Nutrient Recycling From Cashew Biomass Using Vermicomposting Technology- Proposal for Sustainable Development

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Abstract:

Cashew farming is one of the major crop cultivation in Cuddalore district of Tamilnadu in India. Cashew cultivation turns out a large quantity of waste will cause environmental pollution due to not have of administration by farmers; wastes are disposed of by dumping and burning. Dumping of waste will contaminate the soil and water bodies. Burning of waste is not an environmentally friendly method; it can cause land, water, and air pollution. To avoid such circumstances, a sustainable alternative way of the method is to be an approach to convert waste into useful products. Vermicomposting is a well known composting technique for stabilizing different degradable organic wastes. Biological waste treatment technologies such as vermicomposting are extensively observed as a clean and imperishable method to manage cashew biomass and review the result of organic manure on the application of cashew grafts growths.

1. Introduction

Cuddalore district was considered to include the maximum area and production of cashew in Tamil Nadu state [3]. Cashew is an important plantation crop in Panruti and Vridhachalam in this district. Due to its high dietary value and increasing affordability by the consumers, demand for cashews many farmers in the sector are planting cashews [4]. The present production of cashew is less which requires adopting new technology for improving productivity. In Cashew plantations a grown-up cashew tree produces huge cashew biomass waste per year (biomass waste - cashew leaf litter, pruning’s, waste cashew apples, etc.). The disposal of waste has become one of the major complications for farmers. Natural decomposition of cashew biomass will occur nearly 9 month due to the presence of many complex molecules like polysaccharides, Polyphenols, Aminocompounds, lignin, etc. There is a chance of catching fire due to long time exposure to waste in the natural decomposition. During 2017-2018 production of cashew percentage is less in the market. It is largely believed that cashew is a dry land crop and does not need much care, as a result of which it is given the least attention. Low productivity is due to large plantations under seedling origin, the practice of chemical fertilizer and pesticides, poor orchard management practices (accumulation of Biomass) and severe occurrence of tea mosquito bug (TMB). Improper utilization of cashew waste reduces the yield from cashew orchids. There is Solid waste management is a worldwide dilemma and it is fetching more and more complicated day by day [10]. The present tendency about waste...
management is a crucial point in recycling and the revival of waste as new materials [6]. To overcome the issues; a new way of technology is implemented to preserve the environment for our sustainable future. About 3.5 t of cashew biomass available per ha can be converted into 1.5 t of vermicompost which contributes 50 percent of the nutrient essential of cashew plantations Vermicomposting will be one of the best, technological sound techniques for treatment of solid biomass using earthworm and cow dung [2]. People will burn cow dung for various reasons; it will cause an environmental problems and health issues. Cow dung contains valuable nutrients, just the once the cow dung incinerate; the nutrients present in it are helpless. The earthworms and the microorganisms are ingested organic matter and fragmented them into one particle by passing them through its gizzard and produced organic manure is called Humus or worm casting[12]. The castings are enriched with macro and micronutrients when compared to chemical fertilizer. Conventional agriculture is accomplished with chemically prepared fertilizer resulted in the degradation of soil quality and losses of agricultural biodiversity [11]. The worm castings are powdered form like spongy, easily hold moisture, it supplies nutrients, whenever the plant requires [13]. Humus contains cation exchange capacity; swap the cations between root hair and soil. The studies reveal the role of vermicompost in recycling cashew waste and has been identified as one of the potential cost-effective, eco-friendly methods helps in replenishment of plant nutrients, maintains soil health, reduces the pollution problem and creates employment opportunities, therefore, it can be recognized as a strategy for sustainable organic cashew grafts farming.

