

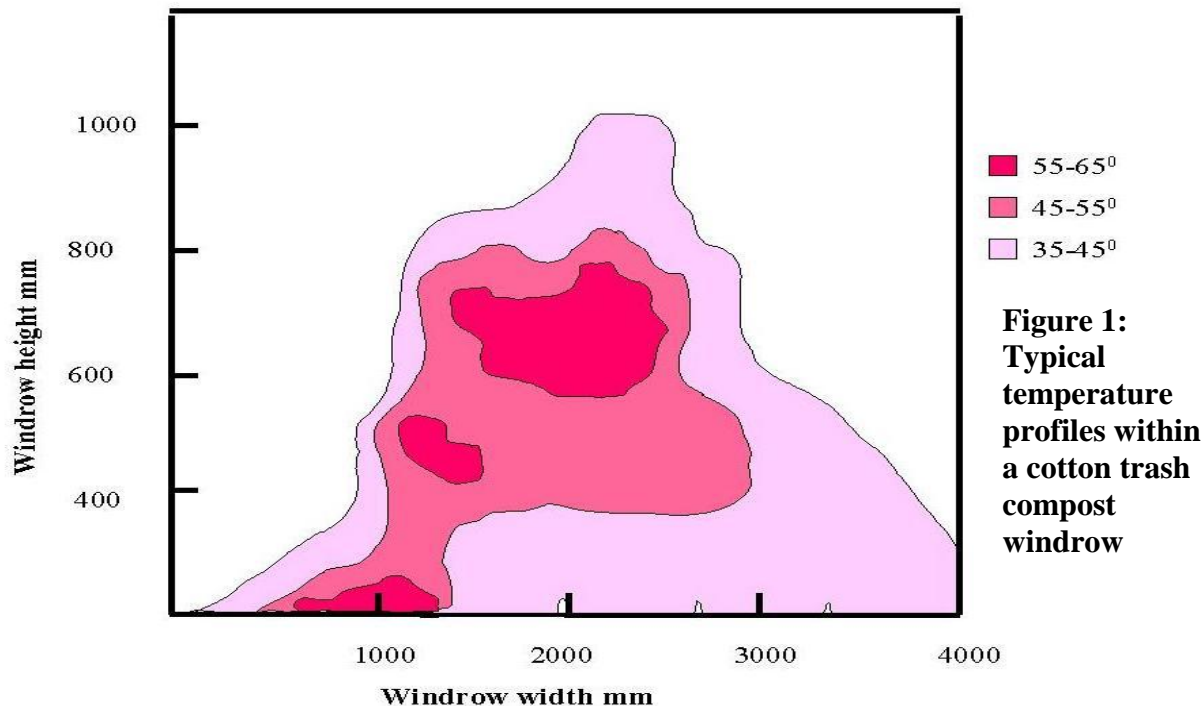
# MAXIMISING LOW-TECH. COTTON TRASH COMPOSTING FOR ON-FARM USE



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**Figure 1:** Typical temperature profiles within a cotton trash compost windrow

## DEFINING THE COMPOSTING PROCESS

Composting is the microbial breakdown of organic carbon into the more **biologically stable** humus compounds (**humic** and **fulvic acids**), carbon dioxide and water. The proportion of small water-filled pores and larger air-filled pores in the compost mix will determine the growth potential of the microbes. The height and width of the windrow will determine the temperature profile within the compost mass. To produce a quality compost the bulk density of the mix, water content and the dimensions of the windrow should be managed to maintain **the core temperature between 50-65°C**, for at least three weeks (**figure 1**). During this time, the windrow should be turned at least 3 times to ensure that all components of the mix have passed through the centrally heated core.

