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Composting for the Tropics

by: Henry Doubleday Research Association

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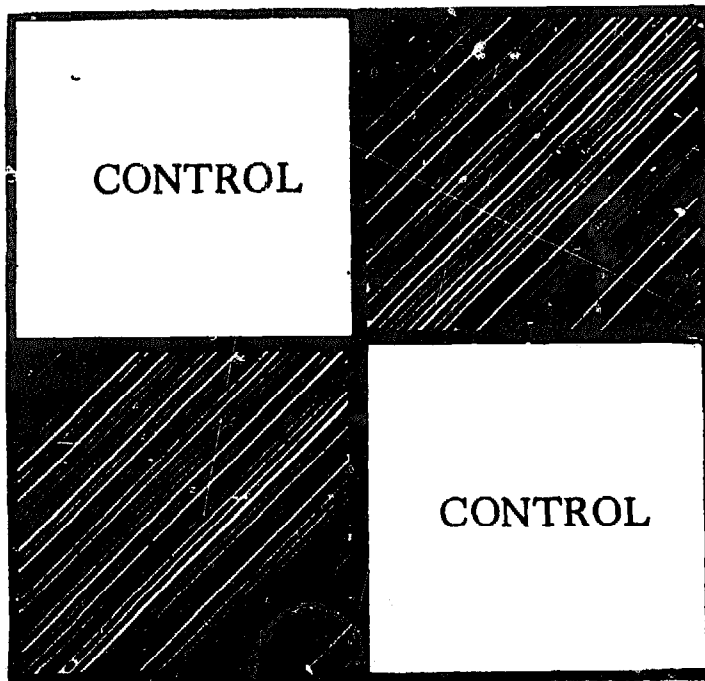
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COMPOSTING FOR THE TROPICS

Written from the experience of our
Overseas Members for the gardeners
and farmers of all hot countries.

MARCH 1963



Price to Non-Members 2/6d

**HENRY DOUBLEDAY RESEARCH ASSOCIATION
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ENGLAND.**

Hon. Secretary: Lawrence D. Hills

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INTRODUCTION

The problem of tropical agriculture is the speed with which humus breaks down in the soil, from the greater heat hastening the decay, the air drawn down to replace evaporated water, and the replacement of earthworms by white ants, in many countries. Another is the time that it takes for knowledge of scientific agriculture won in temperate climates to adapt itself to entirely different conditions.

This booklet is written by three men with long experience of Africa, and edited by a fourth - Mr. V.L. Leroux, formerly of the Belgian Congo. All are successful market gardeners and farmers, writing of what they have found to work in practice, so that others can try both in Africa and in other countries with nearly the same climate.

In Britain a 20 ton an acre dressing of farmyard manure will show an effect on the crop even 20 years later, but in the tropics humus is gone in at most three years, and the land can set like cement. Humus as well as plant foods is a necessity for crops, and in the tropics it is still more necessary to hold some moisture in the soil, than on the "hungriest" sand in Britain.

The most lasting part of humus is in the lignins, which are present with celluloses and hemicelluloses in the woody parts of all plants. With them are proteins and carbohydrates which are not only food for men and stock (grazing animals can digest cellulose and some of the other two) but fuel for the quickly heating amateur gardens compost heap of Britain, the U.S.A. and temperate climates.

These are widely made in the tropics, but the three farmers whose experiences follow are all using sawdust or shavings, for maximum lignins to give the greatest humus value in their soils.

Cedar sawdust contains 28.21% lignins, alfalfa 10.78, maize stalks 11.28%, rye straw 14.63, and there is no point in composting what can be fed to stock at a profit, when sawdust is available and better value in lasting humus for the land, if only it can be used.

In temperate climates much has been written on sawdust mulching on the surface, but digging or ploughing it in means a disastrous fall in crop. It decays slowly and the bacteria that rot it take up the available nitrogen in competition with the crop, producing the "nitrogen robbery" that can last years after sawdust has been turned under.

Sawdust is 500 parts of carbon to one of nitrogen, even rotted cocoa brown it has a 208-1 carbon-nitrogen ratio, or "C-N ratio" which is used by composters to measure when what they have made is safe to dig in without this nitrogen robbery. It is determined by the Black and Walkley Test which can be done by any good agricultural analyst. In addition to compost this applies to green manure, and if stemmy mustard at 26-1 is dug in, this takes up nitrogen for its decay, when it is safe turned in smaller before woody material forms.

Farmyard manure is 14-1, good compost near 10-1, and these are the accepted safe limits, safe that is from the nitrogen robbery, which comes from digging in raw organic matter that is readily decayed.

Lignins, however, are not readily decayed, and extensive work by the United States Forestry department and State Experimental Stations (see Bulletin No. 32 "Wood Products for Fertiliser" North Eastern Wood Utilisation Council, P.O. Box 1577, New Haven 6, Conn. U.S.A.) has shown that this fraction of the humus does not reduce soil nitrogen. A simple Black and Walkley test measures all compounds containing carbon, but where sawdust is the material, one that excludes the lignins is desirable.

Tests on Mr. Leroux's garden in Surrey, where sawdust mulching has been used for many years, explain his results (and those of many others who use this cultivation method by keeping the sawdust on the surface) show 11-1 C-N Ratio for the top twelve inches from worms taking the decayed sawdust down, which is 2-1 with lignins excluded.

So the 40-1 ratio compost made by Major Beadnell, and the 67-1 from Mr. Shepperson are both safe, divide the carbon by 5.5, and the result is the effect in practice. In theory, of course, adding enough nitrogen fertilizer to correct the difference between

the ratio of the material and finished compost is enough. In practice even in a temperate climate the rain will wash it out before the sawdust decays, while in Africa the cost would be the least of the complications.

