Composting
FACTSHEET

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Ministry of Agriculture and Food

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MANAGING AGRICULTURAL COMPOSTING SYSTEMS

PRECOMPOST

Determination of Carbon/Nitrogen Ratio

During composting, almost all of the nutrients in the organic material can be utilized by microbes. However, the most important nutrient balance is the ratio of carbon to nitrogen (C:N). Too much carbon compared to nitrogen (high C:N ratio) will slow down the composting process excessively. Too much nitrogen compared to carbon (low C:N ratio) will lead to higher ammonia emissions and odour problems. An efficient composting process must have ingredients in the proper C:N ratio. The optimum ratio is a function of the nature of the composting materials, i.e., the availability of the nutrients, particularly the carbonaceous components. A C:N ratio of about **25** to **30:1** (25 to 30 parts carbon to 1 part of nitrogen) has been shown to be optimum for most types of wastes. If woody bulking agents are used for composting, a C:N ratio of **35** to **40:1** may be used due to the low availability of carbon.

Selection of Bulking Agents

Bulking agents play two roles in composting:

- they provide an extra carbon source to increase the carbon to nitrogen ratio; and
- they increase the porosity of the composting material which improves air movement.

When selecting bulking agents consider the following:

1. **Economics:** Costs of materials should be assessed, including shipping and processing (sorting, grinding, etc.).

2. **Particle Size:** Particles should be 2 to 10 mm (0.08 to 0.40 in), in length, and fairly uniform.

3. **Availability of Carbon:** If a bulking agent is to be used to adjust the C:N ratio, the availability of carbon in the agent should be considered. Not all the carbon will be immediately available for the microbes to consume. Some woody materials, such as wood chips, are hard to break down, and more bulking agent may be required to compensate for this.

4. **Environment:** Some of the bulking agents being used today may contain toxic substances. For example, sawdust from treated wood and ground paper can contain various pollutants. These materials should not be used as bulking agents.

5. **Permits:** Non-agricultural wastes used as bulking agents may require a waste management permit from the Ministry of Environment, before they can be used on a farm.

Bulking agents currently available are:

- sawdust;
- woodchips;
- straw; and
- shredded or ground paper.

Large particles remaining after sawdust and woodchips are composted can be recycled after screening.

Grinding

If composting materials contain particles larger than 10 mm (0.40 in) in length, and constitute a large portion of the total volume, grinding will be required to mechanically reduce the pieces to 2 to 10 mm (0.08 to 0.40 in) in order to increase the efficiency of composting.

Weighing and Mixing

After weighing different composting materials, as explained in Blending Materials for the Compost Process, Factsheet No. 382.500-4, the composting materials should be mixed thoroughly by using either a front-end loader, a solid manure spreader, a compost turner or a specially-designed mixer. A sorting machine, such as a rotating screen belt may be used to separate the inerts from the biodegradable materials. When using agricultural wastes alone, these machines are not usually necessary. They may be needed if any bulking agents added contain inerts. Sorting and grinding equipment are all commercially available.

If a front-end loader is to be used for mixing, it is easier to form the windrow in layers. The windrows should then be turned two to four times. A specially-designed compost turner will provide far better mixing and aeration than a front-end loader, and save labour at the same time.

COMPOSTING PROCESS CONTROL

Dimension of Windrow/Pile

Windrow size depends on the turning method chosen. Small windrows are typically 3 to 3.6 m (10 to 12 ft) wide at the bottom with heights to 1.5 m (5 ft). Large windrows are typically 5.4 to 6.6 m (18 to 22 ft) wide at the bottom with heights to 2.1 m (7 ft) and up to 2.1 m (7 ft) wide at the top. See Site Selection for Composting, Factsheet No. 382.500-6 for information on a suggested layout of a composting facility.

