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CONTENTS



## UTILISATION OF FARM WASTES*

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Recent investigations at Coimbatore on the effects of manuring a crop on the nutritive and reproductive capacity of the resulting seed, have clearly impressed the necessity for the supply of organic matter to the soil in order to produce food stuffs well supplied with nutrients for the proper nourishment of both man and animal. It is an established fact that the organic matter in the form of humus plays the most important role in the upkeep of soil fertility as well as in the maintenance of ideal texture of the soil necessary for the growth of crops. Apart from this, the demand on the soil for increasing the out-turn from crops to meet the needs of the growing population, have necessitated the augmentation of the manurial resources for crop production. The alarming rate at which the organic matter of the soil is depleted and the urgency for making good the loss, as revealed by the soil surveys conducted in India, make it all the more imperative to supply this want immediately.

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Till recently, the time-honoured farmyard manure, leaf compost, oil cakes and similar materials formed the main sources for the supply of organic matter to the soil. A survey of the amount of the available materials in conjuction with the needs of the area under cultivation, will at once impress the inadequacy of the present supply, which is about 1/20 of the demand. The available supplies of the organic manures being quite limited, means have to be found to tap other sources which can be made to yield manures as good as farmyard manure.

The need for organic manures being universally recognised, this problem of augmenting the supply has naturally attracted the attention of scientists. At Rothamsted, Richards and Hutchison sought to remedy this deficiency by finding a suitable substitute for farmyard manure. They were the pioneers in this direction who realised quite well the gravity of the situation and the demands of the future and succeeded in solving this problem. In their search, they pitched upon waste organic matter of low manurial value which could easily be worked up, by the addition of some fertilising material, to the standard and quality of farmyard manure, in its fertilising value. Wheat straw was used as the basic material with ammonium sulphate as a quick-acting nitrogen starter to hasten the decomposition of the stuff with the result that the fermented manure resembled farmyard manure in appearance, consistency and manurial value. This process was styled as the manufacture of 'synthetic farmyard manure' in contradistinction to the natural farmyard manure. Concentrated starters were put on the market with the patented names of "Adco" accelerator and "Adco" complete manure, with full directions for their use.

Simultaneously, Hutchison in India, started the study of fermentation of green manure using sunnhemp as his material and obtained an odorless product of high manurial value using copper sulphate—potassium cyanide mixture as a deodoriser. Besides, he also demonstrated the superiority of the fermented product to the unfermented. It was established that fermentation of the material was indispensable before application as manure.

Fowler working on the activated sludge system of sewage disposal, has demonstrated a process of converting night soil into an inoccuous and useful fertiliser, fit for application to crops. It was also shown that in this process nitrogen losses were greatly minimised by its conservation in the resulting product. Besides, the activated sludge was found to be one of the best inocula containing bacteria capable of attacking the most resistant materials.

At the Department of Biochemistry, Bangalore, experiments have been conducted on the utilisation of waste, in the form of municipal rubbish, into a useful manure by introducing activated sludge as the inoculum for starting decomposition. Well-fermented organic manure has been obtained possessing high manurial value. In this process the presence of cellulose fermenters in activated sludge was availed of, to give the initial start.

Thus it will be seen that attempts have been made by numerous workers in the direction of utilisation of waste products to produce "wealth from waste" with great success.

Encouraged by the results obtained both at Rothamsted and at Pusa, a beginning was made in Madras in the year 1922, to tap the available sources of waste organic matter found in abundance, for the preparation of synthetic manure. Experiments were planned on the same lines as at Rothamsted but using 1500 lbs. of paddy straw and calcium cyanamide as basic material and starter respectively, instead of wheat straw and ammonium sulphate, proper moisture conditions being maintained for the rapid decomposition. A careful record of the temperature developed was maintained, the maximum temperature attained being 54° C, when the air temperature (in shade) was about 28° C.

It was observed that there was a quick rise in temperature within 24 hours and the heat, developed, naturally led to rapid decomposition of the material but, because of the method of heaping, there was uneven fermentation. The subsequent forking and mixing of the fermented material with the unfermented, resulted in uniform decomposition and there was a loss of 47 per cent. of organic matter and 14 per cent. of nitrogen. The manure was ready in 9 weeks.