The Beadnell system is an efficient method of composting sawdust to build up humus, not only for fertility and moisture retaining but to support the predatory soil fungi that trap eel-worms (see "The Friendly Fungi", by Dr. C.L. Duddington, Faber & Faber, 21/-) and are one of the reasons why a forest can grow for thousands of years in the same place, when monoculture of any crop plant is asking for trouble in all countries.

His problem is root-knot eelworm, *Meloidogyne*, which builds up rapidly in soils where humus has been destroyed by native agriculture. Burning the forest and moving on is the easiest primitive system, but it gives merely a concentrated dressing mostly of potassium with other minerals in forms quickly washed from the soil, and nitrogen released by warming the surface soil, as from burning the veldt. The long recovery period does not matter with unlimited land, but removing the checks of tribal warfare and disease, or restricting the land to reservations makes it impossibly wasteful of resources.

The Shepperson method is a kind of "deeplitter cattle" system, using only as much water as they would normally drink. Here the enemy is the Termite, and the Shepperson discovery that the oil of Eucalyptus in Blue Gum (*E. globulus*) will keep these creatures from destroying humus until it has had time for crops to benefit from it, is of very great value in all countries with white ant problems.

The earthworm of temperate climates is a soil improver, grinding soil particles for better mineral release and top dressing the pastures of Europe that have fed settled civilisations for more than two thousand years. The 10-1 ratio of most fertile soils provides the "power" from the breakdown of that carbon that drives not only the soil bacteria and fungi, but the worms. The white ant takes too much power, and leaves too little behind to build fertility. Experimental work in India on better breeds of earthworm for tropical countries depends on keeping enough carbon compounds in the soil to fuel them for their journeys down to the subsoil and up again. With time enough worms can move soil in greater tonnage than a bulldozer, but this takes almost as many foot pounds of energy to displace by worm power, and like the bulldozer, they need fuel in their "tanks". No soil can live on chemicals alone, only a hydroponic tank, with labour and machines to do the jobs that

good farming gets done unpaid.

It will be noted that Mr. Shepperson failed with Myco, which is a culture of bacteria and fungi used by amateur gardeners very widely in temperate climates and on farms. This is not an effective sawdust breaker anywhere, and it failed to start this difficult decay. The local bacteria and fungi are more suited to the climate. Major Beadnell used "Q.R." effectively, which use these like what are called the Bio-Dynamic activators, such as "B.D. Compost Starter" well known in Britain and the United States. These are relatively cheap and there is value in using them, but it is important to make sure they are the type that uses local microscopic livestock.

The Chingola Poultry system employs the same bacteria as Mr. Shepperson, but it has the immense advantages of paying for all its costs in the profit of the birds, and taking least labour of the three. In Australia, or where native labour was less cheap than in Nyasaland, the Shepperson process could be mechanised more highly, and those who read these accounts of what British farmers in Africa have done and found to pay on try first by hand on a small scale and then see how it can be modified to suit local conditions.

It should be stressed that this booklet applies to Africa, the swift heating up to 160-180°F is hard to achieve without the hastening of chemical and bacterial action by heat. These temperatures for weeks are over the killing heat for all human parasite worms, including Hookworm, and the organism responsible for Amoebic Dysentery, and there is scope for work to modify the methods for composting nightsoil, where wastes of high fuel value are available.

In theory this booklet should fit Australia, Central and South America, Indonesia, India, the Arab countries, the Canary Island, the Pacific Islands and the West Indies. Whether this is true in practice depends on the willingness of farmers, plantation and even sawmill owners to try something new out of Africa, which should work and show profit.

What is certain is that they risk little by trying, for all the materials required are available in almost every country, and no skills other than normal good husbandry in any country are needed. There is also nothing to patent or sell in the knowledge which is given freely by those who found it.

Lawrence D. Hills, F.R.H.S.
Hon. Secretary and Director
Henry Doubleday Research Association.

SAWDUST COMPOSTING IN KENYA

by Major L. C. Beadnell

When Major Beadnell bought a 30 acre smallholding near Nairobi in 1957 he found the land in poor condition and heavily infested with nematodes. He had to contend not only with a hot climate but with rain amounting to 26" during November followed by as much in December. Fortunately his land though having a high proportion of clay, drains very easily.

Being near a sawmill he can obtain quantities of sawdust, whilst a river supplies him with abundant sedge grass.

His crops now include tomatoes, potatoes, Cambridge favourite strawberries and mushrooms, but before anything could be grown successfully the soil's fertility had to be raised and the nematodes mainly Meliodogyne, the root-knot eelworm, controlled.

He has aimed at making large quantities of compost incorporating sawdust for three reasons. The first is that the sawdust will keep the soil cool, a most important factor as humus is rapidly destroyed at over 80°F.

The second reason is to increase the nitrogen in his compost. This at first sight seems incredible as sawdust is almost pure carbohydrate with 400 times as much C. as N. but he points out that sawdust is a food for nitrogen fixing organisms (see later re mushrooms). The third reason is that Dr. Hollis, the U.S.A. nematologist definitely thinks that African forest leaf mould contains predatory eelworms and fungi which controls harmful eelworms.

COMPOST MAKING

After making trials the following method of making general use compost has been evolved (see later for mushroom compost).

His equipment consists of containers having lids, 45 gallon drums split lengthwise and a bin having one fixed end (probably the usual size 5ft. high by 10 ft. deep) and a long fixed back. There is a second side, movable, which is shifted along as the heap gets longer.

1. Fresh manure - chicken, cow or horse etc., are placed in separate containers and sprinkled with a few drops of Q.R. on every 3" layer, and left to mature for a fortnight with a lid to keep out rain.

