

The productivity and economic value of sweet potato (*Ipomea batatas*) planted intercropped with satoimo taro (*Colocasia esculenta* (L.) Schott var. *Antiquorum*) with various levels of compost

*by Muh Jayadi*

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## The productivity and economic value of sweet potato (*Ipomea batatas*) planted intercropped with satoimo taro (*Colocasia esculenta* (L.) Schott var. *Antiquorum*) with various levels of compost

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**Abstract.** Sweetpotato (*Ipomea batatas*), as a well-known plant and widely cultivated by farmers in South Sulawesi, if it is intercropped with satoimo taro (*Colocasia esculenta* (L.) Schott var. *Antiquorum*) as a staple crop should be suspected of being able to be a 'safety' crop when there is a failure in taro plant—due to the relatively new and un-well-known plant. The study was aimed to know the productivity and economic value of sweet potato planted as an intercropped on the staple crop satoimo taro plantation with several levels of compost. The study used a randomized complete block design with four levels of manure compost, namely 400 grams, 800 grams, and 1200 grams per staple plant, which put into and mixed evenly in the plant hole, and 1200 grams per staple plant which mixed evenly in the beds, and three blocks. Sweet potatoes were planted between staple plants satoimo that arranged 20 plants in a bed of 500 cm x 110 cm in two rows. The parameters observed were yields of tuber per plant, size of tuber, number of tubers, and dry weight of tops. The results showed that there is no level of compost affected significantly. However, both of the levels of 1200 grams of compost which is filled into the plant hole, and 1200 grams of compost mixed in the beds tended to be higher than the others in tuber productivity. By economic valuations, the RC-ratio and RC-ratio indicated that planting intercropped sweet potato are beneficially in all levels and increased after the levels of compost. Cultivating sweet potato intercropped in the two kinds application of 1200 grams levels in the taro plantation is more recommended.

### 1. Introduction

#### 1.1. Background

ITPC OSAKA reported, so far, imports of commodity HS 0714 (tubers group) in Japan were dominated by imports of taro, especially Japanese taro "satoimo" with a share of more than 60%, while imports of sweet potatoes reached 22.4%. In terms of taro imports, China currently controls the Japanese market with a 99.6% share, while Indonesia is the sixth-largest supplier (in 2019) with a 0.03% share behind Vietnam, Taipei, Myanmar, and the United States. Indonesia has great potential to develop the taro export market, considering that Indonesia's taro exports to the world show a significant growth of 25% in 2019 [1].



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In South Sulawesi, the satoimo taro plant (hereinafter referred to as "satoimo" only), was designated by Gubernur as one of the important crops to increase exports to Japan. Because of that, socialization and even training and capital assistance have been carried out to farmers in all regions since 2019. However, the failure rate of production is still relatively high, causing economic losses for farmers who work on it. Finding plants that ecologically have characteristics that can be integrated with taro and are well known to farmers, and have high economic value to provide support is important. In general, the intercropping system is more profitable than the monoculture system because the land productivity is higher, the types of commodities produced are diverse, it is efficient in the use of production facilities, and the risk of failure can be minimized [2].

Sweetpotato plant (*Ipomea batatas*) with its character which efficiently utilizes light (C3), is one of the plants that is ecologically expected to be able to adapt and produce tubers normally when planted as an intercropping plant or intercropping in satoimo taro (*Colocasia esculenta* (L.)) which is also a C3 plant. Therefore, it is necessary to test whether the sweet potato plant—which is well known to farmers—can adapt and produce with normal productivity and be economically profitable when grown as an intercrop in taro plantation as a staple crop.

## 2. The objectives

The purpose of this study are to determine: (1) the productivity of the sweetpotato planted as an intercropping plant on taro plantation with four levels of manure compost; and (2) the economic benefits affected by the various levels of manure compost.

