel up to 1/2 mile. Yet, well managed compost operations can peacefully exist within a few hundred feet of half-million dollar houses, as has been shown in Scarsdale, New York.

Your best public relations approach and your best key to success is not to have problems with your neighbors.

If you are using largely wood waste and other high carbon products, you will probably not have problems, but you must be careful if you are using high nitrogen materials like fish waste.

Turning and Air Movement

Adding oxygen to composting piles can be done mechanically with forced-air blowers, but you can also effect oxygen transfer by turning the pile. However, the oxygen introduced during the turning event is normally consumed within a few minutes or an hour, and the key to maintaining aerobic conditions is porosity and natural convection.

Windrow piles will get a convection effect when hot air (generated by the heat of decomposition) rises out of the top of

More On Porosity

• Woody material is an especially good compliment to the fish because it is high in carbon, should have low moisture and has good porosity.

• Porosity and structure are the real keys to good composting. In general, the larger the particle size, the greater the air movement. Too small a particle (fine sawdust) will prohibit air movement.

• The moisture content of the pile should be between 40 and 70 percent.

• In a typical chunk of wood, in a more temperate climate you can expect an eighth or a quarter inch of wood to degrade each year. So if you start off with a two-inch chunk of wood you are going to have to wait a long time before it degrades.

• Particles which are narrow, but long — such as shreds, will degrade well because of their large surface area. Too fine a material — sawdust or something like leaves or newspapers — then may lose porosity after a few weeks. Paper in particular can rapidly turn into pulp and lose its structure, and thus should always be blended with more stable carbon source like wood waste.

• The goal is to keep the compost pile aerobic.

the pile and cool air comes in from the sides and bottom.

There are other reason for tuning piles, though, such as fly control. If you don't want to sell those maggots, you can kill them by turning them into the center of the pile where the high temperatures will destroy them. Turning also serves to re-mix materials and fluff the whole structure up and thus add porosity. Porosity allows new oxygen to circulate, replacing that which has already been used.

Dense materials like fine sawdust will not allow the air to push through. Leaves last for a few months in a composting system. Wood shavings break down faster than wood chips.

A mixture of finer and coarser materials seems to work well. Coarser materials provide porosity and finer materials provide more surface area for interacting with high nitrogen substances like fish waste.

Loading the Fish

Particle sizes left from waste processing might need some further work to get to the right stage for composting.

Tub grinders are the most common machinery found, but other grinders can also be used.

In some operations, magnetic separators are used to get nails, staples and other metals out of the woody material to be composted.

The fish can be added to the compost pile in layers, if you don't have a lot of money for fancy mixers.

After a month and a half or two months — the layer of fish may be a little bit visible, but is mostly gone. But you don't want to go to market with this material without further processing.

Normally you will want to give it one more chance to break down. The compost should be mixed and allowed to work for another couple of months. This will even get rid of gill plates, scales and other less degradable portions.

In a windrow system there are different ways to incorporate high nitrogen materials. You want to get those materials into the center regions of the piles where a buffer of woody materials can soak up the moisture and absorb odors.

With a simple bucket loader, dig out an area in the pile of wood waste from the top. Then load in your fish or other high-nitrogen materials and cover it with a layer of sawdust or finished compost. You can also reduce the fish to an emulsion and inject into the piles of wood waste.

In Iowa, where rendering plants have become rarer and more expensive, a similar method is used to dispose of dead animals. They tend to use an anaerobic composting process, surrounded by a biofilter. The result can then be used as a nitrogen feed stock and mixed with other materials.

In Upstate New York, papermill sludge has been successfully used as the high carbon material to mix with fish waste. Six months were needed to transform the material into marketable compost.

If your compost piles are being turned, then they must be

covered with something, such as sawdust or finished compost. There should be no exposed fish waste.

Aerating Piles

Piles that are not being turned on a regular basis may have a forced aeration system. Pipes are placed inside the pile and then air is forced in. Negative pressure may also be used — which works especially well in conjunction with a biofilter.

Plastic pipes — septic pipes with pre-drilled holes — can be used to provide passive or active aeration to the piles. If septic pipes are used, make sure holes are pointing to the side and down rather than up, or leachate from the piles can run into the pipes and be a breeding area for flies.