2. Half drums are then assembled into which are placed two trowelful of matured manure after these have been well mixed with water in a small tin. The main quantity of water is then added.
3. A sack of sawdust (15-20 gallons) is then added till all the slurry is absorbed. The sawdust should become crumbly and not so soggy that it will not crumble.
4. The treated sawdust is then heaped into conical piles ready for mixing with other materials.
5. Green materials, grass, weeds, *Tagetes minuta* (Mexican Marigold, "Khakibos" in Afrikaans, as eelworm immune plant) etc., are chopped up with a "panga" or rotoscythe and then dipped into fresh made slurry. Large forkfuls are then lifted out, the surplus liquid allowed to drain back into the drum and the wetted material placed on the mixing site. When the level of liquid manure falls, plain water is added to replenish it, but when this diluted slurry is used the drum has to be recharged with fresh made liquid. Thus each charge does two batches of material.
6. As each large forkful of treated material is placed on the mixing site a shovelful of treated sawdust is sprinkled on top of it till the heap is fairly big after which the amount of sawdust is doubled. This extra sawdust assures perfect aeration and more N. at the final breakdown (see mushrooms).
As dipping is slower than shovelling, 3 men each with his own slurry drum work with 1 shoveller.
7. When the green material plus sawdust heap is completed it should be turned to assure thorough mixing.
8. The mixture is now ready to go into the bin which has three walls, the back fixed, one side movable, the other side fixed or the end of the previously built heap. Every 6" layer is treated with Q.R. so as to do away with turning, and the open front is built up as vertically as possible. No treading is required.
9. The heap should then be covered with 150 gauge polythene which may be brought down part of the open front. This retains all the moisture essential in this climate and the heap will begin

to heat up within 24 hours reaching a temperature of 160-180°F.
A complete breakdown is obtainable in 3-4 weeks.

Variation to Above

Whilst the bins are being filled 1/5 of matured compost may be added to the mixture. This gives a breakdown in 2-3 weeks, but reduces the heating temperature.

Tough materials may be included in any mixture after being chopped with a rotoscythe and soaked in the slurry for 2 or 3 hours.

Whatever the mixture sawdust is always added as detailed above.

Special Notes

When raw sawdust is used it should not exceed 30% of the mixture, but more may be used if it has slightly matured - say up to 50%.

On using the matured compost the edges should be shaved off as they contain live weed seeds.

They are then added to the next heap.

If polythene is not available cover the heaps with matured compost.

African compost heaps are notorious for drying out in the dry season but the above method whilst giving the heaps the optimum moisture content is most economical in water and in manure.

Compost for Mushrooms

Mushrooms need a compost in which the cellulose is only partly broken down. When a mushroom heap is spent it is richer in N. than it was before it was spawned. White ants attack anything that contains cellulose, hemi-cellulose or lignin to make the beds on which they cultivate fungi for food. Basing himself on this fact Maj. Beadnell makes a special compost for mushroom growing. The method is the same as that described above but he makes his slurry from horse manure and for green materials uses Kikuyu grass (*Protinus nitrosin*) and sedge grass. Sedge grass because of its very high cellulose content, and sawdust rich in lignin make a compost that is ideal for mushrooms.

Control of Nematodes by Cultivation

Strawberries. An old compost site, which had grown nothing but weeds was given 100 tons of compost to the acre dug in 4" deep.

The paths were heavily mulched with gravillia leaves and irrigated with compost water during the dry season. No overhead watering was given, but the dews were very heavy.

At first there were a few losses due to eelworms (as well as slight butrytis berry mould) but they soon recovered and are now cropping heavily.

Killing Nematodes by Composition

As most of the eelworms are in the top 6" of soil special compost heaps were made into which was incorporated all of the top 6" from a trial plot.

The compost was made as described above, excepting that Q.R. was used only in the slurry. Q.R. was not used in the heaps as these had to be turned so that the outside of the heaps which could not heat up could at turning be placed in the centre of the next heap. The heaps were turned twice.

Five samples taken after three weeks composting showed 100% kill.

Killing Nematodes with D.D. Fumigants

For this type of fumigant to be successful soil conditions must be just right, which for clayey soil means on the dry side otherwise a good water seal will not be obtained. The soil at 6" deep should be examined to see if its bind and crumb is just right.

Small areas should be treated at a time so that they can be water sealed without delay. Maj. Beadnell works along strips 2 yards wide as follows :-

1. Dig holes 6" deep, 1 ft. apart in all directions for a length of strip 2 yards long thus working 4 sq. yds. at a time.
2. Apply 4 c.c. of D.D. in each hole.
3. Fill in the holes with dry top soil.
4. Water with a sprinkler to create a seal.
5. Spread 3 bushels of compost (7.5 tons to the acre) on the 4 sq. yards to give a 2" - 3" cover to make the water seal more effective.

Then proceed with the next 4 sq. yds.

6. A fortnight later cultivate the compost into the soil.

This aerates it, breaks the seal and allows the fumigant to escape. This also incorporates the nematode killing organisms which are in the compost so that they deal with any survivors and prevents any reinfestation.

7. After a further fortnight the ground is ready to be planted up at which time it should be mulched as heavily as possible.

Two analyses showed a complete kill after 9 days in heavily infested soil.

Comparison between killing by Composting and by D.D.

D.D. can be completely effective after 4 days but if over done it will kill soil bacteria. It was found that beans nodulated much more slowly in fumigated soil, and that strawberries grew more slowly as if short of N. It seems therefore as if D.D. tends to kill nitrifying bacteria.

Soil Analyses

The following tables (overleaf) give soil analyses relating to the above report.