### 1.3. Sweet potato, taro and organic fertilizer

Sweet potato is economically important not only to fill export market demand but also to local market demand in line with increasing consumption and demand. Even in Papua, the farming practice of producing sweet potato for own consumption has shifted towards a commercial direction, so 83% of the production was for sale [3].

Sweet potatoes are usually planted on loosened soil and formed by raised beds about 80-120 cm wide. Taro too. Only slightly different in terms of how to grow them. If the taro is planted in a hole filled with compost first, the sweet potato will not. Only insert it into the loosened soil without being given compost, even if it is given compost, by mixing it with the soil at the time of final soil processing. Taro is composted at a high dose of about 20-30 t / ha, but sweet potato is only about 10 t / ha; even the farmers rarely do. The density of taro ranges from 20-25 thousand plants per hectare, with a spacing 100 cm x 50 cm to 100 cm x 40 cm or 80 cm x 50 cm. While sweet potato is about 30-40 thousand plants per hectare with a spacing of 75 cm x 50 cm or 100 cm x 25 cm. In China planting of sweet potato with a high density of 12 plants per square meter (120,000 plants per hectare) has been recommended [4].

Based on the genetic characteristics of the two plants, namely C3 plants that have a low light saturation level, so in terms of solar radiation, they are not worried about interfering with each other if combined in one planting area. What needs to be considered is the level of competition in using nutrients and water. Taro can even grow normally with a shade level of up to 70%; although, for satoimo taro or what in Bali is called salak taro, the tuber yield decreased up to 60.3% in 75% shade; 64.0% if it is covered by 50%, and 70.9% if it is covered by 25%. The decrease in yield occurred in proportion to the percent shade. With 25% shade, production becomes 70.9%, 50% shade production becomes 64.0%, and 75% shade production becomes 60.3% [5].

Fertilization with organic fertilizers can improve soil's physical, chemical, and biological properties. Even the amendments made to the organic fertilizer sand soil increased water holding, increased the microbial enzymatic activity, and the production of maize in China [6]. Through the application of organic materials, agricultural products have a sweeter taste, are more durable, are free from chemical residues so that they are safe and healthy for consumption. Giving organic material has a better effect on sweet potato plants if it is done 30 days before planting [7]. Various sources of organic fertilizers can be used, including chicken, cow, goat, and other manure for plants for taro and sweet potato plants. In

East Africa it was found that organic farming was effective in reducing parasitic nematodes (VAT) under control over a longer period of time (4 months) compared to conventional farming [8]. Another finding was also found in Africa, that the use of goat manure had a very good effect for intercropping sweet potato crops with maize because it was able to control nematodes [9]. However, in South Sulawesi, the compost that is most commonly found and applied to taro plants is chicken cuttings compost.

## 2. Materials and method

The study was conducted at Maros Regency, western of South Sulawesi; located on latitude  $5^{\circ} 7'S$  and longitude  $119^{\circ} 36'E$ , 25 m above sea level. The top soil (0 - 20 cm) texture of the experimental site is clayey loam. The soils are classified as alfisol-pluvisol (complex) with pH 5.25. The experimental field preparation was slashed, plowed, loosened, and made beds by using a cultivator between about end of June 2020. The beds are made to measure 210 cm x 110 cm with a trench width of 40 cm. Meanwhile, the main plant holes (taro) are arranged at a distance of 50 cm x 50 cm in the beds so that there are 2 rows with a total of 20 taro trees per bed.

Before planting the staple crop, compost was given compost of each 400 grams (C1), 800 grams (C2), and 1200 grams (C3), each of which was inserted into the planting hole then mixed with the soil homogeneously in a row. Symbols (C1, C2, and C3), and 1200 grams are spread evenly over the beds, then mixed with soil as deep as 20 cm in layers throughout the beds (C4). After planting the main taro plant, immediately followed by planting the sweet potato between the two taro plants at a distance of 10 cm from the edge of the bed. The number of sweet potato plants is the same as the number of taro plants, each equivalent to 26.666 plants per hectare. The plant material used is one month old taro seedlings in the nursery and old sweet potato shoots. The taro seeds come from tubers harvested from the mother tree at the age of 5.5 months, while the sweet potato seeds from sweet potato varieties are maturing 3 months.

