# Studies on vermicompost production in Rwanda and its nutritive values

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# Introduction

- Vermicompost is the end product of the composting of organic waste materials vegetable or food waste using various species of worms, usually red wigglers, white worms, and other earthworms,
- Vermicompost is a heterogeneous mixture produced by decomposing of organic materials and collected from the excreta of the worms
- Vermicompost contains water-soluble nutrients and is an excellent, nutrient-rich organic fertilizer and soil conditioner. It is used in farming especially small scale sustainable, organic farming as adopted in Rwanda
- Rwanda needs to produce more and more food because every year its population increases at the rate of 2.5%. Use of vermicompost is one of the solution for it.
- Attention is needed in the areas of loss of soil, organic carbon, and preserve the crop nutrients from the undulating topography of Rwanda.
- Chemically grown foods have adversely affected human health all over the world. As per UNEP and WHO some 25 million farmers and agricultural workers are poisoned by pesticides every year and nearly 3 million people suffer from acute pesticide poisoning and some 10 to 20 thousand people die every year from it in both the developed and the developing countries including Rwanda (UNEP Report, 2001).
- Global movement for organic farming is directed towards the production of bio-fertilizers and bio-pesticides with restoration of beneficial microbes and nematodes that can also protect plant health while promoting growth.

# Objectives of the Research

**Overall Objectives**

To produce vermicompost with locally available cow dung and to estimate the nutritive values of the compost for increased crop production.

**Specific Objectives**

- To produce vermicompost with available cow dung using earth worms.
- To estimate the content of total nitrogen (N), total Phosphorus (P), total potassium (K), total organic matter of the vermicompost and to test the acid-base through pH.

## REVIEW OF PREVIOUS WORKDONE

NPK Values of vermicompost made from cow dung compared with conventional cattle dung compost made from similar cattle dung significantly increases by 3 to 4 times. Agarwal (1999).

| S.No | Nutrients | Cattle dung compost pit | Vermicompost |
|---|---|---|---|
| 1 | N - Nirogen | 0.4-1.0% | 2.5-3.0% |
| 2 | P - Phosphorus | 0.4-0.8% | 1.8-2.9% |
| 3 | K - Potassium | 0.8-1.2% | 1.4-2.0% |

## Methodology adopted to produce vermicompost

- The work was carried out in a room with mud floor at the Kimonyi district
- Earth worms were collected in a cup from existing compost pits by digging the soil as shown below:

Collection of earth worms

Placing the earth worms in windrows

Watering the windrows

- Placing the cow dung on the ground as windrows. Two windrows of each 20 Kg weight of cow dung with the 0.5 m length and 0.5 m breadth are set up on the ground.
- 25 Number of worms are counted before placing them in each windrow of cow dung pile.

| Days | 1st day | 2nd day | 3rd day | 4th day | 5th day |
|---|---|---|---|---|---|
| Weight of added cow dung in kg on 1st windrow | 4 | 6 | 5 | 1 | 4 |
| Weight of added cow dung in kg on 2nd windrow | 5 | 4 | 2 | 3 | 6 |

- Water is sprayed on the windrow so as to keep the top surface without drying.

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- 25 Number of worms are counted before placing them in each windrow of cow dung pile.

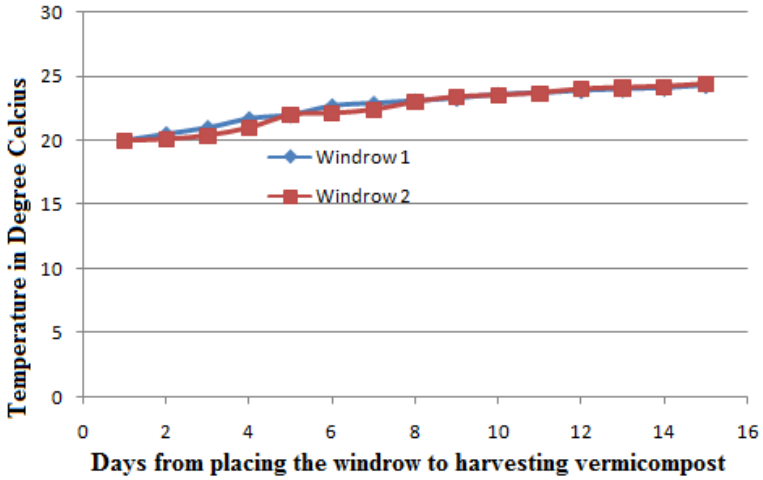
| Days | 1st day | 2nd day | 3rd day | 4th day | 5th day |
|---|---|---|---|---|---|
| Weight of added cow dung in kg on 1st windrow | 4 | 6 | 5 | 1 | 4 |
| Weight of added cow dung in kg on 2nd windrow | 5 | 4 | 2 | 3 | 6 |

- Water is sprayed on the windrow one time every day so as to keep the top surface without drying.