Improvements were introduced to minimise the sudden rise of temperature and to regulate the maintenance of moisture conditions necessary for even decomposition. Experiments were started with *ragi* straw both under aerobic and semi-aerobic conditions, the latter condition being obtained by mud-plastering the exposed parts. The following results indicate clearly a reduced loss of nitrogen and organic matter under semi-aerobic conditions.

| | Per cent loss of | |
|---|---|---|
| | Nitrogen. | Organic matter. |
| Aerobic | 26·76 | 37·7 |
| Semiaerobic | 9·29 | 22·2 |

In the light of these observations, the following experiments were conducted in 1923 with *ragi* straw both in heaps and in pits and with various amounts of nitrogen. Nitrogen was added as ammonium sulphate or calcium cyanamide respectively at 0·75 per cent. and 0·5 per cent. calculated on dry matter. In the case of ammonium sulphate lime carbonate was also added to correct the acidity.

| | Ammonium sulphate series. | | | | Calcium cyanamide series. | | | |
|---|---|---|---|---|---|---|---|---|
| | Higher Nitrogen per cent of loss. | | Lower Nitrogen per cent of loss. | | Higher Nitrogen per cent of loss. | | Lower Nitrogen per cent of loss. | |
| | N. | O. M. | N. | O. M. | N. | O. M. | N. | O. M. |
| Heap | 40·09 | 43·59 | 29·02 | 46·45 | 25·68 | 36·34 | 33·46 | 38·00 |
| Pit | 34·66 | 33·30 | 26·46 | 23·85 | 22·99 | 29·63 | 15·83 | 27·00 |

(Note:— N. is Nitrogen. O. M. is Organic matter).

The loss of nitrogen from experiments in pits was less in every case than that from heaps. In pits it ranged from 16 to 34 per cent and in heaps, from 26 to 40 per cent. The high percentage of losses in all these experiments might have been due to the soaking of the liquid portion of the manure into the soil.

Apprehending the loss to be due to the exposed condition of the manure to the heat of the sun, a shelter was provided to the manure pits, but even then, the losses ranged from 44 to 55 per cent. These experiments have shown beyond doubt that the resulting loss under Indian conditions is due, chiefly to, too rapid decomposition at the initial stages and has been traced to the unsuitability to suit Indian conditions of the starters employed elsewhere. Naturally, attention was directed to the introduction of a suitable starter.

With this object in view, a detailed study of the "Adco" accelarator and "Adco" complete mixture was undertaken. These analysed with the following results :—

| | "Adco" accelarator. | "Adco" complete mixture. |
|---|---|---|
| | % | % |
| * Loss on ignition | 8·12 | 9·16 |
| Insolubles | 3·80 | 4·83 |
| @ Solubles | 88·08 | 86·01 |
| Total. | 100·00 | 100·00 |
| * Nitrogen | 2·91 | 6·63 |
| @ Iron and alumina | 11·90 | 3·92 |
| Lime (Ca0) | 42·90 | 46·50 |
| Total Phosphoric acid | 6·64 | 6·90 |
| Potash | 1·45 | 1·08 |

A bacteriological examination revealed the presence of active ammonifiers and nitrogen fixing organisms but cellulose organisms and nitrifiers were absent.

A synthetic mixture of calcium cyanamide, tricalcic phosphate and potassium sulphate were prepared resembling "Adco" and starters. This was compared with the "Adco" starters both on green and dry materials under laboratory conditions. The results are given below.—

**Average of duplicates.**

| No. | Details of experiment. | Per cent loss of Nitrogen. | Per cent loss of dry matter. |
|---|---|---|---|
| | Air-dry Ragi straw: 1 kilo in each glazed pot. | | |
| 1. | Ragi straw only | 1·28 | 69·67 |
| 2. | Ragi straw plus Adco mixture enough to supply 0·75% Nitrogen | 34 05 | 64·90 |
| 3. | Ragi straw plus Nitrolim mixture made up in laboratory enough to supply 0·75% Nitrogen | 23·60 | 64·5 |
| | Ragi green: 1 kilo in each pot and "Adco" accelarator. | | |
| 1. | Control-ragi stems and leaves | 12·16 | 54·6 |
| 2. | Green ragi straw plus Adco accelarator to supply 0·22% Nitrogen | 29·01 | 50·8 |
| 3. | Green ragi straw plus Nitrolim mixture made upto supply 0·22% Nitrogen | 26·56 | 48·57 |

Even though the fermentation was quite even in both cases, the loss of nitrogen occurred in both. But green materials do not require any nitrogen starter. The decomposition of the waste material was accelarated and this might be due to the stimulation of the organisms by the phosphate present in the starters.