Notes on Analysis, which is on a dry matter basis :

If the lignins are excluded as mentioned in the Introduction, the "Lovely Compost" becomes near 9-1, and the subsoil 2-1 perhaps less from even more lignins left from past tree roots. Nitrogen from this level washed down from above in mineral salts is commonly tapped by trees and thorn bushes. The variation in phosphorous between 3 and 4 and 2 and 5 is probably due to differences in sawdust composition, as the high ones are also high potash. The low nitrogen is typical of composts, and on the same dry basis British F. Y. M. is 2.2% N. 1.6% phosphoric acid, and 2% potassium. Municipal composts are still lower in plant foods, 1-1.3% N., 0.5-0.6% phosphorous and 0.3-0.35% potash. Major Beadnell's worst compost is 2½ times as rich in potash as good F. Y. M. His plant foods are held in organic combination for slow release in the soil, and his lignins are in reverse behind the more quickly spent part of his humus. Low nitrogen can be corrected by legumes or fertilizer, but calculations based on temperate climates on the amount necessary can fail to fit the tropics. The more nitrogen the faster the humus spends, and the proof of the manure or compost is in the crops it grows and the profit for the grower. The nitrogen cycle of fertile soil has been studied at Rothamstead, but the same detailed work in Africa is needed before it can be applied exactly.

	1 Well Com- posted Soil	2 Com- post made with- out Soil	3 Com- post made with soil	4 Com- post made with soil	5 Com- post with- out soil	6 Sub Soil A (Below 10ft)	7 Sub Soil B (Below 10ft)
pH	6.1	7.4	7.4	7.4	7.5	5.2	5.5
Nitrogen m. c. %	0.2	0.4	0.3	0.3	0.8	0.1	0.1
Potash m. c. %	1.4	5.1	6.3	5.8	7.7	0.9	0.9
Calcium m. c. %	12.4	18.7	15.0	14.6	18.8	5.2	4.6
Magnesium m. c. %	3.8	8.5	8.2	8.5	8.2	1.9	1.0
Manganese m. c. %	1.0	1.5	1.6	2.0	1.4	0.5	0.4
Phosphorous p. p. m.	21	38	75	36	73	20	14
C-N Ratio					40-1 and yet lovely compost	11-1	12-1

Both the 40-1 and the 67-1 compost from Nyasaland are far richer in lasting humus ton for ton than any farmyard manure, which has only a fraction of its 14-1 as lignins. In terms of building fertility Major Beadnell's compost is nearly ten times as rich. Plant foods are easy, as chemical fertilizers, but humus to hold moisture and stop the land setting like cement, as well as feeding the soil life that replaces the complications of hydroponic tanks. For these are the only method of growing crops by chemical alone.

COMPOSTING BLUEGUM SAWDUST IN NYASALAND

By L. A. Shepperson

Mr. Shepperson who is composting Eucalyptus sawdust for use on a 10 acre market garden in Nyasaland has had considerable success with its use.

In 1956 an analysis of the loamy sand site showed it to be in very poor condition. The analysis was :-

Colour	10 Yr 4/2 Dr. Gr. brown
pH _____	5.5
Texture Coarse sand % _____	61
Fine Sand _____	32
Silt _____	5
Clay _____	2
<u>Base Exchange Characteristics</u>	
(m. g. e. /100gm)	
Base Exchange Capacity _____	6.8
Exchangeable Hydrogen _____	1.4
Total bases _____	3.0
<u>Nutrients</u>	
Exchangeable Potassium _____	.06
Sodium _____	.14
Calcium _____	2.0
Magnesium _____	.8
<u>Phosphate - ppm</u>	
Available _____	11
Reserves _____	31
Organic Carbon _____	0.61
Total Nitrogen % _____	0.65
C/N Ratio _____	12.2

On the strength of the overleaf analysis the Government advisers **recommended that** the 10 acres should be treated with 500/600 lbs. of 6 : 18 : 12, E.P.K. Compound Fertilizer supplemented with 100/150 lbs. of sulphate of ammonia.

Instead of using artificials as recommended Mr. Shepperson applied sawdust compost at the rate of 50 tons per acre, cultivating this shallowly into the soil, whilst using only a small amount of 6 : 18 : 12 on any young plant which seemed to need stimulating.

According to the Government Agricultural advisers his compost is poor in N. and he was advised to leave his sawdust in the kraal for 40 days instead of for 20 (see composting procedure) so as to double its urine and dung content. Sheer pressure of demand, however, prevents him from so doing. He must have 80 to 100 cubic yards, i.e. 30 finished tons of compost a month and this can be obtained only by clearing the kraal every 20 days.

The low N. value, however, does not worry him. His main object in using compost is to increase field capacity so as to store up water for the dry season whilst improving the soil structure.

This district has a dry season of 7 months, the rains which begin in December total about 40". Normally towards the end of the dry period the land is as hard as cement, but since being composted at the rate of 50 tons to the acre the market garden can be dug with one's fingers to a depth of 6" right up to the end of the dry season.

A striking feature is that soon after planting vegetables on heavy applications of 2½-3 month old compost, the soil becomes full of thread-like grey hairs, especially around the roots of cabbages. These hairs are not part of the cabbage roots and whether they are soil fungi breaking down the compost, or the hyphae of mycorrhizas they are doing no harm.

Mycologists are scarce in Nyasaland.

In the early days Mr. Shepperson was very dubious about using non-matured compost so as an experiment he spread some 2½ month old compost on top of very hard ground without incorporating any soil into it. Some lettuces, one cabbage and a few beans were then planted in this pure compost. Twenty days later as the beans were rather light coloured, one unit dose of 6 : 18 : 12 fertilizer was given in water.

During a visit the local Agricultural Officer remarked that these plants looked healthy and as they finally matured successfully it was decided that in future compost could be used when only 2½-3 months old supplementing it with a little 6 : 18 : 12 if necessary,

instead of waiting till it was at least 4 months old. In fact later practice showed the advisability of using 2½ month compost as will be stated further on. One significant observation was made, no thread-like hairs were found in this compost and Mr. Shepperson's conclusion, strengthened by his experiment with Myco activator (see later) is that for these to form soil must be intimately mixed with the compost.