High tech composting systems are available, but are not usually considered for low

value wastes, like wood and fish wastes, but are used for the treatment of municipal sewage sludge and other potentially noxious materials. Some systems are so automated that you load the materials in one end and finished compost comes out the other. Other systems may work with windrows, where the material is moved down a conveyor belt each time it is turned.

Complete containment of the material is even an option, albeit an expensive one.

Philadelphia at present is composting all of their sewage sludge — probes are put into the pile and the blowers are cycled on and off to keep the piles from getting too hot. This 18-acre biosolid processing site co-exists with a spate of hotels at the city's airport.

Moisture

35 to 40 percent moisture range is the recommended range for finished compost.

Finished compost tends to be dry enough to preclude transporting water needlessly, but moist enough not to be dusty.

You may need to add water to the piles. Catching and re-using leachate and runoff to moisten the piles can keep pollutants contained on your site, and avoid water quality problems in nearby ground and surface water.

Bad Messages Travel Fast

In addition to the odors and fires previously discussed, there are a few other challenges to watch out for when composting.

Prevention of these problems is always the best policy, since any mistakes you make will be widely known and long remembered.

With the compost itself, phytotoxicity is the most common concern. It is possible to produce toxins in compost that can damage or kill plants. Alcohols and organic acids that form under low- or no oxygen, anaerobic conditions have caused expensive damage in greenhouses and bedding plant production, and can even be a problem in landscaping when lots of compost is blended into small amounts of soil. Also, wood products exposed to salt water may have high concentrations of salt. Both of these problems are less likely to be an issue when compost is diluted in large volumes of soil, and both can also be corrected before marketing the compost. The organic acids and alcohols will break down once the compost is aerobic, and salt can also be leached out of the compost by rainfall over time.

Be sure to keep finished compost from getting too wet, because even a good stable compost can go anaerobic and develop odors.

Rain and Snow Issues

In any composting system, you must deal with the runoff that comes off the site. You typically want to have slope on the windrows so you don't have pooling, which can quickly turn the pile anaerobic. This will be a particularly important issue in areas like southeast Alaska, where high rainfall is a fact of life.

Snowfall may be a problem, too if it blocks off convection exhaust from the top and sides of the pile. Cold in itself is not a problem — the pile has the capacity to stay warm enough from its own biological reactions, particularly if you have a woody source, high in slowly usable carbon.

Plastic covers can be used to protect the piles from excessive rainfall, but the covers need to be removed periodically in between rainfall events to allow convection heat to emanate from the top of the pile and draw in fresh, cool, oxygen rich air. A cover left in place can cause anaerobic conditions and odors to develop. Materials that shed water but allow air movement, such as fabric covers (some made with Gore-Tex), are available, but expensive.

Fairbanks, Alaska reports that sludge composting is still going on, even in winter at minus 70 degrees F.

Some other materials will freeze straight through and you will have to bring them back to life in the spring.

What to Do With Runoff

If you are in a situation where you can't collect all the water — there are low cost ways to treat it. One is to use vegetation, such as grass strips to try and filter out the solids and nutrients.

It is often the materials that fall between window piles that end up in the runoff.

Marketing

You want to think about your composting operation as a manufacturing process. Those processes start with a focus on the product that is to be made. "I think I know somebody who would buy that."

You want to start out with a customer in mind, and a product that they would buy. Identify your customers and be ready to

customize your product to their needs.

Customers may be low value but high volume. Or low volume, but high value. But be aware that if you are going to shoot for high value markets, it will take some extra effort to meet those quality expectations.

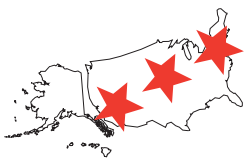
Strip mine land reclaimers in western Pennsylvania pay to have Philadelphia's treated sewage sludge trucked to old strip mines for use in land reclamation.

Washington State spreads its composted municipal sludge onto the forest revegetation sites. Special trucks can hurl the materials from the access roads several hundred feet deep into the forest.

Possible Markets

Agriculture — Organic farmers are large consumers of compost. They are in need of soil amendments, since they eschew chemical fertilizers.

In New York, California and the Mid-west, organic farmers are paying $15-20 per ton for composting materials to use in their operations.



