

# Cost Effectiveness of Producing Compost and Its' Applicability in Farmers' Field

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**Abstract-** *Composting is becoming more and more important as the detrimental effects of synthetic fertilizers grow. Particularly in the Sri Lankan context, with the low fertility of agricultural soils, increasing environmental and health issues and Government initiatives and policies, there is a timely requirement to incorporate compost into agriculture. Therefore, potential opportunities for compost production have increased with the rising demand for compost. This study aims to evaluate the profitability of medium-scale compost producers in Sri Lanka and to estimate the cost of replacing synthetic fertilizers. The study was carried out with eighteen medium-scale compost producers through telephone interviews. The results reveal that the production of organic compost is a profitable venture in terms of Net Present Value (NPV) Rs. 207981.91, Benefit Cost Ratio (BCR) 1.121 and Internal Rate of Return (IRR) 29.53%. Based on the production capacity, the producers were classified into three classes. However, there are no significant differences between the three classes in the measures of project worth. All the producers in the three classes almost produce compost within the acceptable range of Nitrogen (N), Phosphorous (P) and Potassium (K) and there are no significant differences between the classes in the N, P and K content. The average compost selling price is Rs.30.84/Kg. Between the three classes, there are no significant differences in the compost selling price. Attempts were taken to estimate the cost of fully (100%) and partially (50%) replacing inorganic fertilizer (IOF) with organic fertilizer (OF) for five crops. The findings indicate that the amount of OF to fully replace Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MOP) to provide recommended N, P and K levels for the crops are 13.6, 16.3 and 53.8 times higher respectively. The cost incurred to fully replace MOP is the highest followed by TSP. Thus, it is evident that the farmers have to bear a substantially high cost when replacing synthetic fertilizers with compost. This study provides important implications for compost producers when venturing into compost production and policymakers about the practical limitations associated with applying compost to farmer fields.*

**Keywords:** *Compost, Project worth, Cost of replacing*

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## 1 INTRODUCTION

Sri Lanka had a thriving and subsistence agriculture sector in ancient times with organic farming being a key determinant factor. Traditional Sri Lankan farmers used organic inputs such as crop residues, animal and green manures. They practiced traditional measures such as shifting cultivation, crop rotations and diversification to improve soil fertility. However, with the colonization, there was a significant shift in the agriculture sector from conventional subsistence farming to export-oriented commercial plantation agriculture (Dandeniya and Caucci 2020). With the 'green revolution' in the 1960s, to meet the increasing demand for food, high-yielding hybrid seeds and agrochemicals including inorganic fertilizer (IOF), pesticides and hormones were introduced to Sri Lanka. Furthermore, with the open economy and liberalization of imports in 1977, the usage of agrochemicals has intensified in the country (Ranasinghe 2016).

With the excessive use of synthetic fertilizers, depletion of nutrients and decline in the overall fertility of soils have become major issues in agriculture. According to Dandeniya and Caucci (2020), improper handling of these fertilizers has also led to health and environmental problems, including contamination of surface and groundwater with harmful metals. The increment of chronic kidney disease and cancer is debated as causes of long-term exposure to agrochemicals (Ranasinghe 2016; Dandeniya and Caucci 2020). Furthermore, the increasing population and demand for food highlight the requirement to restore soils by mitigating soil degradation and preserving the soil organic matter content (Hettiarachchi *et al.* 2020).

Given this context, the need for composting is crucial. Compost is a mixture of organic materials, multiple nutrients, microorganisms and water. The short, mid, and long-term potential benefits of using compost include the supply of nutrients, sequestration of Carbon to the soil, suppression of pests, diseases and weeds, increasing crop yield, prevention of soil erosion, increasing the capacity of soil to retain moisture, improving soil workability, influencing the soil biodiversity and biological properties and improving crop nutritional quality (Martínez-Blanco *et al.* 2013). Applying compost to the soil improves soil fertility by replenishing the soil nutrient pool. Therefore, it is viewed as a better solution for land restoration and applying compost is recommended to soils that have decreased fertility (Dandeniya and Caucci 2020; Hettiarachchi *et al.* 2020).