It is to be noted that the procedure adopted does not include any protecting of the heaps from rain. Heaps left maturing during the full 5 months of rain were found to exude a black liquid as nutrients were leached and lost. The analysis made by Aynsome Laboratories Ltd., shows N. 0.08% with C/N 67.6 : 1. This terrible leaching effect of the rains is one of the reasons why compost is now used when only 2½ months old (see also White Ants). The best heaps are in fact made during the dry season when the moisture content of the heaps can be controlled.

Sample of : Eucalyptus Sawdust Compost. Rainy Season.
December Compost.

From : Henry Doubleday Research Association.

Received : 11th July 1958. Lab. No. U.267.

	(As received)	(Dry basis)
	%	%
Nitrogen _____	0.08	0.11
Phosphoric Acid _____	0.16	0.21
Potash _____	0.11	0.15
Calcium (expressed as CaO) _____	0.24	0.32
Organic Carbon _____	5.5	7.44
Lignin _____	8.73	11.8
Moisture _____	26.05	
Ash _____	62.8	84.9
Carbon: Nitrogen Ratio _____	67.6 : 1	

(Excluding Lignins approx. 12 - 1)

The extent of the harm done by rain is stressed by the analysis made by the Nyasaland Agricultural Chemist of a sample taken 8 days earlier from the same heap and therefore submitted to 8 days less rain. This showed N. 0.32% instead of 0.08%.

COMPOST. 3rd July. 1958.

The sample of compost recently submitted by you had the following composition on a dry weight basis.

/Over.....

Insoluble Matter _____	80.7 %
Loss on Ignition _____	11.5
Organic Carbon _____	3.8
Equivalent to Organic matter _____	3.4
Calcium _____	0.2
Magnesium _____	0.2
Potassium _____	0.2
Phosphate (as P ₂ O ₅) _____	0.20
Nitrogen _____	0.32
Reaction (pH) 1 : 5 water _____	7.5
C/N ratio _____	12.00

The value of this compost would appear to be very much reduced because of the high content of siliceous material (insoluble matter 81%)

Procedure followed for making Compost

Size of heaps - 40 yards x 15 yards x 5 feet high.

As this compost obtains its nitrogen from cattle urine and dung a roofed cattle kraal in which the cattle are housed over night and during the mid-day hours, if necessary.

Fresh gum sawdust (0.2% nitrogen, C.N. 500/1) is spread on the earth floor of the cattle kraal to a depth of 12 inches.

As cattle urine used for composting can be diluted in the proportion of one volume of urine to ten or water, this initial DRY sawdust covering should be watered to make it fairly damp, NOT WET.

Each day following, the cattle droppings should be spread evenly over the floor area, and fresh damp sawdust spread over to a depth of four inches. If preferred a dung slurry can be made with the night's dung droppings, and the fresh sawdust damped with it instead of with plain water.

In this part of the world, it is usual to spread dry grass in the kraals daily for bedding and to make farmyard manure; the result being that in the wet season the F.Y.M. in the kraal becomes wet and muddy and the cattle never attempt to lay down to rest, and the place is often full of flies, and a little smelly.

The remarkable difference with the sawdust procedure is first the daily tip-top CLEAN APPEARANCE of the kraal, the complete disappearance of flies, and no smell of ammonia losses; and last but not least the restful and relaxing sight of nearly all the beasts laying down on the sawdust bed at dawn each morning.

This sawdust bedding soon compacts with the weight of the cattle, and it is therefore most advantageous and necessary to dig

over and turn to whole mass, say once a week, until about the third week when the sawdust will have become the colour of a strong dark infusion of tea. The sawdust now has 1% N. with a C:N ratio of 100/1.

This bedding is then dug out every 20 days and loaded on to a trailer and transported a few yards away from the kraal to the compost site; where it is piled up in a heap, and if left for one or two days, the internal temperature generated is high enough to make it almost impossible to keep one's hand inside the heap at a depth of one foot.

The compost site overlooks a vlei, a low lying area which is covered with a good grass turf, which keeps fairly green throughout the year.

The soil analysis of a similar vlei not far from this site and of a similar soil composition proved the soil to be fertile.

The idea then developed to look upon this turf as a GRASS LEY, of which a very small area is daily dug to a depth of say four inches, and incorporated into the compost heap; and later some of the finished compost can easily be spread back to replace the turf thus taken away. Transport should be employed to bring loads of green wilted weeds and any vegetable refuse to the site, whenever these are available.

Manufacture.

With a large hot heap of urine and dung impregnated sawdust, (nitrogen content approx. now 1.0% C/N 100:1) and several loads of weeds and vegetable refuse at hand, all is now ready for the making of the compost.

Two men are used daily on building up the heap, which when finished is usually 30 yards long by five yards wide by one yard high.

Each day the hot sawdust is spread on the site five yards wide by one yard to a depth of one foot, on the top of this is spread the cut up turf (GRASS LEY). Five boxes by volume of grass sods being mixed to every 25 boxes of sawdust.

The whole of this "grass ley" soil and hot sawdust is then mixed up by hand, with the idea of getting the "soil population" well mixed up with sawdust, on top of this mixture is spread the green wilted weeds, 6", this process being repeated until a height of five feet is reached, when, this last layer is "topped" with four inches of turf soil on which is spread a good sprinkling of lime.

Several of these "five x one" sections can be done in one day with good men as the materials are at hand, and the only digging done by the men is the turf cutting.

As soon as the mass becomes too compact it should be turned over to allow the air in, if labour cannot be spared for this work then a man can be usefully employed to break down the almost vertical sides and ends of the heap to a gentle slope, which will allow a tractor to climb up and with a two disc plough turn over the whole lot in about two hours, when more lime can be spread over the top.