Landscaping — A relatively high value use, but commercial and governmental customers can purchase a lot of volume, including AK DOT for roadside revegetation. On steep slopes the coarser materials work better for erosion control.

Retail sales — High value product, but producers have found the retail market is better for volume producers. Caution is urged for the small- or medium-sized composting operation, because of the high cost of bags and equipment, transportation etc. Retail sales can be good way for a medium-sized producer to establish a brand to then market to landscapers or other bulk buyers.

> *"Be on spec, on time. Be someone your customer wants to come back and do business with again, and again, and again."*

Tree nurseries, greenhouses or flower or vegetable start operations — are high value users. They may also require surprisingly high volumes, since they often market their soil with the plants they sell and have to replenish it every year.

Think about custom blends — a lot of compost producers find that their best and biggest customers are willing to pay extra for getting a product blended to their needs. People have been blending 1 part compost with 4 or 5 parts low nutrient, poor texture subsoil and producing a loamy, high nutrient topsoil mix that might go for 5 times what that subsoil went for without the compost.

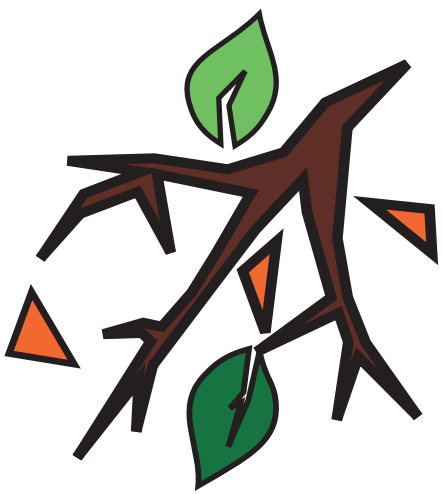
Be prepared to produce different products for different customers. While state standards are a good thing, be ready to work outside the standards if the customer decides they want something different — for instance, he wants his mulch at 1 inch or less, rather than the standard less than 2 inches.

Different customers may want different concentrations of nutrients, depending on what they are working on. Find out

what your customer needs.

Even particle size may matter to customers. Seedling growers would want a very small diameter product, where erosion control applications usually require a more porous material.

To please customers, be on spec, on time. Be someone your customer wants to come back and do business with again, and again, and again.



John Dean: Recycling for Profit — Environmental Recycling of Anchorage

Since 1993, John Dean has been forging real world solutions in the tough world of commercial recycling. Dean is owner of Environmental Recycling, a commercial firm operating near the Anchorage International Airport.

Environmental Recycling composts organic wastes, making a product meant to be mixed with poor quality or mineral soil to create a rich growing medium. The firm also recycles glass.

In 2000, for instance, Environmental Recycling collected 800 tons of Anchorage grass clippings otherwise bound for the municipal landfill. A collection firm offered customers weekly pickup of yard waste for $2 per month, and paid Dean's firm $10 per ton to take it.

However, in the summer of 2001, the local refuse company decided that even the $10 a ton (tipping fee) was too expensive and cancelled this possibly very beneficial program.

Environmental Recycling also charges a tipping fee for construction-generated and other wood waste being brought to Environmental Recycling's 2.5-acre facility. Contractors bringing Dean wood waste are charged $60 per ton. At the municipal landfill, the charge is only $45. So why do contractors bring their wood to Dean?

Because, he explains, the in-town transfer station requires the wood to be cut to 3 foot lengths and that can be time consuming. Driving all the way out to Anchorage's main landfill takes both time and gas. Dean accepts wood waste of larger sizes, cuts and grinds it to the sizes he needs and composts it.

A value-added service-oriented approach is what sets Environmental Recycling apart.

Such a value-added service-oriented approach is what sets Environmental Recycling apart. While many recycling efforts exist with solid government support, Dean's has to make it in the real world of commerce.

Overall, Environmental Recycling collects 3-4 thousand tons of wood, fish waste and

other waste materials annually. But with Anchorage's total compostable waste stream topping 75,000 tons, Dean points out that his company's needs are minuscule, and that the industry has plenty of room to expand.

Environmental Recycling operates on a 2.5 acre site, with 100,000 square feet of asphalt pads covered with a 60 mil plastic liner, with 4 inches of gravel on top and then asphalt on top of that.