Particularly in Sri Lanka, the soil of agricultural lands has low soil fertility levels and organic matter content. Therefore, the application of organic fertilizer (OF) can enhance the soil organic matter content, soil fertility and ultimately the crop productivity of Sri Lanka (Dandeniya and Caucci 2020). Sri Lanka has also pledged its commitment to the 2030 agenda for sustainable development with a set of seventeen Sustainable Development Goals (SDGs). The direct effect of composting on waste management, nutrient recycling, and agriculture supports achieving several SDGs. SDG two on zero hunger, SDG twelve on responsible consumption and production, and SDG thirteen on climate action are all directly aided by increased composting activities (Hettiarachchi *et al.* 2020).

The Government of Sri Lanka practices a development policy with the target of reducing synthetic fertilizer imports and promoting OF usage. It has also initiated different programs to popularize compost production. In 2008, the '*Pilisaru*' program aimed to recycle biodegradable waste on a household and municipal level (Basnayake and Visvanathan 2014). By incorporating the ideas of integrated plant nutrition management and organic farming, home gardening was encouraged under the '*Api wawamu rata nagamu*' (let's grow and develop the country) initiative (Dandeniya and Caucci 2020). To make the country free from harmful agrochemicals, the program '*Vasa Visa Nethi Ratak*' (Towards Toxin Free Country) was launched in 2016 (Ranasinghe 2016). The project '*Saralanka*' was conducted in 2016 to help small-scale OF producers to develop to medium-scale by giving loans at low interest rates. The most recent and most controversial Government policy on banning the import of synthetic fertilizers, forced the farming systems to convert to organic farming. Thus, the demand for OF has suddenly boomed in the country (Dias *et al.* 2022). This has increased the opportunities for compost producers.

On this background, this study aims to methodologically evaluate the profitability of medium-scale compost producers in Sri Lanka by using measures of project worth. The study also focuses on evaluating the Nitrogen (N), Phosphorous (P) and Potassium (K) content of the compost produced by medium-scale producers. Further, this paper attempts to estimate the cost of replacing synthetic fertilizers i.e. Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MOP) with compost.

## 2 METHODOLOGY

In this study, eighteen medium-scale compost producers were selected based on practical considerations and the availability of data. The Department of Agriculture maintained three lists of compost producers categorized as small, medium, and large-scale. However, the large-scale producers were reluctant to provide data, and many small-scale producers lacked sufficient records and were not operating consistently. As a result, medium-scale producers who have registered with the Department of Agriculture and obtained the issued certificate, were purposively selected. The sample includes producers from several key Districts, including Colombo, Galle, Matara, Kalutara, Kurunegala, and Gampaha, covering a range of geographical areas. Additionally, both new and experienced producers were included, offering a broad perspective on compost production in Sri Lanka.

However, there are potential biases in the data collection process. Data were gathered through telephone interviews, which limited the ability to verify certain aspects of compost production in person. Moreover, the reliance on self-reported data introduces the possibility of biases, as producers may have overstated or understated certain aspects of their operations. These biases may affect the accuracy of the findings, but the use of telephone interviews was a practical necessity during 2020-2021. Despite these limitations, the sample of eighteen medium-scale producers provides valuable insights into the composting sector in Sri Lanka, particularly in understanding the operations of producers who are most likely to be representative of the broader composting population.

### 2.1 Profitability of Producing Compost at Various Scales of Production

The different costs, including the cost of the machine/s, machine maintenance, raw materials, labor, fuel, water, etc., were collected. The costs of packing were calculated by considering the price of an empty compost bag. The expected shelf life of the machine was also asked from the producers. The compost selling price and returns they have received from their compost production were also gathered. In addition, the data on N, P and K content of the compost produced by the producers were collected.