2. Materials and methods

2.1 Predecomposition of cashew Biomass and CowDung

Cashew apples, the pseudo fruits are rich in ascorbic acid sugars, minerals, and other anti-oxidants. On average of 35 tones of cashew apple is wasted every year. The Cashew biomass waste was collected from Cashew Cultivators in Vriiddachalam Taluk. Cattle dung is collected from cow shelters. Dry cow dung should be used for vermicomposting. Wet dung will generate heat; it will influence the earthworm’s progress. Eudrillus Eugenia earthworm was collected from Vermiculturist entrepreneur Mr. Sekar, Kattukotagai, Thoravalur, Virudhachalam, Cuddalore district. Adequate water is essential for maintaining moisture in the compost Pit. 3-5 liters every week per pit. Predecomposition of cashew waste with cow dung is necessary for achieving better activity of earthworm and nutrient-enriched vermicompost production.

![Collection of Earthworm (Eudrillus Eugenia)](image-url)

**Figure 1.** Collection of Earthworm (Eudrillus Eugenia)
All parts of cashews are important. Especially Cashew apple is famous for its high ascorbic acid content (vitamin - c). It is useful for digestion. Different products are prepared from the apples, such as fruit juice, syrup canned fruit; pickles, jam, jelly, chutney, and vinegar by the self-help group women in Virudhchalam taluk.

3. Preparation of Organic Manure from Recyclable Cashew Biomass
Vermicomposting it can be done in both a large and small scale. A small vermicompost pit is constructed in peralaiyur village, Vriddachalam Taluk with 6 feet in length, 3 feet in height, and 4 feet in width. The size of the Pit depends upon the availability of raw materials.
Table 1. Cashew Nutritional Content per 100 Gm (Anacardium occidentale)

| Nutrition   | Content    |
|-------------|------------|
| Carbohydrates | 30.19 g   |
| Protein     | 18.22 g    |
| Total Fat   | 43.85 g    |
| Cholesterol | 0 g        |
| Energy      | 553 Kcal   |
| Dietary Fiber | 3.3 g  |
| Vitamin E   | 5.31 mg    |

Source: CEPCI, 2015 (Cashew Export Promotion Council of India)

By the side of the bottom of the pit small hole is connected with a small channel pipe for collecting vermiwash. Add a layer (3 inch) of soil followed by a layer of sliced dried leaves should be kept a bedding material at the bottom of the pit. Disperse the predigested waste material evenly on the bedding material layer.

Figure 4. Cashew biomass in the pit

After adding all the biomass release the Eudrillus Eugenia earthworm (1kg) species over the mixture and cover the compost pit with moist gunny bags. Throughout the experiment moisture content at 60–76% and temperature at 25°C to 35°C was maintained with proper aeration. Repeated checking is required to preserve the compost pit from overheating. Vermicompost pit should be turned once after 20 days for maintaining aeration and for decomposition. Maintain proper moisture, Aeration, and temperature brown color humus are formed after 90 days. Sieving is done for separating cocoons; earthworms and organic manure (Humus). Samples are collected for nutrient analysis.

Figure 5. Humus before Sieving & After Sieving
Table 2. Methods of analysis of parameters

| S.No | Parameters                          | Instruments Used             |
|------|------------------------------------|------------------------------|
| 1    | PH                                 | pH meter                     |
| 2    | Electrical conductivity             | Digital EC meter             |
| 3    | Total Kjeldahl Nitrogen (TKN)      | Micro Kjeldahl method        |
| 4    | Total Phosphorus (TP)              | spectrophotometrically       |
| 5    | Total Potassium (TK)               | Flame Emission Technique     |
| 6    | Total organic carbon (TOC)         | Walkey and Black’s Rapid Titration method |

Table 3. Physicochemical analysis of Cashew Biomass waste- based Vermicompost

| Parameter          | Initial weight of cashew biomass (%) | Vermicompost values in (%) |
|--------------------|-------------------------------------|-----------------------------|
| PH                 | 10.60                               | 6.40                        |
| OC (%)             | 42.4                                | 25.2                        |
| N (%)              | 1.6                                 | 2.32                        |
| P (%)              | 0.59                                | 1.12                        |
| K (%)              | 0.50                                | 1.02                        |
| C:N                | 30:2                                | 11.2                        |

4. Organic Cashew Cultivation in Cuddalore District

In the cuddalore district, the main crops are paddy, sugarcane, groundnut, pulses, etc. Cashew is considered a dry land horticultural crop and is also a main commercial plantation.