Advertising, advertising and, oh yeah, advertising. That's the secret to selling your compost product, says Dean. He has tried advertising on radio and on public transit bus signs, before deciding that the most effective option for his business —albeit an expensive one — is on television.

Dean says he also makes a point of visiting commercial greenhouses, landscaping and lawn maintenance companies with samples of compost and information. Environmental Recycling sells compost to most of the lawn maintenance companies in and around Anchorage, Dean says.

For those interested in using compost at home, Dean teaches workshops both in home composting and in the proper use of commercially-produced compost. Despite instructions printed on the sacks, too many home gardeners wrongly assumed Dean's brand of compost was meant to be used full-strength. Dean tells his class that compost products like his are meant to be mixed with potting or other soil.

But Dean also "cultivates" a good number of compost consumers by teaching the classes.

"What I found was that people would compost in their back yard and then use their compost and like the results, they'd get good flowers and a nice lawn," Dean says. "But making compost in your backyard is a lot of work. So what happens is they were now familiar with composting and familiar with the results of using compost, so they buy it from me."

Dean notes that 150,000 sacks of potting soil and other garden products are imported into Anchorage annually — a sign of a healthy consumer base.

Dean says he sells compost from May through July, although he services landscapers and bulk buyers according to their schedules. Starting in June, he says, he starts to receive his compostable materials for the next year. This material is stockpiled, then composted in the nine months following and is ready to be sold the following May.

Al Poindexter: "Composting With Fish and Peat Wastes — A Business Perspective for Identifying Opportunities in Local Markets."

Al Poindexter is a busy man, between his Anchor Point Greenhouses and his work with the Homer Soil and Water District. A long-time resident of the Kenai Peninsula, Poindexter is a retired teacher for whom instructing would-be composters comes naturally.

Poindexter produces Fishy Peat, a potting soil mixed with compost that he says is far superior to the usual stuff. The secret of Fishy Peat, Poindexter says, is active microorganisms that help plants thrive —living rather than sterile soil.

"If you have the right combination and they colonize the plant roots, you don't need any fertilizer," he says. "The microbes create all the proper nutrients."

These days, Poindexter creates Fishy Peat from fish meal, seaweed and peat dug from muskegs, all naturally harvested in Alaska.

Poindexter said he started off using crab and raw fish waste in Fishy Peat, which resulted in a product even richer than what he sells today. At another time, he used herring, also with superior results. But he found it much easier — especially in terms of not attracting flies that could annoy neighbors — to do his composting in autumn and early winter. And he now uses less odorous fish meal, which can also be easily stored.

"The reason we use seaweed is for the micronutrients. There's just about every micronutrient a plant would ever want to use in the seaweed."

Fishy Peat Sails

Poindexter says he sends his pickup truck on the Alaska Marine Highway ferry to Kodiak, piled high with bags of Fishy Peat. The truck returns laden with bags of fish meal — enough to last Poindexter for the entire season.

In what has to be one of the more pleasant tasks in Alaskan agriculture, Poindexter says he drives his pickup truck slowly along the beach near his home at low tide. A helper walks alongside the truck, loading in seaweed with a pitchfork.

"The reason we use seaweed is for the micronutrients," Poindexter says. "There's just

about every micronutrient a plant would ever want to use in the seaweed."

Poindexter says he tries to harvest equal amounts of red, green and brown seaweed for their differing properties. He also adds some rock phosphorus, which the plants need.

As for Fishy Peat's "peat" component — Poindexter digs about 500 cubic yards from a muskeg bog a mile and a half from his home. He runs the peat through a shredder and adds a little lime. Then he wets down the material before use.

"Alaska has probably more peat supplies than Canada ever thought of having," Poindexter says. "We thought (making Fishy Peat) would be a neat way to utilize (the resource.)

And, Poindexter notes, wetlands laws do not come into play because state and federal environmental officials consider digging holes that fill with water to be enhancing the wetlands.

Poindexter warns commercial compost producers to test and measure their ingredients and the resulting compost carefully, in order to achieve consistency and reliability for their customers.

Loading Windrows

Poindexter says his first step is to form a long windrow of pure peat. The finished windrow will be about 30 feet long, six feet wide and four feet high.

Poindexter forms a trench in the windrow and adds a load of seaweed. He then adds fish or bone meal that has been soaked in water into a slurry-like consistency.