To calculate the worthiness of producing compost, the Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) were calculated assuming a five-year Project benefit period. A discount rate of 10% was used to do the calculations.

NPV can be defined as the difference between total discounted cash inflow (benefits) and cash outflow (costs) over the project's lifetime. As shown in equation (1), NPV is calculated by discounting future benefits and costs to their present values. A project is considered profitable if the NPV is positive and not profitable if it is negative. When there are multiple projects, the one with the highest NPV receives the highest priority.

$$NPV = \sum_{n=0}^N B_n / (1 + i)^n - \sum_{n=0}^N C_n / (1 + i)^n \quad (1)$$

where  $B_n$ - benefit in each year,  $C_n$  – cost in each year,  $i$ = discount rate and  $n$ =number of years with  $N$  being the total project lifetime

BCR, as expressed in equation (2), can be defined as the ratio of total discounted cash inflow (benefits) to cash outflow (costs) over the project's lifetime. A project with BCR more than one is considered profitable. The higher the BCR, the higher the benefits of the project.

$$BCR = \frac{\sum \frac{B_n}{(1+i)^n}}{\sum \frac{C_n}{(1+i)^n}} \quad (2)$$

where  $B_n$  – benefit in each year,  $C_n$  = cost in each year,  $i$ = discount rate and  $n$ =number of years

IRR is the discount rate that makes the NPV of a project equal to zero as presented in equation (3). It shows the average returns of the funds used over the project life. When the IRR is greater than the opportunity cost of capital, a project is considered profitable.

$$IRR = \sum_{n=0}^N \frac{B_n - C_n}{(1+i)^n} = 0 \quad (3)$$

where  $B_n$ = benefit in each year,  $C_n$  = cost in each year,  $i$ = discount rate and  $n$ =number of years with  $N$  being the total project lifetime

The collected data were analyzed using Microsoft Excel and IBM SPSS Statistics 23. Based on their production capacity, the producers were divided into three main classes as class 1, 2 and 3 as displayed in Table 1.

**Table 1 Three classes of producers**

Class	1	2	3
Production Capacity per annum	<20Mt	20-40 Mt	>40Mt

## 2.2 Cost-effectiveness of Using Compost over Synthetic Fertilizers

The average levels of N, P, and K in the compost samples and the average selling price of compost were determined using the collected data.

Subsequently, secondary data on NPK application, represented by Urea, TSP, and MOP for other field crops (OFCs) such as maize, chili, and big onion were gathered from the Cost of Cultivation information of 2021 from the Department of Agriculture. The cost and quantity applied of Urea, TSP and MOP were considered.

However, with the unavailability of data on the cost of cultivation in 2021 for paddy irrigated and rainfed for the whole island, the data for 2019 were taken and then adjusted using the National Consumer Price Index values to 2021.

A sensitivity analysis was carried out to check the cost-effectiveness of using OF by replacing 100% and 50% of IOFs.

## 3 RESULTS AND DISCUSSION

The average total fixed cost, variable cost and returns of the producers are Rs. 322581.7, 659724.67 and 796166.67 respectively. The worthiness of producing OF was calculated using the measures of NPV, BCR and IRR. The average NPV, BCR and IRR of the producers in the sample are Rs. 207981.91, 1.121 and 29.53%. These measures reveal that producing compost

is a profitable venture. This is in line with the findings of Pandyaswargo and Premakumara (2014) with a BCR 1.12 of Matale Composting Plant that can produce 0.3 Compost Tons Per Day. Further, they estimated the NPV for the plant as 33,194 USD.

Table 2 displays the average NPV, BCR and IRR computed for producers categorized into three classes. The findings indicate that producing compost is a profitable venture across all three classes. In terms of NPV, it is evident that the producers in class 3 yield the highest returns followed by those in class 1. In contrast, class 1 demonstrates the highest BCR while class 3 exhibits the lowest. However, when considering IRR, class 2 emerges as the most favorable scale of operation. Nonetheless, the results of the one-way ANOVA revealed no significant differences among the three classes in any of the calculated indicators (Table 3). This suggests individuals across various scales ranging from 6 Mt to 66 Mt per annum can profitably engage in compost production.