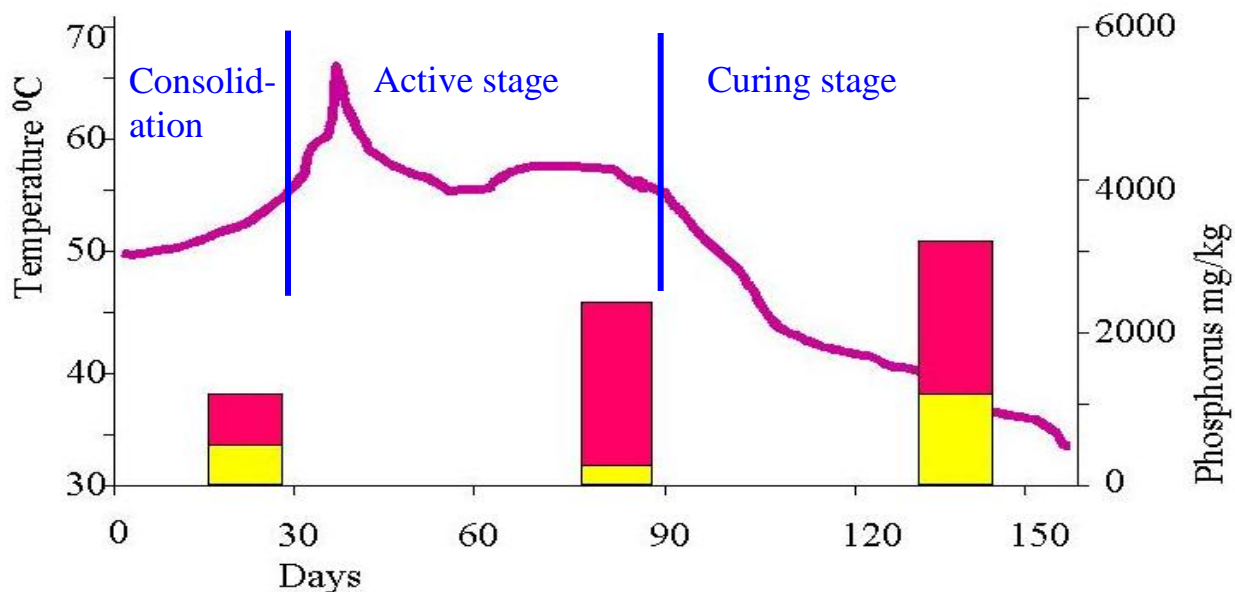
Ideally a **mature** compost should contain about 50% of the total phosphorus (P) content in the **mineral** (plant-available) form. **Immature** composts will not only have most of the nitrogen (N) and P locked up in the organic form, but microbes may still be sufficiently active to induce **nutrient draw-down** if the compost is added to a cropping soil. The effect on the crop will be symptoms of nitrogen and phosphorus deficiency.

## WHY COMPOST COTTON TRASH?

Cotton trash may contain **weed seeds** and **fungal pathogens**, in addition to the desirable materials organic carbon, N, P and potassium (K). In our trials exposing trash infested with fusarium wilt to temperatures within a windrow of above 50°C for 14 days, reduced pathogen survival to undetectable levels. Exposing weed seeds to temperatures within the preferred range of 50-65°C is also effective at killing all but the most hard-seeded species. Composting is also accepted as one of the best methods for breaking down **chemical residues** such as herbicides and insecticides.

Composting cotton trash not only maintains **farm hygiene**, but provides an organic carbon resource rich in humus and other biologically stable carbon fractions to improve the **fertility** and **structure** of your cropping soil. Gypsum is often recommended in soils where organic carbon is low, but the addition of a compost instead will not only improve the **physical** nature of the soil but also its **chemical** (fertility) and **biological** (pest and disease control) activity.

A quality compost can offset inputs of phosphorus and potassium fertiliser in the first crop, providing a **slow-release** store of nitrogen and phosphorus for future crops. Cotton is moderately dependent on **mycorrhizae**, and **slow-release P** improves root colonisation by these beneficial fungi. The **soil health** benefits of a mature compost also relate to changes in the microbial population. Increasing the diversity and amount of organic carbon in a soil increases the **microbial diversity**, at the expense of soil-borne pathogens. A compost maintained within the preferred range of 50-65°C is better still (**figure 2**), because the temperature selectively enhances the population of bacteria known to be **antagonistic to pathogens** such as fusarium and verticillium. Much over 65°C and these bacteria are killed off too, increasing the potential for less desirable species to recolonise when the compost cools!



**Figure 2: Temperature changes over time in a cotton trash windrow, describing the three stages of composting, Consolidation, Active and Curing. The bars show changes in the total phosphorus concentration over the three stages, with mineral P (available) in yellow, and organic P (slow-release) in red. Windrows were turned only once every 5 weeks.**

## MANAGING THE COMPOSTING PROCESS

**Windrow** composting is the least capital-intensive method, requiring a front-end loader or bobcat for turning the pile. Construct a compacted earthen pad, with bunding or a spoon drain to divert overland flow away from the composting site. Any water leaching from the pile should be contained in a pond. Construct a windrow about **1.5 m high, 3-4 m wide at the base and 0.5-1 m wide at the top**. Layer alternating portions of ingredients in the windrow, leaving enough space in between piles for turning (ie layer 2 buckets of trash with one bucket of **manure** on top –see later section on value of manure to a compost). Turn the pile once before watering, to mix the feedstock (mixing is better using a back-hoe bucket instead of the front end bucket).

The selection of compatible ingredients for co-composting is essential to achieve both good **aeration** and good **water retention** in the pile. Cotton trash alone will adequately compost, once the initial water repellance is overcome. Wetting with a soaker hose placed on the top of the windrow, watering over night when evaporation and drift is minimal, is effective. However if water is to be jetted in, a wetting agent may be necessary to overcome the water repellance. The compost windrow should be watered to **field capacity** and no further. At **field capacity**, a hand-full of the mixture should hold water without dripping, but drips should fall once the mixture is squeezed. Avoid excess watering as puddling will occur at the base of the windrow, leaching out valuable nutrients and causing bad odours! If this happens, turning the pile will redistribute the sodden portions and will restore good passive aeration.