"Like Cream of Wheat, it swells up when it gets wet," Poindexter says.

The next addition is of rock phosphorus. He then covers the top with a layer of processed compost, and completes the windrow with more peat.

Poindexter insets long probes into the piles to stay apprised of temperatures — he does not want to let the piles rise above 140 degrees F., where beneficial microbes will start to die. But between 120 to 140 degrees F. only pathogens and weed seeds are killed. Poindexter turns the piles when they get too hot — sometimes four times a day at certain points in the process, he says.

Poindexter sets up the windrows in October and thus is done processing the compost by Christmas. The material is bagged, but allowed to cure until the following spring.

Poindexter produces about 25 cubic yards of compost a year, and adds value to the product by bagging the potting soil mix he has named Fishy Peat. Poindexter sells about 12,000 cubic feet of potting soil per year, about 9,000 of that on the Kenai Peninsula.

Customers must want a premium product, though. Poindexter says it costs about $3 for him to produce a bag of potting soil, which he then sells for $4. But big box department stores are selling potting soil imported into the state at $1.99 per bag, a feat that amazes him.

The Japanese, long respected for their appreciation of quality, were thrilled with an ad for Fishy Peat that appeared in a State of Alaska export catalog, but are not able to import biologically active substances into the country. Too bad, says Poindexter, for both the Japanese and Koreans were willing to buy vanloads of Fishy Peat.

And, Poindexter says he is constantly assailed by commercial fish processors and charter fishing firms looking to dispose of fish waste. Someday, Poindexter says, he will buy some kind of digester that can take raw fish waste and partially process the material into something that won't attract dogs, birds and, especially, flies.

He'll do that — right after he figures out how to employ more than 5,000 cubic yards of sawdust — a good carbon source to offset all that nitrogen from fish waste — sawdust Poindexter laments is "just sitting there."

Dr. Susan Thomas: Fungi and Compost

A spider does not "eat" a web-trapped fly the way we eat a tomato. Spiders inject their immobilized prey with enzymes that turn the fly's insides into fly juice. Which the spider then sucks out for food.

Fungi work the same way, says Dr. Susan Thomas of Battelle Marine Sciences Laboratory in Sequim, Washington. Dr. Thomas' expertise in fungal organisms is so deep, she declares herself to be "quite fond" of them.

Like our juice-drinking spider, fungi have the ability to digest things outside their body, by introducing enzymes into the environment. This permits fungi to break down things that bacteria and other organisms cannot — like lignin in wood, for instance.

The fungus' ability to break down lignin gives it great potential in composting wood and wood products, says Thomas.

"That's one of the main jobs of fungus in the world is to break down material," whether it's corpses or wood or whatever," she says matter-of-factly.

Cleaning with Fungi

"There are wood-degrading fungi," she continues. "Here is a big chunk of lignin, a complex molecule that is hard to break down. Nothing can get through it but fungus. Bacteria can't break it down, but a fungus can break the molecule into smaller pieces. And then bacteria and other fungi come in and break things down further."

Besides breaking down complex molecules, fungi also can change the pH of a substrate to suit itself, greatly affecting the presence and health of other members of the local plant and microbe — even insect — communities.

Because they digest outside their body, fungi can

> ***"That's one of the main jobs of fungus in the world is to break down material," whether it's corpses or wood or whatever."***

tolerate toxic material that would kill bacteria or other organisms, making fungi an excellent ally in bioremediation efforts, Thomas says.

"Bioremediation," says Thomas, "is defined as the application of mycelium and the enzymes, organic acids and solvents that the fungus produces to break down contaminants."

Fungal tolerance for high levels of salt makes applications in marine environments possible. Fungi also tolerate a wide range of temperatures and can sometimes can be seen growing adjacent to the snow line.

Much of Thomas' work deals with hydrocarbon contamination both in the marine environment and on land. But, she notes, fungi could be used to clean up toxic or hazardous materials on battlefield sites and to neutralize explosive residue.

Thomas says Battelle continually expands its collection of fungi, with more than 200 species now in active culture, including aquatic and marine species, as well as those that live on land.

Fungi and Wood

Those doing the composting of wood and fish wastes might benefit from the introduction of fungi into their process in several ways, Thomas says.