The study was arranged using a Randomized Complete Block Design (RCBD) with 4 levels of compost and 3 groups. Thus there are 12 plots. Sample 3 plants each per plot. Parameters observed were tuber yield per plant, tuber size, number of tubers per plant, top dry weight; as well as the economic value consisting of farm profits and revenue cost ratio (RCR).

## 3. Results and discussion

After statistical tests were carried out, the compost level variation did not have a significant effect at the 0.05 level on all parameters. The yield of tubers per plant, the average size of tubers, and number of tubers per plant were not significantly different (Table 1). However, with the analysis using the histogram and trendline, it is seen that there is a trend of increasing linearly for all parameters (Figures 1, 2, 4, and 5).

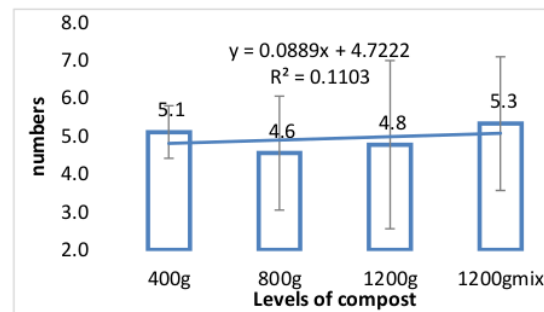
**Table 1.** Statistical analysis of parameters

| Parameters              | Level of Compost |       |       |          | Statistical Analysis |       |     |
|-------------------------|------------------|-------|-------|----------|----------------------|-------|-----|
|                         | 400g             | 800g  | 1200g | 1200gmix | F                    | First | Sig |
| Yields, g/plant         | 522.2            | 753.6 | 862.2 | 884.4    | 2.98                 | 4.76  | ns  |
| Size of tubers, g/tuber | 102.8            | 173.5 | 219.2 | 165.3    | 2.07                 | 4.76  | ns  |
| Number of tubers        | 5.1              | 4.6   | 4.8   | 5.3      | 0.33                 | 4.76  | ns  |
| Plant tops, g/plant     | 78               | 99    | 142   | 120      | 2.54                 | 4.76  | ns  |

ns = not significant at the 0.05 level

### 3.1. Number of tubers

The highest number of tubers per sweet potato plant (5.3 tubers) was achieved at the level of giving 1200 grams of compost per staple plant (taro) which was spread and mixed evenly in all parts of the bed, higher than the others, especially for giving the same amount but placed in a hole taro plant (Figure 1).