Table 4. Major Areas of Crops in Cuddalore District

| Crops      | Hectares |
|------------|----------|
| Sugarcane  | 30.304   |
| Rice       | 30.250   |
| Maize      | 20.520   |
| Black gram | 52.338   |
| Green Gram | 11.229   |
| Cashew     | 30.146   |

Source: Cuddalore District handbook
Farmers in Vriddachalam Taluk regularly followed with chemical fertilizer Cultivation. But some farmers under the guidance they go behind with traditional organic farming. Cashew plantation in rain-fed cultivation without proper management and chemical fertilizer is the main reason for low productivity. Cashew cultivation needs basic nutrients for optimal growth performance and production on a sustainable basis. Inorganic fertilizers are insufficient, expensive, and have several side effects on soil and water bodies. Application of organic fertilizers has been reported to have long and permanent effects on soil better access to water, nutrients, reduced bitterness, and improved soil biological activities which are advantageous to soil and plant relations. The analysis reveals that the study region has rapid growth in the area under organic cashew cultivation.

5. Cashew Varieties
The District has been identified as the originality and cashew trade quality in the market. Most of the crops are destroyed due to the usage of chemical fertilizer and by natural disasters like rain.

![Figure 6. Tamil Nadu varieties of cashew VRI 3](image)

By adapting the organic farming method there are the new ways for generating varieties of plants. In study region, farmers cultivate various varieties of cashew VRI 1, VRI 2, VRI 3, and VRI 4, VRI (CW) H1. The VRI 3 variety is more popular among the farmers.

6. Intensification of Cashew Grafts
Cultivation of cashew was made from seeds methods but the yielding was very low. Therefore farmers have adopted different grafting methods. Appropriate Period for grafting is January to April because the success rate of grafting is high within this period as a result grafting method is commercially adopted in the study region. Planting of grafted plants is usually carried out in July-September. Four different ratios of vermicompost were used for the study of cashew grafts. The cashew cultivation and production need controlled knowledge, proficiency with the help of technology. But it is observed that the level of usage of chemical fertilizers, pesticides, fungicides is very low in our study region.
Organic cashew grafts production reduced the usage of chemical fertilizers and pesticides. The Majority of farmers obtained grafts from horticultural entrepreneurs even though it is costly 20 to 30 Rs per plant due to natural farming and high productivity.

In the present germination studies, cashew seeds were sown in the poly bags filled with soil mixed with different levels of vermicompost (Control, 5, 10, 15, and 20 %). The application of different levels of vermicompost increased the seed germination percentage of cashew grafts. The major nutrient requirement of cashew graft growth demands supplementary liberal function of Nitrogen, Potash in large quantity, and Phosphorous in less important quantity. The highest germination percentage was observed in 2 Kg of vermicompost applied bags.

### Table 5. Vermicompost Ratio for cashew grafts

| parameter | Quantity of Vermicompost                                      |
|-----------|-------------------------------------------------------------|
| T1        | Garden soil – Control                                       |
| T2        | (4.5kg soil +0.5kg vermicompost -5%)                        |
| T3        | (3 kg soil + 1kg vermicompost – 10%)                       |
| T4        | (2.5 kg soil +1.5kg vermicompost- 15%)                     |
| T5        | (2 kg soil +2kg vermicompost -20%)                         |

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### 7. Results and discussion