She explains that fungi could be used as a pre-composting step to break down lignin, which includes many benzene rings, reducing the woody fiber to smaller and smaller molecules that secondary organisms than digest further, until there is nothing left but carbon dioxide and water. Fungi could also be used to neutralize other toxins in, say, a load of contaminated wood: for example, wood that had been treated with creosote or pentachlorophenol.

Fungi also might be able to pretreat fish waste, Thomas says, but adds that she knows of no experiments conducted in that area.

Thomas says the bioremediation or pretreating of substrate can result in the production of a valuable cash crop — edible mushrooms for the U.S. and Asian markets and medicinal mushrooms for Asia. The only exception would be in cases in which metals are involved. The few, select fungi that are metal accumulators tend to concentrate mercury, cesium or other elemental metals in the fruiting bodies (mushrooms), making them unsafe to eat. However, these special fungi could used to test for the presence of such metals, and possibly to remediate metals-contaminated sites.

Thomas says fungal strains can be found and cultured that prefer certain substances, by making tests on small initial samples and then incrementally increasing the size of the contaminant concentration in the substrate on which the fungus grows.

She notes that it is possible to condition a fungus so that it actually prefers contaminants as a nutrient source.

"What we do is not genetic engineering," says Thomas, "but rather, we build on the natural biology of the organism."

Sci-Fungi

The science fiction world of fungus research includes organisms sophisticated enough to attract and trap tiny nematode worms, before injecting their victims with enzymes and invading their bodies with fast-growing fibers.

"The fungus grows very quickly, so fast that you can

watch it happen under a microscope," Thomas says. "The strands fill up the worm and the enzyme converts the worm into worm juices and drinks it up."

Thomas' experiments with petrochemical hydrocarbons also show the great ability of fungus to break down even difficult chemicals.

When faced with Bunker C oil, which can form into asphalt-like chunks, the first thing the fungus does is release a surfactant that liquifies the clumps.

"We did early work with hydrocarbons using gallon jars full of soil and wood chips, like a miniature compost pile," Thomas says, "Then we added Bunker C oil, diluted with a little bit of Number Two diesel oil. In eight weeks we ended up with a 97 percent reduction of polycyclic aromatic hydrocarbons, which are the most toxic and difficult fraction of oil contamination to remediate."

Scientists also got good results growing fungus on straw and using it to actively destroy fecal coliform bacteria out of a wastewater stream.

Thomas says she starts culturing a fungus in a petri dish. The fungus is then cut into pieces and mixed into sterilized grain in a gallon jar.

"They are all part of the same organism," Thomas says, "so the pieces recognize each other and they all grow back together again."

The now larger pieces of fungus in the gallon jar are then broken apart again and placed in a still larger container with sawdust or wood chips. The fungus grows out again in a week or two.

"Its not long," Thomas says, "until you have a truckload of material that you can use to inoculate a compost pile."

Thomas did warn however, that although many fungi are worldwide in their distribution, it is important to avoid introducing non-native fungal species to compost shipped to customers in different geographical locations.

But she reiterates that fungus can perform many useful functions in the pretreatment of wood for compost, bioremediation of contaminants and the production of valuable products. She says a wealth of information can be found in the many books published on fungi, or at websites such as the "big hairy index" of mycology (http://biodiversity.bio.uno.edu/~fungi/findex.html).

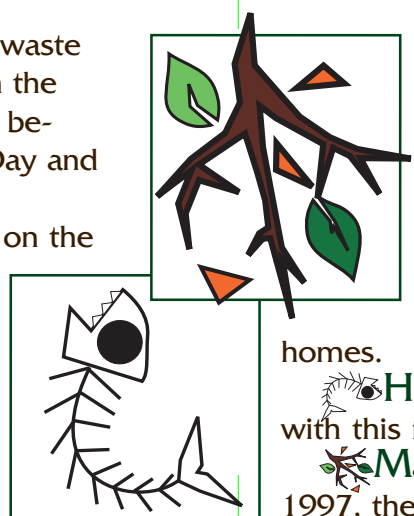
or www.fungi.com.