Having partly succeeded to control the loss of nitrogen by the use of the quick acting starters of the nature employed so far, an attempt was made to introduce slow acting starters by using bonemeal and cattle dung in reasonable amounts so that the process might be slow and steady. Cane trash was tried in pits with these slow acting starters in suitable proportion. Results are given in the adjoining table.

| Quick acting starters. | | Slow acting starters. | |
|---|---|---|---|
| Percentage loss of | | | |
| Nitrogen | Organic matter | Nitrogen | Organic matter |
| 34·05 | 64·9 | 15·1 | 69·4 |
| 33·6 | 64·5 | 3·6 | 53·0 |
| 33·0 | 60·3 | 5·2 | 55·0 |

This led to even decomposition resulting in a minimum loss of nitrogen. Thus under our Indian conditions the use of slow-acting starters appears to be more advantageous than the quick-acting starters of the "Adco" type.

In order to popularise the preparation and use of synthetic manure for crops and to study the rate of decomposition under varying climatic conditions prevailing in the different parts of this Presidency, as also with a variety of waste materials, demonstration experiments were started on the Government Farms, private estates and tea and coffee plantations. The results are summarised in the following table.

**Results of analyses of Synthetic Farm Yard Manure obtained with different basic materials, calculated on moisture free basis**

| Basic Material. | Nitrogen. | Phosphoric Acid. | Potash. | Remarks. |
|---|---|---|---|---|
| | % | % | % | Composition of farmyard manure. % |
| 1) Cumbu straw. | 1·25 | 0·48 | 1·09 | Nitrogen 1·02. |
| 2) Paddy straw. | 1·60 | 0·16 | 1·93 | Phosphoric acid 0·63. |
| 3) Guniea grass stubbles etc. | 1·04 | — | — | Potash 1·76. |
| 4) Ragi straw. | 1·43 | — | — | Moisture in the final manure ranged from 50 to 70 % |
| 5) Dry weeds chiefly grass. | 1·90 | 0·55 | 1·09 | |
| 6) Lantana leaves and stalks. | 1·55 | 0·52 | 1·07 | |
| 7) Forest grass. | 2·49 | 0·51 | 2·26 | |
| 8) Wild lemon grass: | 1·93 | 0·24 | 0·90 | |
| 9) Lemon grass + lantana. | 3.03 | 0·43 | 1·77 | |
| 10) Lemon grass only. | 1·06 | 0·34 | 0·16 | |
| 11) Paddy straw. | 1·59 | 1·34 | 3·37 | |
| 12) Cotton waste and groundnut husk. | 1·62 | 1·04 | 1·25 | |

It will be seen that the composition of the resulting manure varies considerably depending upon the nature of the starting material and the time of the year in which the experiment is done. The combined action of dung and bonemeal was tested on highly resistant material such as cotton—stalks, etc., with success, but the time taken to ferment was six to eight months, whereas with other waste materials it ranged from three to five months. The manure retains fairly large amounts of moisture and has the texture and colour cf farmyard manure. Cactus which possesses hard spines when subjected to this treatment shows considerable softening of the spines rendering the handling of the manure easy. The slow-acting nature of the starter introduced, has the additional advantage of maintaining a steady and even fermentation in the manure pits, without the danger of loss of the most valuable manurial ingredient—nitrogen. Hence it may be said that with high temperature conditions, prevailing in India, slow-acting starters are to be preferred.

Any waste organic material like weeds, leaves, coffee pulp, husks of grains, waste straws, stems of succulent and ligneous materials can be composted. Based on numerous trials conducted all over the Presidency with various materials ranging from easily decomposable to resistant, the following technique of manufacture has been evolved.

A pit of convenient size, 12 feet by 6 feet by 3 feet should be dug on high ground. The basic material is uniformly and loosely spread to a depth of 9 to 12 inches and water is evenly sprinkled till the whole material gets moist, every part of the heap being carefully watered so that no portion remains dry. This is the most important point to be remembered in the construction of the heap. Then 1 to 2 lbs of fine bonemeal are evenly broadcasted and over this an emulsion of 10 to 20 lbs of fresh cattle dung in 5 to 10 gallons of water is applied. A second layer of basic material is placed over this and treated similarly. The whole material is thus disposed of until a heap, about 2 feet high above the ground level is formed and then the top and the sides are mud-plastered. After the feremeniation has proceeded semiaerobically for four to six weeks depending on the nature of the material, the plaster is removed to permit aerobic fermentation If the heap has sunk unevenly, which is an indication of the defective fermentation the material is reheaped after forking in and proper moistening. The raw material is ordinarily decomposed in three to four months and is fit for application as manure. This is not too long a period seeing that no fresh inoculum is added, as is done by Fowler, nor great attention paid subsequent to the starting of the compost. By this process synthetic manure of normal composition as farmyard manure may be made at a cost of Rs. 3/- to 3½ per ton. From this we can easily judge that the synthetic farmyard manure. compares favourably with that of farmyard manure as regards the cost of production.