The second turning is usually done by loading up the unfinished compost and transporting it to the site where it is eventually to be used.

This compost is used on a market garden proposition, is not required for its N.P.K. content, but more for its building up of the soil structure and to enable the soil to have a much better moisture holding capacity in our prolonged dry season.

The first sawdust compost to be made on the above lines was started in November 1956 and no protection was given from the rains which by the end of February 1957 amounted to over 36 inches.

At the end of February, 4 months old, a sample of this compost was sent in for analysis, it was described as "looking and smelling like good potting soil" and the analysis was :-

Organic matter _____ 12.40%

Nitrogen _____ .49

pH value _____ 7.1

Carbon/Nitrogen _____ 14.4 / 1 which

indicates that the nitrogen should be released gradually, and immediately, rather than be fixed until further decomposition occurs.

Results Obtained.

Carrots. Carrots seem to have an affinity for sawdust compost. Averaging 1½ lbs. each they have a soft textured outer skin, whilst the whole are never coarse. Some actually grow to 3 lbs.

Cabbages. These do very well but when a few plants showed signs of mottled leaf samples were sent to the Agricultural Chemist for analysis to trace suspected deficiencies.

As the following analysis shows there was nothing untoward in their growth.

Cabbage Leaf Composition, 15th July 1958.

I refer to the samples of good and mottled leaf submitted by you, and which was suspected of Magnesium deficiency.

Details	Satisfactory Green Leaf	Purple & Mottled Leaf.
Moisture	11.5%	10.5%
Ash	12.1	14.1
Nitrogen (N)	3.4	4.0
Phosphate (P ₂ O ₅)	0.65	0.75
Potassium (K)	2.7	3.1
Calcium (Ca)	1.3	2.0
Magnesium (Mg.)	0.4	0.6

As you will see the suspected leaves had a rather higher general nutrient status level than did the green leaves showing no purple colouration. The Magnesium content is well above that at which deficiencies have occurred. As discussed with you at the time you brought the samples - the purple tinge is most probably characteristic of the plant, and has no nutrient significance. Also as observed on the garden there would appear to be nothing untoward in the growth of the cabbages, to suspect a nutritional disorder.

Celery. Celery grown in trenches manured heavily with sawdust compost were judged by the Agricultural Officer as exceptionally healthy and vigorous.

Value of Compost

The value of the compost at Nyasaland's prices for N.P.K. in 1958 was £1 per ton.

WHITE ANTS

White ants are prevalent and have been one factor showing the advisability of using compost when only 2½ months old.

Raw eucalyptus sawdust spread on roads is not attacked by white ants, nor is eucalyptus sawdust compost invaded before it is nearly 4 months old having reached a C:N ratio of 14:1.

Mr. Shepperson believes that there is some significance in this ratio of 14:1 which happens to be that at which earth worms enter compost heaps. Personally I do not believe that the C:N ratio had any influence on white ants invasion as these pests eat most raw timber which naturally has the same C:N ratio as raw sawdust, i.e. 500:1.

The controlling factor is certainly due to eucalyptus oil which is either broken down or evaporated out by the composting.

When the compost is used at 2½ months old, it is steaming hot, and white ants do not enter it till it is nearly 4 months old. This gives the plants a good 6 weeks before the termites begin to rob the soil. It seems as if the eucalyptus does not inhibit plant growth.

Summary. Mr. Shepperson maintains that he is making THREE composts in one. By the use of grass sods he incorporates a grass ley which he believes provide soil colloids in an Indore type compost which incorporates sawdust as a moisture retainer.

The owners of the estate are satisfied with the compost, and are confident that this sawdust compost will with a proper rotation including grass or lucerne, keep the soil in good heart.

EXPERIMENTS WITH MYCO

In order to reduce the cost of labour involved in carting soil sods to the sawdust heaps, Myco was tried as in innoculent.

On August 1st. four tons of urine and dung impregnated sawdust was sprayed and a heap built and sprinkled with soil as per instructions.

After 19 days no change had taken place so the heap was rebuilt with an incorporation of the residue from a green pea crop. Within 3 days the heap sprang to life and the temperature rose to 143°F.

22/8/58	Temp. _____	143°F	1/10/58	_____	118°F
1/9/58	_____	130	10/10/58	_____	120
9/9/58	_____	125	14/10/58	_____	115
18/9/58	_____	115	18/10/58	_____	120
20/9/58	_____	122	27/10/58	_____	118
27/9/58	_____	116	1/11/58	_____	116
			6-13/11/58		117 constant.

On Nov. 14 the heap was turned and watered, after which the temperature rose to 127° which it retained till 10th December when it fell to 121°.

On Dec. 11th it was turned for the second time and the temperature once more rose to 127°F varying between this and 130 for a few days.

At the end of December the heap looked like damp sawdust and it was almost unchanged after 4 months.

The "Myco" instructions state "do not turn the heap over" the heap being small 4' x 12' the digging by hand daily into the

heap down to say 3 feet to put in the thermometer always in a different place, amounts to a good "turning over" in the centre parts.

The appearance of the sawdust to date is the same as the day it was taken out of the cattle kraal, it is just as if it had been kept nice and warm in an oven. The texture and colour are the same and there is no sign of the "Myco" mould, only the tea tops have disappeared.

This experiment shows that the organisms in Myco though very good for European conditions cannot replace Nyasaland's natural soils organisms.