Deric Marcorelle: Alaska Compliance Issues Related to Wood Waste Composting

Through the late spring and early summer in Ninilchik, on the Kenai Peninsula, more than 400 customer-laden charter fishing boats head out on a normal sportfishing day. Each angler has paid dearly for the experience and is intent on catching the limit of fish.

If the fishers return triumphant, their fish are cleaned — generating a lot of fish waste. Think of the waste on one halibut. Now multiply by 500.

Deric Marcorelle, who works on compliance assistance and pollution prevention projects for the Alaska Department of Environmental Conservation, says one study showed 4,000 lbs/day of halibut waste being disposed on the Deep Creek beach between Memorial Day and the Fourth of July.



Elsewhere on the Peninsula, loggers working in the forests were generating thousands of tons of wood waste. Loggers trim off branches, tree tops and log butt ends as a matter of course. The normal load was compounded by a massive amount of timber felled as a result of the spruce bark beetle infestation.

All this wood was being burned, some days generating smoke so thick that highways were closed and people were forced from their homes.

Hence a need to deal with this fish and wood waste.

Marcorelle said that in 1997, the Alaska Science and Technology Foundation and ADEC teamed up to form the Compost Work Group.

The pulp mills and sawmills were closing down and there were a lot of people unemployed," he says. "The idea was to try and put some of these waste streams to good use and put these people to work."

After about two years' effort, the Compost group had some success. Marcorelle says the work group's influence could be traced from a wood-and-fish waste composting facility in Metlakata, in extreme southern Alaska, to helping ARCO compost their Prudhoe Bay kitchen waste and use it to revitalize gravel pads.

Thinking of starting up a commercial compost operation? Concerned about pollution from your home composting? Assistance from ADEC's Compliance Assistance Office, says Marcorelle, can be "non-enforcement" and "regulatory free" when a property or business owner needs advice on how to proceed with construction or remediation.

"Nothing gets reported to the EPA or other divisions," Marcorelle says, "It would just be between myself and the operator."

DEC strongly supports compost producers embracing some form of state standards, says Marcorelle, to prevent someone from just "mixing horse manure with gravel" and calling it compost.

A "certified" Alaska product would protect both compost producers from unscrupulous competitors and consumers from using a substandard product on their home gardens. Such certification could be established with a logo, similar to "Made in Alaska." The label could also disclose the particle size, moisture content, pH, or other properties of the compost, Marcorelle notes.

Marcorelle says facilities treating more than five tons of waste daily or 10 tons in any one batch require a permit. Permitting will cover such issues as property ownership; the long-term storage of materials; the use of fence and covers; animal controls and disease vectors; fire prevention; control of runoff; odor prevention and monitoring of the waste piles to prevent other pollution.

Alaska state composting standards and other important information can be found at www.uaf.edu/coop-ext, the Cooperative Extension's web site.

Jan W. Allen, P.E.: Composting Techniques Suitable for Wood and Fish Waste Systems – A Comparison of Aerated Static Piles vs. Windrow Systems.

You might not know it at first, but the state of Alaska has excellent potential in the composting industry, says a Seattle environmental consultant, who has worked with many of the major composters of the Pacific Northwest.

"In Alaska, you have the potential to do some incredible things in composting with the feedstocks you have," says Jan Allen, a senior technologist with CH2MHill in Seattle, one of the environmental engineering industry's leading firms. "Most of the country does not have feedstocks as clean and abundant as you have."

Namely, copious amounts of wood and fish waste in the 49th State.

In the final presentation before the 2001 Wood 'N Fish Composting conference, Allen described Alaska's bark, wood and fish combination as "synergistic" — the whole being more than the sum of the parts.

Good Roots

Absolutely vital to a successful composting system, Allen says, is to get the material being composted to be the right mix of density, moisture and porosity. He says that later problems often can be traced back to mistakes made at the beginning of the process.

"The most important parameters — density, moisture and porosity — are really closely related. ...chances are the carbon-nitrogen ratio and all your nutrients, ...[will] fall into place – If you get the first three right."

A proper working surface, appropriate to the type of composting method being used, with the right amendments added at the beginning of the process, is also vital.

"The most important parameters — density, moisture and porosity — are really closely related," he says. "If you get that right, chances are that the carbon-nitrogen ratio and all your nutrients, they're all going to fall

into place. If you get the first three right."