## Temperature change in the windrow systems

- Temperature at the middle of each windrow system was measured using a thermometer at mid day from 1st day to 15th day (day of harvesting)

| Days | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp,˚ C (1st pile) | 20.0 | 20.5 | 21.0 | 21.7 | 22.0 | 22.7 | 22.9 | 23.1 | 23.3 | 23.6 | 23.7 | 23.9 | 24.0 | 24.1 | 24.3 |
| Temp,˚ C (2nd pile | 20.0 | 20.1 | 20.4 | 21.0 | 22.0 | 22.1 | 22.4 | 23.0 | 23.4 | 23.5 | 23.7 | 24.0 | 24.1 | 24.2 | 24.4 |




Temperature of the windrows increases from 1st day to 15th day for both windrows. The difference in temperature is between two windrows are not significant. The mean temperature of 1st windrow is 22.7˚C and the 2nd windrow is 22.55˚C. It is not appreciable.

## Harvesting the vermicompost

After 15 days ,the vermiculture was harvested. Its color is almost black.

**Method of Harvesting**

- Remove gently the whole bedding of windrows from its location with hoe
- Keep the harvested vermicompost without disturbance for few minutes so that worms move to lower layers in order to escape heat and light (because naturally worms prefer a shaded area).
- Remove gradually the vermicompost at the top layer of the bedding. The worms in the top layer has to be taken safely by hand to use it in new windrows. This procedure is repeated in the second layer, third layer and so on.
- The materials without worms in the decomposed windrows is the vermicompost that can be used directly on crop.
- In order to store the vermicompost for a long time, it has to be dried to safe moisture content.
- The dried vermicompost has to be screened to remove impurities for concentrating the manure
- The dried and screened vermicompost has to be tested in the soil science laboratory for their NPK content.

# Unit Operations in Vermicompost production in Rwanda

Harvested Vermicompost

Earth worms from windrows kept on plastic sheet

Drying of vermicompost

Crushing the vermicompost

Sieving the vermicompost

**Total Nitrogen (N):**

The total nitrogen content of the vermicompost sample was tested and is shown below:

| Sample label | Sample Weight | Volume of $H_2SO_4$ (95-98%) | Catalyst | Sample Volume | Distilled Volume | Calibration factor | %Nitrogen in vermicompost |
|---|---|---|---|---|---|---|---|
| $S_1$ | 0.5g | 25ml | 3g | 100ml | 10ml | 20 | 1.41 |
| $S_2$ | 0.5g | 25ml | 3g | 100ml | 10ml | 20 | 1.48 |
| Percentage Nitrogen content in the vermicompost = | | | | | | | 1.45% |

The % nitrogen in the vermicompost is obtained by feeding the analyzer machine which analyses the inputs fed and the % Nitrogen is directly shown on the monitor of the machine. The above table show that the average percentage Nitrogen content in the vermicompost is 1.45% and it varies from 1.41 to 1.48%.

Agarwal (1999) stated that % N content of vermicompost made from cow dung will be 3 to 4 times higher than the ordinary compost from pits (0.4 to 1%). Agarwal (1999) has achieved 2.5-3.0% of N from the cow dung in India.

The variation between India and Rwanda may be due to

1) components in the cow dung 2) species of earth worm 3) Temperature effect 4) Windrows adopted above ground surface in Rwanda leads to volatilization of nutrients back to atmosphere and 5) Leaching of nutrient to atmosphere. Further research needed.

**Total Phosphorus (P):**

The total phosphorus content of the vermicompost sample was tested and is shown below:

| Sample label | Sample Weight | Volume of $H_2SO_4$ (95-98%) | Catalyst | Sample Volume | Estimated based as per lecture, P in ppm | Total Phosphorus in ppm | % total Phosphorus |
|---|---|---|---|---|---|---|---|
| $S_1$ | 0.5g | 25ml | 3g | 100ml | 5.32 | 1064 | 0. 1064 |
| $S_2$ | 0.5g | 25ml | 3g | 100ml | 6 | 1200 | 0.1200 |
| Percentage phosphorus content in the vermicompost = | | | | | | | 0.1132% |

The % phosphorus in the vermicompost is obtained by laboratory analysis. The above table show that the average % total Phosphorus content in the vermicompost is 0.1132% and it varies from 0. 1064% to 0.1200%.

Agarwal (1999) stated that % P content of vermicompost made from cow dung will be 3 to 4 times higher than the ordinary compost from pits (0.4 to 0.8%). Agarwal (1999) has achieved 1.8-2.9% of P from the cow dung in India.

The variation between India and Rwanda may be due to

1) components in the cow dung 2) species of earth worm 3) Temperature effect 4) Windrows adopted above ground surface in Rwanda leads to volatilization of nutrients back to atmosphere and 5) Leaching of nutrient to atmosphere.
2) Further research is needed for different agro climatic conditions in Rwanda.

**Total Potassium (K):**

The total potassium content of the vermicompost sample was tested and is shown below:

| Sample label | Sample Weight | Volume of $H_2SO_4$(95-98%) | Catalyst | Sample Volume | Estimated K based on lecture, K in ppm | %Total Potassium |
|---|---|---|---|---|---|---|
| $S_1$ | 0.5g | 25ml | 3g | 100ml | 18 | 0.36 |
| $S_2$ | 0.5g | 25ml | 3g | 100ml | 16 | 0.32 |
| Percentage potassium content in the vermicompost = | | | | | | 0.34% |

The % potassium in the vermicompost is obtained by laboratory analysis. The above table show that the average % total Potassium content in the vermicompost is 0.34% and it varies from 0. 32% to 0.36%.