With synthetic manure thus prepared, field trials were conducted with the results recorded in following table.

**Statement showing the yields of crops raised with organic compost as compared with Farmyard manure. Yields are for 5 cent. plots in lbs**

| Year | Crops | Grain | | | Straw | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | No manure | Organic compost | Farm-yard manure | No manure | Organic compost | Farm-yard manure | |
| | | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | |
| 1927—28 | Chitarai Cholam Yellow | 88·4 | 96·0 | 90·4 | 291·8 | 303·0 | 285·5 | Manured |
| 1928—29 | Ragi | 118·0 | 120·4 | 124·0 | 570·4 | 597·6 | 601·2 | do. |
| 1928—29 | Chitarai Cholam | 129·0 | 129·0 | 120·0 | 321·6 | 353·4 | 348·0 | do. |
| 1929—30 | Cotton | 338·1 | 369·2 | 371·3 | ... | ... | ... | Weight of kappas (residual effect) |
| 1930—31 | Ragi | 125·0 | 141·0 | 139·5 | 228·0 | 290·0 | 232·0 | Residual effect |
| 1931—32 | Chitarai Cholam | 137·4 | 146·4 | 142·8 | 402·0 | 379·2 | 391·2 | Manured. |

The yields from synthetic farmyard manure plots were greater than those from unmanured plots and in some years were either equal to or slightly higher than, those of farmyard manure plots. The residual effects of the organic compost were more marked in some years than those of the farmyard manure. This clearly shows that the organic compost is as good as farmyard manure. An analysis of the crop—grain and straw—further showed, that the quality of the crop was as good as that of the crop raised with farmyard manure.

Even though by this process the majority of waste materials can be turned into a most useful manure there are certain limitations with such materials as night soil, wherein a process like this can only be applied with certain modifications. The process consists in pitting the night soil with rubbish and certain chemicals, which act as deodorisers and are non-toxic to plants when applied after fermentation. Fowler has recently recommended a method for using night soil as a starter in composting rubbish for conversion into a useful manure. This involves repeated exposure of the material with the night soil suspension on it, with the result that a manure of high value is obtained. But the sentimental objections to the handling of night soil and the cost of labour involved are two prime factors which are against the process, whereas the process developed here is without these drawbacks and the manure obtained compares favourably in composition and in cost of production with farmyard manure.

Experiments conducted here using various deodorising agents in composting night soil and the estate rubbish are sufficiently satisfactory and their results of analysis show that the process is a success as could be seen in the following table.

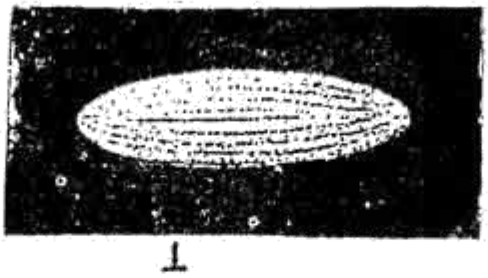
**Results of analysis of 9 samples of poudrette for moisture and nitrogen (dry basis)**

| Original materials and treatment, if any. | Moisture. % | Nitrogen. % |
|---|---|---|
| 1. 492 lbs. night soil plus 250 lbs. sweepings. | 44·88 | 1·05<br>0·80 |
| 2. 480 lbs. night soil plus 500 lbs. sweepings, treated with 0·025% solution of $CuSO_4$ | 32·82 | 1·37<br>0·64 |
| 3. 420 lbs. night soil plus 500 lbs. sweepings treated with 0·025% solution of $CuSO_4$ dissolved in excess of KCN solution. | 29·63 | 0·68<br>0·64 |
| 4. 524 lbs. night soil plus 500 lbs. sweepings treated with Bordeaux mixture ($CuSO_4$ solution turned alkaline to litmus). | 40·94 | 1·53<br>0·93 |
| 5. 532 lbs. night soil plus 500 lbs. sweepings plus 5 lbs. common salt. | 39·28 | 1·15<br>1·15 |
| 6. 1121 lbs. night soil alone. | 69·87 | 1·91<br>1·47 |
| 7. 562 lbs. night soil plus 1000 lbs. sweepings. | 29·66 | 0·79<br>0·55 |
| 8. 514 lbs. night soil plus 500 lbs. sweepings. | 28·77 | 0·81<br>0·53 |
| | 40·27 | 1·29 |

The observations so far recorded are so encouraging that it would be possible to produce manure out of wastes quite economically.