For a simple field test of those parameters, Allen recommends filling a five gallon bucket with compost, top off with water, and then measure the amount of water you can add to the sample. More water — more pounds of water in the bucket — means more porosity.

Allen says for further refinement, a sample could be sent to a testing lab, where the exact correlation between the rough bucket method and more refined measuring can be worked out.

Allen worked with a big facility in Seattle that measured the tons of compost yielded per batch as a way of monitoring the density, moisture and porosity factors. The facility ran well at 3,000 tons per batch. But when the weight of the batches went up to 4,500 tons per batch, those parameters collapsed. Allen said the facility has since lowered its target to 2,500 tons per batch or less, to improve efficiency even further and achieve a better ratio of density, moisture and porosity.

For operations using fish, Allen recommends using no more than 650 to 900 lbs. of feedstock per cubic yard — with fish being about 1/3 the weight of the mixed material to be composted. To go over 1,000 lbs. per cubic yard is to risk odor and other problems, Allen says.

Aerated Static Piles

There are three main types of composting systems. First is what Allen calls "Cadillac" or so-called "in-vessel" systems. The expense for these systems comes from the complex hoppers and other machinery needed to process and contain material until it is mostly composted.

Windrow systems are considered inexpensive — especially since they can be constructed on undeveloped ground.

A mid-range system both in terms of expense and control of the composting process is known as "aerated static piles." These are piles of material, like windrows, but with ventilation pipes buried in the base pad and/or placed throughout the pile itself.

These pipes allow air to be blown through or drawn from the pile as needed, to control aeration, temperature and odors. "Static" is partially a misnomer, since the piles are turned, although much less often than in conventional windrows. Overall, aerated static pile facilities are more compact that a windrow facility with similar capacities and they require less labor.

Allen says the aerated static pile system is seen as an excellent compromise for cost-conscious small- and mid-range businesses to consider.

He mentions a company in Oregon that sells kits for installing a ventilation system into aerated static piles. These kits come with piping, manifolds, fans, control systems, even a biofilter. The company offers a 10hp and 50hp model, with the 50hp model aerating 5,000 cubic yards of material and operating in either a positive or negative mode.

While a windrow system may take up to six months for processing, an aerated static pile can do its work in 4-9 weeks.

"This is the second generation of aerated technology," Allen says.

Odor Control

Allen stresses that many odor problems can be traced back to conditions of the

composting pad or the mix of materials. Yet, even when conditions are perfect, the composting process may produce some odors.

"It's dangerous to say you are going to have an odor-free facility," Allen says, noting that a $25 million "technologically extravagant" in-vessel system in Oregon still had odor problems.

In aerated static pile systems, a negative air feed can direct odors through a biofilter, reducing odors that could annoy neighbors.

"A lot of the work I get is troubled windrow facilities with odor problems with their surrounding communities," Allen says. "The trend is for many facilities to go to negative air for that reason."

Don't Be Fooled By Vendor Promises

Allen says that using chemical masking agents to control odors is merely treating the symptoms. The disease, he says, comes from problems with the initial mix — again, density, moisture and porosity. A good working surface is paramount. And the type or quality of amendments added to the mix can greatly affect the odors produced.

He says to beware claims made by some in-vessel system vendors that their systems can produce compost in 10-14 days. The material will still need a curing time of about 40 days before being salable, Allen says.

The need for grinders can be overstated, Allen cautions. Good-sized woody debris will degrade in a healthy composting pile. Allen mentions 17-foot deep composting piles in one Washington facility that could break down wood up to six-inches in diameter.

Screening is a good idea to control the materials in the mix, Allen says, and roofs may be a good investment as well. That is especially true in an aerated static pile system with a ventilated base pad, where a high percentage of the cost of the entire facility will be in building the pad.

To Market

The Fourth of July is a key date for commercial composters, as well as a holiday, marking the effective end of the retail buying season for compost products, Allen says. That makes composting a seasonal industry, like agriculture, he notes.

Composting may be carried out as a pollution preventer, a cost-avoidance measure and a product-making process. Compost can be produced as a high-volume product or a high-value product.

For a smoothly functioning system to continue to do so, it is important to keep careful records to improve quality and efficiency.

"But one of the good things about composting," Allen comforts, "is that no matter how many things you do wrong, it is a self-healing process."