Comparison between Beadnell and Shepperson

	Beadnell	Shepperson
Locality	Near Equator	About 15° south
Pests	Nematodes	Termites
Rain	52" Nov. Dec.	36" in 5 months from Dec.
Soil	Rather heavy clay content	Loamy sand

Compost

Temp.	160 - 180	123
Usable	2½ - 3 weeks	2½ - 3 months
Process	Sawdust etc., mixed in slurry	Sawdust spread in kraal.
Activator	Q.R.	None
Protection	Polythene	None.

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DEEPLITTER POULTRY KEEPING IN THE TROPICS

By. L.G. Fairchild, Chingola, N. Rhodesia.

Introduction by L.D. Hills.

The deeplitter poultry system ("Built-up Litter" in U.S.A.) is the only economic method of converting shavings and sawdust into usable compost in a temperate climate. It also pays well for those who do it well. The test of a good deeplitter house is to be able to walk across it at any time of year and clean your boots by dusting, and if lime must be added, the litter frequently forked up, or there are wet patches, then the bacteria farming is below standard.

The creature mainly responsible is Hutchinson's spirogaete, but there are many, specialising in breaking down straw in farmyards with the ammonium carbonate in urine, very quickly available.

The dab of white on a poultry dropping is the urine, and the ammonium carbonate is what makes poultry droppings "fierce" so no gardener will use crude battery manure

In the deeplitter system the bacteria grab this fierce nitrogen to make up their bodies and supply their needs to break down the celluloses, hemicellulose and some of the lignins in the litter, producing just as much heat as if they had burnt it, and needing as much oxygen. So ventilation is all important, and the heat dries off the poultry manure which becomes a very useful fertilizer now sold by a number of poultry keepers as a by-product under various trade names. The analysis varies according to the litter but the table on page 23 gives average figures.

The hardwood sample is the best, with as much potash as nitrogen, because there is more in oak and beech than pine and this has been released to make a first class product for use on tomatoes, gooseberries and other crops by a market gardener next door to a furniture factory. The shavings farmer, with free soft wood waste from a fish box factory in Hull is making a grassland fertilizer worth about £8 a ton on current chemical manure valuation, apart from the value in humus. It behaves like one on his land and has for the past eight years.

Mr. Fairchild's is the Rhodesian, from a local sawmill, soft wood shavings, and he has used it for six years, building up his land to a high state of fertility with plant foods and lasting humus, using no more water than the poultry drink normally. The profit on eggs and table birds of European quality in Africa pays for the labour, and the gain to the land is far greater than if he had paid for the fertilizers that the rains could wash away more readily.

In Britain or America a deeplitter house is a solid wooden building, insulated to hold the heat in, for the warmth from the bacterial "bonfire" slowly breaking down the shavings helps winter laying. In africa the problem is to get rid of the heat, and Mr. Fairchild sites his houses where the Trade Wind blows through the wire netting sides, and his asbestos roofing is whitewashed for least sunlight absorbed. A black surface absorbs heat, and even a bitumen painted corrugated iron shed can get hot inside, in even an English summer. It is attention to detail that makes a good poultry keeper of any colour in any country.

The Chingola Poultry System

Experience has shown that orthodox deep litter methods in the tropics are not practical and most so called deep litter enthusiasts

sooner or later switch to a modified form of strawyard or outside run. Many "deep litter" projects I have seen in Central Africa are essentially run on these lines.

When I first started deep litter at Portmore I found the houses were too dark and too hot, the birds sweated and then got colds, and broodiness, even in leghorn crosses, was rife. After a season of this during which I had a large out-break of roup, I constructed outside runs of a size equivalent to the house area but soon found the birds to be infested with lice. Later when the rains came the outside runs, in spite of tons of straw cover, became unusable and the birds were put back into the houses with a consequent drop in egg production.

Definitely a new system had to be devised if deep litter was to be an economical proposition in this part of the world. Under our own local conditions arks and range shelters were not practical owing to the theft hazard and birds of prey; straw yards worked very well during the dry season, although lice were troublesome, but were impossible during the rainy season (50 inches of rain in five months); deep litter therefore was the only answer.

Another very important feature was the saving in labour to be gained from a well organized deep litter set up. This was obviously the answer to local poultry keeping problems and we set out to devise a practical economic and, as far as possible, fool proof system which would overcome such hazards as theft, climatic variations, native un-reliability and so on.

Three or four temporary houses were built with pole and dagga (mud) having a rough thatchroof and results over a season were noted. The best results were obtained from a house for 200 birds measuring 60° x 12°, having its long axis sited east to west. This house consisted of a 2° wall with 6° pillars at ten foot intervals to support the roof. The open spaces between the wall and roof were then covered with wire netting. The production figures for this house were 67% for the season which is above average for the tropics.

Following this experiment, seven permanent houses were constructed of bricks made and burnt on the farm and these were roofed with iron or asbestos. The spaces between the pillars were covered, on the inside aspect, with heavy gauge 2" wire netting. Roof trusses were made from 4½" x 1" oregon with a 3° pitch and 4" x 3" timbers were used for cross members.

The houses were spaced 15 feet apart as this was calculated to let in the maximum amount of light with the minimum amount of

rain, and at the same time allow an adequate space in which to grow greenfood for the laying birds.

The houses were stocked and during the first season gave very good results with no illness. The areas between the houses became covered with a very fine dust from the litter during the dry season and during the first rainy season these plots were planted to lucerne which came away in lush growth without fertilizer or inoculant. The lucerne however, died off in the dry season and we found ourselves like everybody else in these parts short of greenfood.

About this time the possibilities of Russian Comfrey came to my notice and one plot was planted to this herb which grew very well and gave green food all through the dry season. Yields of Comfrey were not measured but an experimental irrigated bed yielded 66 tons of fresh green food to the acre in its first year and in its second year scaled 85 tons to the acre.

All the plots between the houses are now planted to Russian Comfrey at 60 plants a piece which yield an average of $2\frac{1}{2}$ lbs. green food per plant per month unwatered.