Control of Moisture and Aeration

Moisture content and aeration are two critical interdependent factors in composting. The lower limit of moisture content in composting is normally about 45 to 50%. If the composting material is too dry, biological activity will be slow. The upper limit of the moisture content is largely a function of the nature of the composting materials. If the composting materials are porous as is the case for example, in hog manure mixed with sawdust, the upper limit of moisture content may be as high as 70%; if the compost cannot maintain well-defined pores within its mass, as is the case in for example, chicken layer manure mixed with shredded paper, the upper limit of moisture content should not be over 60%. If the materials are too wet, anaerobic conditions will dominate the composting process, slowing decomposition and generating foul odours.

Determination of moisture content can be made easily by using the following steps:

1. Weigh an empty container
2. Weigh the container with the compost sample in it
3. Dry the sample in an oven at 105ºC (220ºF) for six to eight hours
4. Weigh the container with the dried sample in it
5. Subtract the container weight (1) from both the wet (2) and dry (4) weights to obtain sample weights
6. Use the following equation to determine the moisture content of the sample

$$\text{Moisture Content} = \frac{(\text{Weight of Wet Sample} - \text{Weight of Dry Sample}) \times 100\%}{\text{Weight of Wet Sample}}$$

In the field, the “squeeze test” will give an indecations of wetness. When the moisture content is about 60%, the material should feel damp to the touch, with just a drop or two of liquid expelled when the material is tightly squeezed in the hand, as shown in Figure 1.

When the composted materials are too wet (above the upper limit), windrows and piles should be turned more frequently. An alternative is to add drier material, such as dry compost or bulking agent, to absorb extra moisture. If the composting materials are too dry (below 45%), water should be added during turning or mixing until a suitable moisture level is achieved. Overwatering should be avoided.

Air requirement is determined by the nature of the composting materials and the stage of the composting process. Aeration also provides a means of cooling down the composting material when overheated. Air requirements can roughly be assessed by observing the colour and smell of the compost. Under the following conditions, more air is needed:

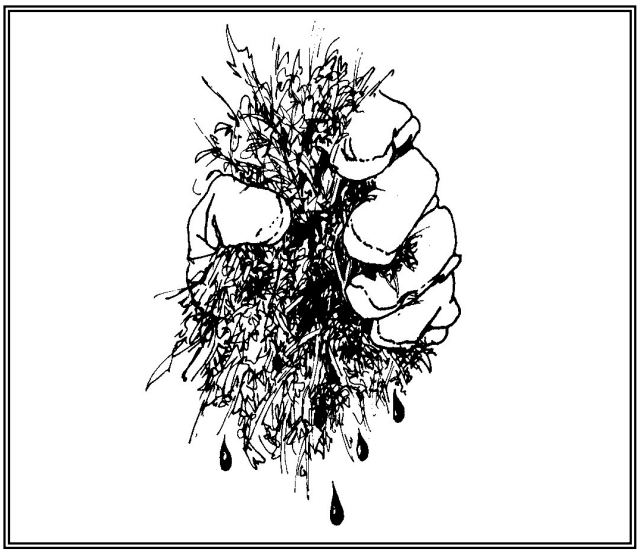

Figure 1 The Squeeze Test

1. There is an objectionable odour from the windrow;
2. Colour is lighter in the inner section of the windrow; and
3. The composted materials are too wet.

During the first two weeks the windrows/piles, should be turned every second day, if the temperature remains between 35º and 60ºC (95º and 140ºF). For the next two weeks (weeks 3 and 4), turn the windrows/piles twice a week. For the third two weeks (weeks 5 and 6), turn the windrows/piles should be turned once a week. Following these six weeks and until the process is complete, the composted materials should be turned once a month. Maturity will typically be achieved in a minimum of three months.

Temperature

Temperature needs to be monitored consistently during composting. The ideal temperature range for microbes to flourish is between 35º and 55ºC (95º and 130ºF). Temperatures over 60ºC (140ºF) will slow down the microbial activity and hence the composting process. However, for a significant reduction of weeds and pathogens, maintaining temperatures of over 55ºC (130ºF) is required for at least three days. Temperatures over 70ºC (170ºF) should be avoided by aeration or turning. Temperatures over 55ºC (130ºF) will usually be reached after two to six days of composting.

Daily reading of temperatures should be taken for the first four weeks; if temperatures move close to 60ºC (140ºF), more frequent readings are suggested to check for overheating. After composting for four to six weeks, less frequent readings of once or twice a week may be taken.