The tendency of earthworms to decompose cashew biomass waste was studied by using Eudrillus Eugenia under laboratory conditions. The present research confirmed beyond doubt that Cashew biomass can be served as feedstock for earthworm and converted into nutrients and microbial rich organic manure called vermicompost by the action of Eudrillus Eugenia. The vermicompost of cashew biomass showed many-fold increase in some important plant nutrients, which suggests that the product can be used as potential plant growth media. The analysis conducted of cashew grafts growth using both organic manure and chemical fertilizer. Out of five parameter analysis, T5 shows average growth than other parameter sequences. A large number of insects and pests have been reported in cashew younger grafts. Mosquito bugs are the most serious pest and are managed by sprinkling vermiwash (0.2 ml) in the prescribed level. All plant growth parameters were increased in T5 treatment compared to T1. Vermicompost contains...
important plant nutrients required by cashew and also useful microorganism.

Table 6. Cashew grafts Growth Parameters

| Treatment | Height(cm) | Root length(cm) | Number of leaves | Leaf length (cm) |
|-----------|------------|-----------------|-----------------|-----------------|
| T1        | 2.5        | 0.6             | 4               | 0.7             |
| T2        | 4.0        | 1.2             | 7               | 1.1             |
| T3        | 7.5        | 1.3             | 10              | 2.4             |
| T4        | 8.5        | 1.5             | 13              | 2.5             |
| T5        | 9.0        | 2.0             | 15              | 3.0             |

In the present research, it was found that only organic fertilizer was treated for cashew grafts. Average plant height for different experimental plots was in the order of T5 > T4 > T3 > T2 > T1 in cashew grafts. All plant growth parameters were increased in T5 treatment compared to T1. The graft height and root length of grafts were significantly affected by the growing media. Among the growing media, the maximum graft height and root length were recorded in grafts grown in T5 treatments and least in grafts grown in control. The lesser height recorded in grafts might be due to late bud break in such grafts. Better root growth might be due to early sprouting, a better union, quick callus formation, and healing leading to better growth of the scion shoots. It was found that pots containing soil amended with vermicompost (T5) at the time of plant growth achieving significantly large number of leaves, shoot dry matter than T1. Due to the lack of organic matter in orchard soil, the height of the grafts grown in control could not improve. These results revealed that an increase in plant growth could probably be due to improvement in the physicochemical properties of soil; increase in enzymatic activity; increase in the microbial population, diversity and activity; easy availability of macro and micronutrients; and also increase in plant growth hormones by application of vermicompost.

Figure 8. Growth of cashew grafts grown under the various ratio of vermicompost
Many kinds of research researches are propagating the improved varieties and the area covered under cashew in the recent past with the grafts of high yielding varieties.

![Figure 9. Root growth of T2 and T5](image)

Organic manure is acts as a chelating agent. It slowly supplies the minerals in slow manner based on the necessities of plants.

![Figure 10. Growth Parameters](image)

Unavailable nutrients are chelated by organic manure and converted to available nutrients for plants. Due to constant efforts by farmers, strong research back up of good results achieved in organic cultivation.
Humus slowly dissolves in the water and soil converted into humic acid and Fulvic acid. Both the acid is responsible for plant stimulating kick-starter, which promotes the growth of the grafts. The analysis of cashew cultivation reveals that there is variation in the methodology, but organic cultivation which has given more realistic results, over half of the area possesses high-efficiency region.

8. Conclusions
Farmers in virudhachalam Taluk have been demanding a new way of crop growing to protect the environment. The Majority of the farmers like to work with organic farming to the preservation of cashew cultivation and soil. Farmers in virudhachalam Taluk have been demanding a new way of crop growing to protect the environment. The tendency of earthworms to decompose cashew biomass waste was studied by using Eudrillus Eugenia under laboratory conditions. The studies have proved the high degree of organic matter stabilization has been achieved by vermicompost preparation of cashew biomass. The Vermicomposting application had an optimistic result on the ecosystem. It can be concluded that vermicomposting technology is one of the most economic, eco-friendly waste management technologies and resulting in the bioconversion from waste to wealth.

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