**Table 2 Average of Measures of Project Worth of the three classes**

Class	NPV (Rs)		BCR		IRR (%)	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Class 1	208874.67	200409.97	1.17	0.24	30.90	21.93
Class 2	156635.44	149312.44	1.09	0.10	31.25	22.43
Class 3	257096.49	172480.70	1.06	0.06	22.67	10.02

**Table 3 Results of the One-way ANOVA for measures of Project Worth**

Measure	Sum of Squares	df	Mean Square	F	P value
NPV	20202780058.18	2	10101390029.09	0.293	0.750
BCR	0.05	2	0.022	0.603	0.560
IRR	56.54	2	28.272	0.053	0.948

The average N, P, and K content in the compost of the three classes were analyzed and presented in Table 4. The acceptable range of N, P, and K levels, as shown by Samaradiwakara and Nawas (2016), is provided in the bottom row of the table. It's noteworthy that all three major nutrients present in all three classes of production fall within the acceptable range. Interestingly, compost from classes 1 and 3 slightly exceeds the acceptable range. However, although the presence of P and K is within acceptable levels, the levels are closer to the lower end. Nevertheless, there is no statistically significant difference in the levels of N, P, or K across the different classes of compost production studied, as shown in Table 5.

**Table 4 Average N, P, K content of three classes**

Class	N (%)		P (%)		K (%)	
	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Class 1	3.57	2.22	1.30	0.57	1.22	0.47
Class 2	2.68	1.97	1.10	0.14	0.89	0.62
Class 3	3.59	2.93	1.18	0.27	1.08	0.23
Acceptable level* (%)	0.5-3.0		0.5-4.0		0.5-3.0	

\* Source: Samaradiwakara and Nawas, 2016

**Table 5 Results of the One-way ANOVA for N, P and K content**

Content	Sum of Squares	df	Mean Square	F	P value
N (%)	2.52	2	1.26	0.23	0.80
P (%)	0.12	2	0.06	0.29	0.75
K (%)	0.33	2	0.16	0.73	0.50

The selling price of compost was evaluated. The average selling price of compost in the sample is Rs. 30.84/Kg. The producers in the 3<sup>rd</sup> class display the highest selling price (Rs.36.68/Kg) while the producers in class 2 have the lowest (Rs.26.88/Kg) (Table 6). However, the One-way ANOVA test revealed (Table 7) that there is no significant difference between the three classes in compost selling prices.

**Table 6 Average compost selling prices of three classes**

Class	Average (Rs/Kg)	Standard Deviation (Rs/Kg)
Class 1	30.10	8.07
Class 2	26.88	3.75
Class 3	36.68	11.96

**Table 7 Results of the One-way ANOVA for compost selling price**

	Sum of Squares	df	Mean Square	F	P value
Compost selling price	204.55	2	102.28	1.45	0.27

The requirement of fully (100%) and partially (50%) replacing synthetic fertilizers i.e. Urea, TSP and MOP by OF for Paddy-Rainfed, Paddy-Irrigated, Maize, Chili and Big onion were estimated (Table 8). The required amount of OF to fully replace Urea, TSP and MOP is 13.6, 16.3 and 53.8 times high respectively. To partially replace those 6.8, 8.1 and 26.9 times higher OF quantities are required. The amount of OF required to replace MOP is remarkably high.