Odour

Eliminating odours completely during composting is not possible. However, odour can be minimized by following basic procedures. After five to six days of composting under favourable conditions, the composting materials begins to acquire a faintly earthy odour, indicating a healthy process. This earthy non-objectable odour becomes more pronounced as time progresses. Objectionable odours may appear under the following conditions:

1. Inadequate aeration, allowing anaerobic digestion to take place. **Solution:** Aerate the composting materials more frequently.
2. A low C:N ratio. **Solution:** Adjust the C:N ratio by adding more carbonaceous materials.
3. Wet composting materials. **Solution:** Aerate more or add dry materials to absorb the excess moisture.

Runoff and Leachate

If composting is in an uncovered area, all runoff must to be collected. This runoff can be reused in the composting system. In order to control and manage runoff, composting should be done on a hard surface such as concrete. No runoff may be discharged without a permit from the B.C. Ministry of Environment, Lands and Parks. Leachate is not likely to form if the process is controlled properly from the beginning. If leachate appears, it should be collected and pumped back to the windrows or piles during turning. See Site Selection for Composting, Factsheet No. 382.500-6, for an example sizing of a runoff and leachate holding pond.

Maturity and Quality Control

Although there is no fixed standard for compost maturity or quality, the CAN/BNQ 0413-200 National Standard of Canada: Organic Soil Conditioner - Composts, does provide a voluntary standard to the composting industry. Part of the standard are on the next page.

Additional parameters such as nutrient value, (ie nitrogen (N), phosphorus (P), and potassium (K)), cation exchange capacity, pH, soluble salt (E.C.) and particle size could be considered. In practice, the following method may apply to measure the maturity of compost.

After three months of composting and curing, collect about one to three cubic metres of compost from different locations of the windrow (close to the surface and deep inside), thoroughly mix the compost and

adjust the moisture content to about 50%, and pile the conditioned compost up, providing air. If there is no more than a 5ºC, (10ºF) rise or drop, the compost may have reached its maturity. If the temperature rises more than 5ºC, a longer curing time is required.

The final composted material should have the following physical and odour qualities: unrecognizable original materials; dark brown to black; foreign matter/materials less than 1%; relatively porous, not compacted or hard; and no objectionable odours, but an 'earthy' smell.

See Using Compost, Factsheet, No. 382.500-15 for more information on using compost.

POSTCOMPOST

At this stage, compost has completely stabilized and characterized by the qualities described above. The compost is ready to market or use on farm.

Screening

If screening and grinding are not completed before composting, and the final product contains inerts such as plastic, glass, metal, gravels or big chunks of bulking agents, these produces should be screened out before marketing.

Drying or Watering

The final moisture content of the compost should be adjusted to about 50% by either drying or watering. Water in the final product should be evenly distributed by complete mixing.

The CAN/BNQ 0413-200 National Standard

Characteristic	Standard (Type A values shown as example)
Moisture Content:	not greater than 60% (as received)
Total Organic Matter Content:	not less than 40% (% of oven dried mass)
Foreign Matter Content:	≤ 0.5% (oven dried) with maximum diameter 12.5 mm
Maturity:	based on meeting two of three requirements: (C/N ratio ≤ 25, or Oxygen uptake ≤ 150 kilogram oxygen per kilogram of volitile solids per hour, or Germination rate for cress or radish seeds in compost of at least 90% of germination rate of control and plant growth in compost-soil mix shall not differ by more than 50% in comparision to the control sample).

Trace Element Content: (maximum)

Trace Element	Concentration mg/kg (air-dried)
As	13
Cd	3
Co	34
Cr	210
Cu	100
Hg	0.8
Mo	5
Ni	62
Pb	150
Se	2
Zn	500

Faecal Coliform Content:	< 1000 MPM/ g of total solids (oven dried mass)
Salmonella Content:	No salmonella present in compost

This is one of a series of Factsheets on Composting. A list of references used in producing this series is included in the Composting Factsheet "Suggested Reading and References."

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