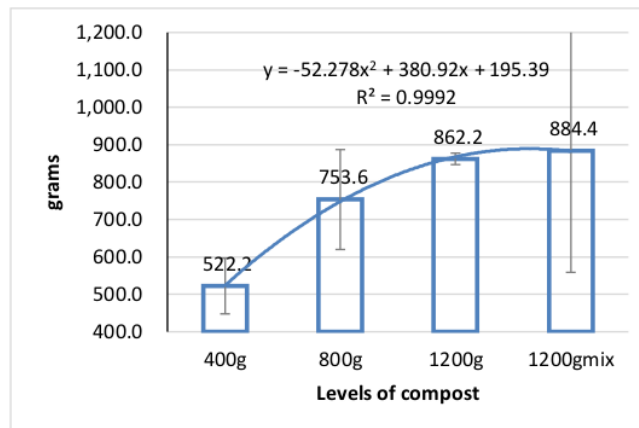


**Figure 1.** Number of tubers per plant

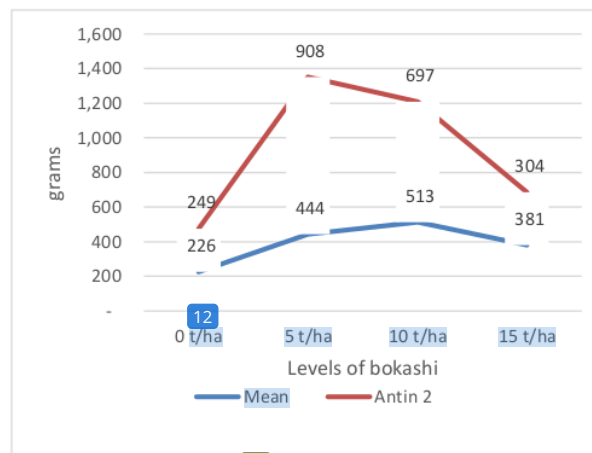
### 3.2. Tuber yields

From a quantitative perspective, tuber yields are the main parameters that determine productivity and production. The highest yield of tubers per plant was achieved (884.4 grams) in the treatment with 1200 grams of compost per staple plant, which was evenly mixed in all parts of the beds (C4) but was not significantly different from all other treatments at the level of 0.05 (Figure 2). However, the treatment of giving 1200 grams per staple plant inserted into the taro plant hole (C3) was significantly different from giving compost 400 grams and was not significantly different from the others.

The interesting thing is that this fact contradicts the expectations of the research, which suspected that the C4 (mixed) treatment would give the best results because the compost provided was not only available for staple crops (taro) but also available for intercropping (sweet potato). Because it spreads throughout the bed. Research results in China. These results indicate that the addition of organic fertilizers will not only improve soil quality but also increase yields of radish and sweet potato compared to chemical fertilizers [6]. However, other researchers also found identical phenomena. Ginting et al. found the highest yield of sweet potato tubers per plot was not the one given the highest bokashi fertilizer (15 t / ha) but, on the contrary, the one has given bokashi between 5 to 10 t / ha. This phenomenon occurs in an average of the three varieties tested. In fact, one of them, the Antin 2 variety, achieved the highest yield at a level of around 5 t / ha [10] (Figure 3). The results of the study of Manohara variety of chicken manure gave the best response to stem length, number of leaves, fresh weight and tuber weight. Compost from household waste also has the best benefits if applied 30 days before planting sweet potatoes with a yield of 28 t / ha [11].



**Figure 2.** Tuber yields per plant



**Figure 3.** Tuber yields of three varieties of sweet potato [10]

### 3.3. Tuber <sup>10</sup>e

Tuber size is one of the quality criteria for sweet potato tubers. If the tuber size is less than 30 grams, it cannot be sold (there is no market). The results showed the highest mean tuber weight (176.5 grams) in the treatment of giving compost 1200 grams per staple plant, which was evenly mixed in all parts of the beds (C4), but not significantly different from all other treatments at the level of 0.05. However, the treatment of giving 1200 grams per staple plant inserted into the taro plant hole (C3) was significantly different from giving compost 400 grams and was not significantly different from the others.

As with tuber yields, the interesting thing is that this fact contradicts research expectations which suspect that the C4 (mixed) treatment will give the best results because the compost provided is not only available for the staple crop (taro), but is also available for intercropping (sweet potato) because it spreads to all parts of the bed. But other researchers also found identical things [10].

### 3.4. Plant tops

One indicator of plant fertility is the level of vegetative development, which is marked by the dry weight of the plant top. The results showed that the highest plant top (142 grams) was treatment with 1200 grams of compost per staple plant inserted into the plant hole, but it was not significantly different from other treatments (Figure 5). When observed carefully, vegetative growth or in other words, the highest producer of biomass is the treatment (C3). This treatment is also close to (almost) significantly different from the other two treatments.