When established this plant is drought resistant and requires no watering through the dry season (although irrigation would increase its yields) and with its constant fertilizing from the dust of hens working the litter, it comes away with great gusto at the first shower of rain.

The litter used is sawdust and shavings which is thought to react with the droppings to produce a fertilizer of high potash content which Russian Comfrey really needs. Whether this is so in actual fact has yet to be proved but the results certainly support the theory.

The preliminary stages of this system give great promise of a trouble free labour saving system of poultry keeping in the tropics and compared with other systems does not require excessive capital outlay.

Mash has been fed ad lib in four 6" double sided hoppers per house. These are topped up weekly and water is laid on by a float valve controlling a 6" drinker. This drinker is mounted on a platform in front of the broody cages at the end of each house so that the free and captive birds can all drink at once. 40 gallon drums are mounted outside each house to feed the drinkers and these drums are filled daily by hosepipe. Nest tunnels are made with old corrugated iron sheets leaning against the side walls.

One native worker is required for each set of seven houses and his task includes cleaning one house thoroughly daily, i.e. scraping

perches, turning litter, brushing the wire, topping up hoppers and cleaning the drinker - this usually occupies him for 2-3 hours. Other duties consist of collecting eggs at 10 a.m. 12 noon, 2 p.m. and 4 p.m., cutting, chaffing and feeding Comfrey at noon and feeding grain at 4pm. During this final round at 5.30 p.m. he collects broodies and puts them into confinement.

The birds, mainly light Sussex and New Hampshires, are kept for two seasons being force moulted after the first year.

No illness has been noted since the installation of this system and vices are non existent. No lice and no worms have been found in any of these birds slaughtered for table and the deep orange yolks of the eggs compare favourably with the pale yolks common to Central Africa.

The advantages of this self contained system are numerous :

1. Economy of labour and ease of checking on the unreliable labour usually available in this country.
2. Equable temperature of the houses described whether under iron or asbestos.
3. The birds grow their own green food. The dust from the houses contains what the Russian Comfrey likes and the Comfrey certainly contains the vital ingredients of a hen's diet in palatable form.
4. The orientation of the houses allows the morning sun and afternoon sun to flood the ends of the houses with its rays while the birds are shaded from the scorching mid-day sun.
5. Ample ventilation day and night.

Flaws in the system as yet discovered are few and are apt to be of local significance only. One such instance which occurred at Portmore was that we found predatory animals would molest and even kill birds roosting near the wire at night. That was the reason for erecting the wire netting on the inner side of the pillars to stop birds from perching on the walls, and of course, all perches are now sited along the centre of each house. Minor problems might be encountered according to locality but the modern farmer is seldom without ideas or the capacity to carry them out.

One final word I would like to say about Russian Comfrey which is well liked by the birds, is its eminent suitability as a poultry diet; its protein fibre ratio is in the region of $1\frac{1}{2} : 1$ in contrast to young lucernes which is rather $1 : 1\frac{1}{2}$ and, this added to the fact

that is grows well without water for many months in scorching heat make it a green crop worthy of consideration in any deep litter system similar to the one described above and especially for the farmer in the tropics.

L.G. Fairchild.

The cultivation of Russian Comfrey is not essential to the Chingola system, where other crops can provide the year round green food that European breeds of poultry require for quality egg and meat production. Its cultivation is fully described in "Comfrey Report No. 2" (H.D.R.A. 2/6d) and in countries where the day length does not fall below that of an English September, it does not go dormant between October and March as in temperate climates, but produces the constant supply of leaf that explains the remarkably high yields of tropical countries. It does not set seed, it is increased by division or root cuttings for plantings lasting many years. The Association can put enquirers in touch with local suppliers in many countries, or arrange export from Britain.

Though it is of value for cattle in tropical climates as a high protein feed to go with higher fibre fodders to supply starch equivalent, poultry feeding is its most valuable use.

Other materials than shavings and sawdust have been used, but, not more than 10% of sugar cane bagasse should be added to any mixture, for the residual sugar becomes alcohol and causes complications in the breakdown of the litter. Very fine and dusty materials such as coir waste (refuse coconut fibre) bind together and exclude air so are unsuitable.

Barks are suitable, though lower in celluloses, they are often richer in minerals especially potash, and there is scope for experiment using shredders if necessary with any dry material high in cellulose that is unsuitable for cattle feed.

Chingola poultry units do not occupy much space, and the manuring of the Comfrey, or other green fodder crop needs only a very small proportion of the compost produced. In a tropical climate this is dry enough to bag and sell and its composition is so much richer in plant foods than any Municipal Compost, that it can compete on price with chemical fertilizers on the same valuation, ignoring the value of the humus. The greatest advantage is where it can be used to build fertility on one's own land, with the profit on the poultry in addition.

CONCLUSION

This booklet deals with three composting methods that have stood the test of time and shown a profit in the tropics. It is hoped that others will share their experiences of simple methods that work in practice under conditions that could apply in other countries, of even roughly the same climate.

We would be particularly glad to hear from Research Stations, Agricultural and Forestry Officers who are concerned with the problems to whose solution our booklet is a very modest contribution. The expensive and difficult today is often easy - the cheap and simple which any peasant or coolie can do on his own land can be easily neglected.

There is an old Chinese proverb "Give a man a fish and you feed him for a day, teach him to fish and you feed him for many days", and we are concerned with that teaching, which must be from knowledge won in hungry countries. Free surplus food from the wealthy West may feed a people in famine, but only feeding the land will prevent another one. Helping the hungry to grow more food on their own land by their own efforts needs knowledge that we have only just begun to gather, and farmers, as well as Research Stations have experience to add that can help in this neglected field.

Lawrence D. Hills.

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BRO - CARDS of PLYMOUTH.