Agarwal (1999) stated that % K content of vermicompost made from cow dung will be 3 to 4 times higher than the ordinary compost from pits (0.8 to 1.2%). Agarwal (1999) has achieved 1.4-2.0% of K from the cow dung in India.

The variation between India and Rwanda may be due to

1) components in the cow dung 2) species of earth worm 3) Temperature effect 4) Windrows adopted above ground surface in Rwanda leads to volatilization of nutrients back to atmosphere and 5) Leaching of nutrient to atmosphere.
2) Further research is needed for different agro climatic conditions in Rwanda.

**Total Organic Matter (OM):**

The total organic matter content of the vermicompost sample was tested and is shown below:

| Sample label | Sample Weight | Crucible weight | Crucible weight+ Sample weight(A) | Crucible weight+ Sample weight at 105°c(B) | Then B is elevated at 450°c and weight is recorded (C) | % Moisture (%M) | % Organic Matter (%OM) | % Organic Carbon (%OC) |
|---|---|---|---|---|---|---|---|---|
| $S_1$ | 2g | 43.57 | 45.57 | 45.40 | 44.37 | 0.18 | 56.34 | 32.68 |
| $S_2$ | 2g | 32.74 | 34.74 | 34.56 | 33.54 | 0.18 | 55.95 | 32.46 |
| Percentage Organic Matter (OM) and % Organic Carbon (OC) in the vermicompost = | | | | | | | 56.15 | 32.57 |

The % organic matter (OM) content in the vermicompost is obtained by laboratory analysis.

The above table show that the average % organic matter (%OM) content in the vermicompost is 56.15% and it varies from 55.95% to 56.34%.

The above table also show that the average % Organic Carbon (%OC) content in the vermicompost is 32.57% and it varies from 32.46% to 32.68%.

**Hydrogen ion Concentration (pH):**

The pH of the vermicompost sample was tested and is shown below:

| Sample label | Sample Weight | Distilled Water | PH |
|---|---|---|---|
| $S_1$ | 10g | 50ml | 8.55 |
| $S_2$ | 10g | 50ml | 8.66 |
| hydrogen potential ($PH_{H20}$) of the vermicompost = | | | 8.605 |

The pH of the the vermicompost is obtained by laboratory analysis.

The above table show that the average pH level in the vermicompost is 8.605 and it varies from 8.55 to 8.66%. It indicates that vermicompost is not acidic compost. Since, the pH of 8.605 is little above 7 (neutral), it is slightly base. It is a good fertilizer for crops.

## Summary and Conclusions 1/2

The following conclusions are drawn from the studies:

1. The average %N content in the vermicompost is 1.45% and it varies from 1.41 to 1.48%. It is higher than the %N content of ordinary compost from pits (0.4 to 1%). Agarwal (1999) has achieved 2.5-3.0% of N from the cow dung in India. Hence, there is a need to conduct coordinated trails in different regions of Rwanda to arrive a final conclusion for Rwanda.

2. The average % Phosphorus content in the vermicompost is 0.1132% and it varies from 0. 1064% to 0.1200%. It is higher than the %P content of ordinary compost from pits (0.4 to 0.8%). Agarwal (1999) has achieved 1.8-2.9% of P from the vermicompost produced from cow dung in India. Further research is needed for different agro climatic conditions in Rwanda to get final conclusions.

3. The average % Potassium (K) content in the vermicompost is 0.34% and it varies from 0. 32% to 0.36. It is higher than the %K content of ordinary compost from pits (0.8 to 1.2%). Agarwal (1999) has achieved 1.4-2.0 % K from the vermicompost produced from cow dung in India. Further research is needed for different agro climatic conditions in Rwanda to get final conclusions.

## Summary and Conclusions 2/2

The following conclusions are drawn from the studies:

4. The % variation of NPK content of vermicompost made in India and Rwanda may be due to 1) components in the cow dung 2) species of earth worm 3) Temperature effect 4) Windrows adopted above ground surface in Rwanda leads to volatilization of nutrients back to atmosphere and 5) Leaching of nutrient to atmosphere. Further research is needed for different agro climatic conditions in Rwanda.

5. The average % organic matter (%OM) content in the vermicompost is 56.15% and it varies from 55.95% to 56.34%. The average % Organic Carbon (%OC) content in the vermicompost is 32.57% and it varies from 32.46% to 32.68%. The vermicompost has high organic carbon which is good for higher crop production.

6. The average pH level in the vermicompost is 8.605 and it varies from 8.55 to 8.66%. It indicates that vermicompost is not acidic compost. Since, the pH of 8.605 is little above 7 (neutral), it is slightly base material. It is a good fertilizer for crops.

7. The authors wishes to have a coordinated research project on vermicompost production and its nutritive values in different agro climatic conditions to produce more accurate results. It is needed before technology transfer among farming communities.

# THANK YOU