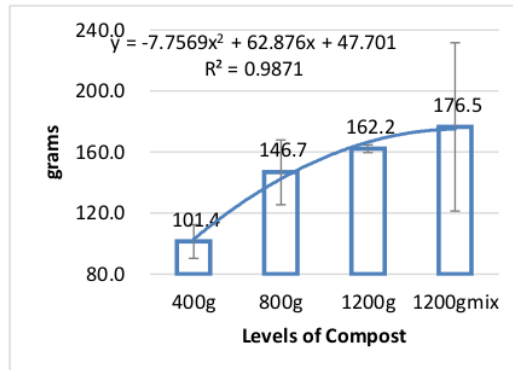


Figure 4. Tuber size

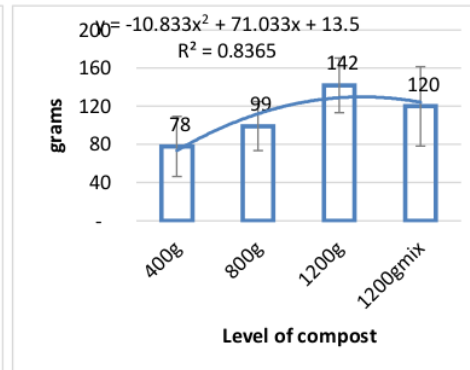


Figure 5. The dry weight of plant tops

### 3.5. Productivity

The productivity of sweet potatoes is mainly assessed by the yield of the tubers both in quantity and quality. In this study an approach was used to measure the yield of tubers per plant — which can be converted into tons per hectare — and tuber size. Based on this perspective, although the treatment of 1200 grams of compost into the main plant hole is not the highest, it is more advisable because it has a different significance level (level of confidence) from other treatments. The productivity of the tested plants was relatively higher individually than the average productivity of the "extract" varieties tested. The results of the research from treatments C1, C2, C3, and C4 were 522.22, 753.56, 862.22, 884.44 grams per plant compared to the average productivity in the field, generally around 700 grams per plant (14-40 or an average of 27.67 t / ha for a population of 40 thousand plants per hectare). In fact, other studies have found that the average production is only 22.5 t / ha [12].

### 3.6. Economic benefits

The indicator used is the profit and benefit cost ratio (BCR). In this analysis, according to the concepts and facts, several assumptions are referred to according to: (a) production costs consist of sweet potato seeds, planting costs and weed maintenance/control, and harvest costs; (b) does not cover land leases, costs for processing land, irrigation, pesticides because they have been borne by the cost of staple crops; (c) with early varieties (var. Sari) harvested at the age of 90 days does not cause harm to the staple crop (taro); (d) labor for planting and special planting in the 1200 compost treatment which is mixed evenly throughout the beds (C4) is less than the other three treatments because the soil is looser (light) because additional processing has been carried out when mixing the compost just before planting ; and (e) the number of productive plants is the total population as much as the taro population multiplied by 90% survival rate, namely 26,667 plants per hectare multiplied by 90% or 24,000 population.

The results of the benefit analysis are shown in Table 2. It appears that sweet potato farming, which is planted by intercropping with the main taro crop is very profitable with varying levels of profit according to the compost level treatment of the staple plant (taro). The RC-ratios were 2.31, 3.23, 3.66, and 4.01 for C1, C2, C3, and C4 treatments, respectively. This value is relatively higher than in general

sweet potato farming; range 2.0. A study in Teluk Dalam Subdistrict, Asahan Regency, shows the R / C Ratio value of 2.35 [13], in North Sumatra, the value is 1.8, and in Bogor, it is 2.1 [14] because it has been financed by the main planting business. However, it should be reminded that this analysis is partial, because it does not take into account the (negative) impact of sweet potato cultivation on taro as its main crop.