## MONITORING THE COMPOSTING PROCESS

Monitor the composting process by using a **temperature probe** (stem 0.5-1.0m long, should cost around \$300 from scientific equipment suppliers). During the **Consolidation phase**, temperatures may remain below 50<sup>0</sup>C for a week or so (**figure 2**). However once the water content is at **field capacity** and if **passive aeration** is sufficient, temperatures will increase as the microbes acclimatise and grow. Monitoring temperatures **before** and **after** watering is the best indicator of compost maturity. A rise in temperature after watering indicates that water had become limiting, and that there is still sufficient available organic carbon to fuel microbial growth. Turn the windrows (ensuring that the **outside** of the pile is turned **inside**) about **every 2 weeks**. Turning the pile more frequently may be necessary if the internal windrow temperature regularly exceeds 65<sup>0</sup>C. Turning more frequently also accelerates the maturation process.

Alternatively, lowering the height of the pile (reducing the **bulk density**) may improve the heat transfer, to maintain temperatures within the preferred range (50-65<sup>0</sup>C). To maximise the **disinfection process**, turn the windrows **at least 3 times** during the Active stage, to ensure that as much of the feedstock as possible passes through the heated core. A compost is **mature** when water is adequate, but the temperature remains below 50<sup>0</sup>C (readily available organic carbon used up). Continue the composting process beyond the point of maturity, to ensure that about 50% of the P is plant-available (**figure 2**). In our trials this occurred 10 weeks **after** the temperature dropped (**figure 2**). More frequent turning accelerates this process. Reduce the frequency of watering over the **curing phase**, to reduce the water content for cartage and spreading (25-30%, upper limit to reduce dust generation). Screening the compost before use will exclude large contaminants which may damage tillage equipment, and will improve the accuracy of spreading.

## MAKING THE MOST OF COTTON TRASH COMPOST

Cotton trash alone will adequately compost, but the addition of **animal manure** will increase the temperature (greater bulk density, greater water holding capacity), and the nutrient content (N, P, K and Ca) of the compost. In our trials adding 1 part feedlot manure to 2 parts (by volume) cotton trash increased the total P content at the **curing stage** from 3,116 mg/kg to 4,984 mg/kg (dry-weight basis). The composting process reduces the water content and particle size, improves the friability and uniformity of the manure and trash, making it much easier to spread **more accurately**. The high **calcium** and **magnesium** content of manure plus the high **cation exchange capacity** of a mature compost (**humic** and **fulvic acids**) can also offset the need for **gypsum application**, by reducing the **sodium adsorption ratio** of a soil. Adding animal manure to the mix (feedstock) also increases the trace element content of a compost (**Table 1**).

	Trace element content of fresh manures (cow, horse, pig, poultry, sheep)					
	mg/kg dry-matter basis					
	boron	manganese	cobalt	copper	zinc	molybdenum
minimum	4.5	75.0	.025	7.6	43.0	0.84
maximum	52.0	549.0	4.70	40.8	247.0	4.18
average	20.2	201.1	1.04	15.6	96.2	2.06

**Table 1: Trace element content of a range of fresh farmyard manures. Adapted from T. McCalla (1974) Journal of Soil and Water Conservation 29: 213-16.**

Measure the nutrient value of a compost during the **curing** phase, well **after** the drop in temperature, when more of the P (aim for **50%**) is in the **Available** form. Chemical tests on **Total and Available** N and P will be necessary, on soil samples dried at **below 60°C** (higher temperature reduces the N content). **Available (mineral) N** in a mature compost will be predominantly in the **nitrate** form (Nox test), with **Total N** (Kjehldal N test) both the mineral and organic fractions. Ask the laboratory to measure **available P** by the Colwell (or bicarbonate-extractable) test, and **Total P** by fusion or x-ray fluorescence. Subtracting the **available** value from the **total value** will indicate how much of the nutrients will become available over time (**slow-release** organic form). P mineralises much more quickly than N, because plant and microbial requirements for P are about a third that of animals (ie only animals have bones!). The K content of both plants and animals is held in cell fluids, and is therefore readily lost from dying cells. Accordingly request a **total K** analysis only, and assume that 80-90% of this will be immediately **available** (mineral form) for plant growth.

Determine the maximum application rate on the **early crop growth** need for K (80% total), **and/or P (available P value)**. In our experience the bulk of the N remains in the organic (**slow-release**) form, becoming available over time for **subsequent** crops. Hence expect to use urea or other conventional forms of N fertiliser with the first application of a **mature** compost, but adjust **future** crop requirements on the basis of **soil tests** for both available N (Nox test) and available P (bicarbonate extraction).

Follow these recommendations to make the most of the **super P** and **muriate of potash replacement value** of your compost. Excessive accumulations of N and P (which may lead to uncontrolled crop growth flushes) can be avoided, by applying a **mature** compost with about **50% of the P available**, and by adjusting future crop fertiliser NPK requirements on the basis of **soil tests** before the next planting.