**Summary.** Results of experiments on the preparation of synthetic manure from organic wastes are discussed.

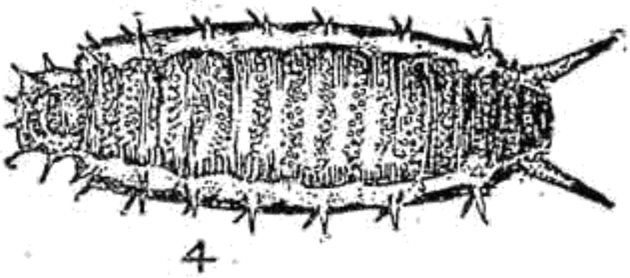
The losses of nitrogen and organic matter resulting from decomposition have been minimised by introducing semiaerobic conditions and slow-acting nitrogen starters such as bonemeal and cowdung-water.



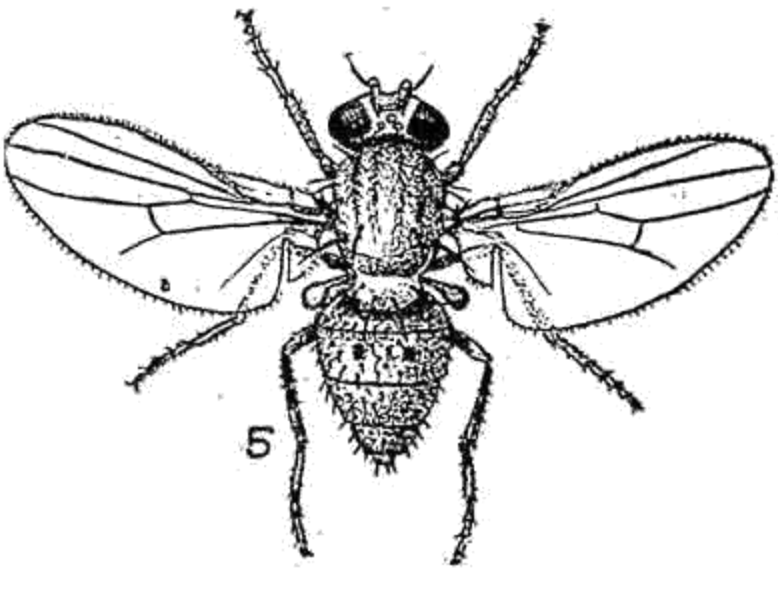
1. Egg

2. Newly hatched maggot

3. Full grown maggot.



4. Pupa.



5. Adult.

The "Adco" products are not suitable to our Indian climate and if used will result in serious loss of nitrogen. Analyses of organic compost obtained from various grades of stuffs under varying conditions are set forth and discussed. Based upon the experience gained, a working formula suitable for the production of composts under Indian conditions is described.

The effect of compost thus prepared has been compared over a series of years on crops against farmyard manure and the results of yields obtained are discussed.

The composition of the crops as regards quality compares favourably with those raised with farmyard manure.

The economics of the process are laid down and the modifications necessary in handling night soil are indicated.

The results of field trials warrant the preparation and use of organic wastes profitably in the form of organic compost on an extensive scale.

## AN AGROMYZID FLY PREDACEOUS ON APHIDS

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**Introduction.** This short note deals with the life history and habits of a beneficial insect, a fly* whose maggots are predaceous on Aphids (sucking insects)—one of the worst pests of cultivated crops. Along with Hover flies (*F. Syrphidae*), Lady-birds (*F. Coccinellidae*) and Lacewings (*F. Chrysopidae*) these fly maggots attack aphids on a large scale and destroy them in numbers. As this insect is one the farmer should be familiar with and protect as far as possible, a short description of its various stages is given below.

**Life History.** *Eggs* (Fig. 1) are laid singly by the female flies on plants infested with Aphids. These look like the Syrphid eggs being oval and white, but are smaller. These measure 0·36 m. m. in length while the Syrphid eggs are 0·8 m. m. long. Again the ridges found on the Leucopis eggs are longer than those of the Syrphid eggs. Also the Leucopis eggs have both ends more or less pointed while in the Syrphid eggs one end is slightly broader than the other. The egg period lasts two to four days.

*Larvae.* The newly hatched maggots (Fig. 2) which are about 0·45 m. m. long are pale white in colour. Unlike the young Syrphid maggots, hairs are absent on the body. Two short tubular out-growths from the dorsal aspect of the anal end directed backwards and outwards, which are the beginnings of the long larval respiratory

* *Leucopis sp.* Sub-family—Ochthiphidinae. Family—Agromyzidae.