**Table 2.** Cost analysis of sweet potato intercropped with taro based on the effect of treatments

| Item   | Volume | Unit Price | Levels of Compost |                   |                   |                   |
|--|--------|------------|-------------------|-------------------|-------------------|-------------------|
|  |        |            | 400g              | 800g              | 1200g             | 1200gmix          |
| <b>FIXED COST</b>                                  |        |            |                   |                   |                   |                   |
| Management cost (MM)                               | 4      | 2,000,000  | 8,000,000         | 8,000,000         | 8,000,000         | 8,000,000         |
| Equipment amortization and maintain                | 4      | 500,000    | 2,000,000         | 2,000,000         | 2,000,000         | 2,000,000         |
| Total FC   |        |            | 10,000,000        | 10,000,000        | 10,000,000        | 10,000,000        |
| <b>VARIABLE COST</b>                               |        |            |                   |                   |                   |                   |
| Seeds  | 30,000 | 75         | 2,250,000         | 2,250,000         | 2,250,000         | 2,250,000         |
| Planting cost (MD)                                 | 10     | 70,000     | 700,000           | 700,000           | 700,000           | 700,000           |
| Weeding & filling cost (MD)                        | 25     | 70,000     | 1,750,000         | 1,750,000         | 1,750,000         | 1,400,000         |
| Harvesting cost                                    | 30     | 70,000     | 2,100,000         | 2,100,000         | 2,100,000         | 2,100,000         |
| Bag/sacks, 'second'                                |        | 1,500      | 470,000           | 678,200           | 776,000           | 796,000           |
| <i>sub total VC</i>                                |        |            | 7,270,000         | 7,478,200         | 7,576,000         | 6,450,000         |
| <b>Total Cost:</b>                                 |        |            | <b>17,270,000</b> | <b>17,478,200</b> | <b>17,576,000</b> | <b>16,450,000</b> |
| <b>REVENUE</b>                                     |        |            |                   |                   |                   |                   |
| Tuber yields (depend on tretment, grams per plant) |        |            | 522.22            | 753.56            | 862.22            | 884.44            |
| Tubers yields, from 24000 plants/ha (kg)           |        |            | 12,533            | 18,085            | 20,693            | 21,227            |
| Price  |        | 3,000      | 37,600,000        | 54,256,000        | 62,080,000        | 63,680,000        |
| Seeds  | 30,000 | 75         | 2,250,000         | 2,250,000         | 2,250,000         | 2,250,000         |
| <b>Total Revenue:</b>                              |        |            | <b>39,850,000</b> | <b>56,506,000</b> | <b>64,330,000</b> | <b>65,930,000</b> |
| Profit   |        |            | 22,580,000        | 39,027,800        | 46,754,000        | 49,480,000        |
| Revenue Cost Ratio (RCR)                           |        |            | 2.3               | 3.2               | 3.7               | 4.0               |
| <b>Benefit Cost Ratio (BCR)</b>                    |        |            | <b>1.3</b>        | <b>2.2</b>        | <b>2.7</b>        | <b>3.0</b>        |

#### 4. Conclusions

The productivity of the sweet potato planted as intercropping plant on taro plantation is within the normal range, namely 522.22, 753.56, 862.22, 884.44 grams per plant, and tends to vary but does not differ significantly according to the level of compost application, respectively 400 grams, 800 grams, and 1200 grams of compost that is put into the hole of the satoimo staple plant, and 1200 grams per plant are mixed evenly as deep as the processing layer throughout the beds. The highest yield of tubers was treated with 1200 grams of compost which was evenly mixed into the processing layer in all parts of the bed.

The total profit and revenue-cost ratio of IDR 22,580,000 (RCR 2.31), IDR 39,027,800 (RCR 3.23), IDR 46,754,000 (RCR 3.66), and 49,480,000 (RCR 4.01), respectively, varies by level. compost, respectively 400 grams, 800 grams, and 1200 grams of compost that is put into the hole of the satoimo staple plant, and 1200 grams per plant are mixed evenly as deep as the processing layer in all parts of the bed. The highest yield of tubers was treated with 1200 grams of compost which was evenly mixed into the processing layer in all parts of the bed.

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