**Table 8 Requirement of OF to replace synthetic fertilizers.**

Crop	IOF Requirement (Kg/ha) *			Requirement of OF to replace 100% IOF (kg/ha)		
	Urea	TSP	MOP	N	P	K
Paddy (Rainfed)	61	18	27	830.72	293.35	1453.7
Paddy (Irrigated)	111	24	21	1511.63	391.13	1130.7
Maize	177.33	65.5	103	2414.94	1067.47	5545.6
Chilli	251	90		3418.20	1466.75	
Big onion	50	75		680.92	1222.29	

\* Source: Cost of cultivation, Department of Agriculture

**Table 8 Continued**

Crop	Requirement of OF to replace 50% IOF (kg/ha)		
	N	P	K
Paddy (Rainfed)	415.36	146.68	726.85
Paddy (Irrigated)	755.82	195.57	565.33
Maize	1207.5	533.74	2772.79
Chilli	1709.10	733.38	
Big onion	340.46	611.15	

Table 9 displays the cost of replacing IOF by OF at 100% and 50% levels for the five crops. The costs of replacing MOP are very high for all the crops followed by the TSP replacement. The cost of replacing urea is the lowest. It is visible that fully replacing IOF with OF requires double the costs than partial (50%) replacements. This analysis also depicts that replacing synthetic fertilizers with compost requires a substantially higher cost.

**Table 9 Cost of replacing synthetic fertilizers with compost**

Crop	Cost of IOF* (Rs/ha)			Cost of OF to replace IOF fully (Rs/ha)		
	Urea	TSP	MOP	N	P	K
Paddy (Rainfed)	693.17	204.54	306.81	25622.67	9048.11	44837.83
Paddy (Irrigated)	1355.65	272.72	238.63	46624.86	12064.15	34873.87
Maize	5497.23	2145.13	4171.5	74486.37	32925.07	171048.03
Chilli	6902.5	2700		105431.00	45240.55	
Big onion	1600	3000		21002.19	37700.46	

\*Source: Cost of cultivation, Department of Agriculture

**Table 9 Continued**

Crop	Cost of OF to replace 50% of IOF (Rs/ha)		
	N	P	K
Paddy (Rainfed)	12811.34	4524.05	22418.92
Paddy (Irrigated)	23312.43	6032.07	17436.93
Maize	37243.18	16462.53	85524.01
Chilli	52715.5	22620.27	
Big onion	10501.10	18850.23	

Thus, it is clear that farmers should be given more incentives to be involved in organic farming and to adapt compost to their fields. Given the relatively high expenses of using compost over synthetic fertilizers, which are economically viable but environmentally unfavorable, government subsidies are necessary for compost.

Incorporating compost and involving in organic farming practices require additional effort and costs for the farmers. Thus, they require additional prices for their organic products. Organic food has a 20–40% price premium in international markets (Xia and Zeng 2008). Furthermore, several studies in Sri Lanka show that consumers are willing to pay price premiums for organic products (Wijesinghe *et al.* 2019; Wijesinghe and Nazreen 2020; Malkanthi 2020). However, it is questionable whether these additional costs involved in organic farming can be covered by the price premiums displayed by the consumers. Even though, organic products have potential markets with consumer segments in urban areas, their potential to succeed in rural and estate sectors is quite doubtful. Rather than adapting organic farming as a general practice in the country, organic products can aim at niche markets and international markets.

Further, we recommend future research with increased sample sizes to include a more diverse range of producers across all scales, as a more representative sample encompassing small, medium, and large-scale producers will provide a more holistic view of the compost

production industry in Sri Lanka. Additionally, employing a mixed-methods approach would be beneficial. This could involve incorporating on-site visits or third-party validation in conjunction with telephone interviews, which would help address the risks associated with self-reported data.

#### 4 CONCLUSIONS

Considering the measures of project worth i.e. NPV, BCR and IRR, medium-scale compost production can be viewed as a profitable venture in Sri Lanka. The N, P and K content of compost produced by medium-scale producers are in acceptable amounts. Using compost instead of synthetic fertilizers comes at a substantial price for farmers. This study provides insights for producers regarding the profitability of compost production and for policymakers about the applicability of compost in farmer fields.

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