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# Evaluation of biomass production of CO-3 fodder grass under coconut and its effect on nut yield of intermediate zone coconut plantations in Sri Lanka

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## Abstract

Six CO-3 fodder grass planting systems under coconut palms were evaluated for six years concerning biomass production and coconut yield. This study was carried out at Potthukulama (PRS) Research Station of the Coconut Research Institute, in the Low Country Dry Zone of the Northwestern province of Sri Lanka, where the soil series is Ambakele. According to the experiment results, the highest CO-3 biomass was produced when five CO-3 rows were planted between coconut rows and harvested in 30 days lopping interval. There was no significant effect of CO-3 planting densities and lopping intervals on the yield of coconut.

Keywords: CO-3, Fodder grass, Coconut, nut yield

## Introduction

Coconut is a tropical perennial plantation crop and its canopy structure requires wide spacing between palms, which permits abundant sunlight to the understory. It does not fully utilize all incoming radiation or all the available moisture and nutrients. As a result, the unutilized space beneath the plantation is invaded by a wide range of perennial and annual weed species (Senarathne et al., 2003). From an animal production point of view, the understory natural vegetation of coconut plantation can be divided into species that are eaten by ruminants and those which are unpalatable. In this context, the latter will be referred to as weeds while the 'eaten' species will be called forages. The establishment and maintenance of a good herbaceous pasture in the coconut understory can provide livestock feed, while also preventing the invasion of non-nutritious, yet aggressively competitive weeds (Plucknett, 1979). The positive effects of integration are therefore the “replacement” of nonproductive weed species with pasture and fodder species. The introduction of high-yielding pasture and fodder species into mature plantations may be expected to exert a stronger competitive effect than natural vegetation, primarily due to the increased demand for nutrients and moisture. *Brachiariabrizantha* grown in monoculture with routine agronomic practices caused a 13% nut yield reduction in mature coconut plantations, which could be due to significant absorption of soil water (Vidhana Arachchi, 1998). Humphreys (1991) stressed that the yield of plantation crops may be positively or negatively affected by pasture systems, depending on the nature of the interference and the net effects on the crop environment. Therefore, managing pasture under coconut is very important to achieve maximum herbage production of good quality, without affecting the coconut yield. It is to be noted that aggressive pasture species such as *B. brizantha* are likely to compete with coconut unless they are well managed (Liyanage, 1999). When improved pastures are first established there is likely to be a slight initial depression in coconut yields due to soil/root disturbance and the nutrient demands of the sown pasture. However, provided that soil moisture and nutrient levels are adequate, as long as sufficient nutrients are applied in the form of fertilizer to match the expected off-take of pasture where soil fertility is low, and assuming that adequate stocking rates are used, then coconut yields should be unaffected or may even increase (Watson & Whiteman, 1981).

CO-3 is an inter-specific hybrid between Bajra (*Pennisetumamericanum* L.) and a selection of a common Napier (*Pennisetum purpureum* Schum). It is one of the highest-yielding perennial tropical fodder grasses and is often preferred by smallholders and, e.g. in East Africa, constitutes up to 80% of forage grown (Staal et al., 1997). The characteristic features of CO-3 fodder grass are profuse tillering, high yield potential, high dry matter content, quick regeneration capacity, high leaf-to-stem ratio, high palatability, free from pests and diseases, and low in advance factors (Premaratne & Premalal, 2006). This has been attributed to its wide range of adaptation, vigorous growth, high biomass productivity and deep root system to survive under drought conditions (Lowe et al., 2003; Anderson et al. 2008; Zewdu 2008). It grows best in high-rainfall areas (more than 1,500 mm per year).

The optimum temperature for growth is usually 25-40°C and grows better in full sunlight. Therefore, an agroecological basis could be recommended for most of the agricultural soils in wet and intermediate parts of the county. It should be recommended for the dry zone only if irrigation facilities are available (Premaratne & Premalal, 2006). Experimental results of evaluation of the performance of Hybrid Bajra Napier (CO-3) as a mixed crop in coconut gardens revealed that it can be successfully grown in coconut gardens in coastal sandy soil by adopting suitable soil moisture conservation measures. Burial of one layer of dried coconut husk in trenches and planting of grass resulted in higher fresh fodder yield (96.83 t/ha) (Subramanian et al., 2007).

Since this grass is a heavy yielder, it requires high doses of nutrients. On the other hand, nutrient management has a pronounced effect on the yield and quality of the fodder grass. As this grass is a heavy user of soil inputs, some farmers are unwilling to handle this type of high-yielding fodder grasses. Although this grass responds very quickly to inorganic fertilizer, livestock manure that could be supplied within the farmer's premises is an important resource for grass cultivation. Optimal management practices for Napier grass are not clear (Mutegi et al., 2008). An appropriate cutting management system is essential for the high production and quality of this species (Jørgensen et al. 2010 & Tessema et al., 2010). Since the species is well suited for cut-and-carry systems (Bayer, 1990), many studies have dealt with cutting management to optimize forage yield and quality of Napier grass (Bayble et al., 2007, Tessema et al., 2010, & Rengsirikul et al., 2011). Manyaw et al. in 2003 reported a significant effect of the growth stage on yield and quality and suggested a cutting interval of 6–7 weeks for optimum yield and quality of Napier. Therefore, this study was designed to determine the CO-3 fodder biomass production under coconut plantations and to assess the effects of growing CO-3 fodder grass on the nut production of coconut plantations in the dry zone of Sri Lanka.

## Materials and Methods

This experiment was carried out at the Potthukulama (PRS) Research Station of the Coconut Research Institute of Sri Lanka, in the Low Country Dry Zone of the North Western province of Sri Lanka from January 2012 to December 2018. The experiment site is characterized by a bi-modal pattern of rainfall with an annual mean precipitation of 1,200 mm. Approximately 65% of the annual rainfall is received from September to February (Maha rain season). The soil at the Potthukulama site is a predominantly well-drained Red Yellow Podzolic (RYP) soil with soft or hard laterite (70-90%) (Panabokke & Alwis, 1972). The surface soil is brown in color with a sandy loam texture. Structure development is moderate due to the presence of sand in the surface soil. Sub-surface soil is dark to yellowish brown with prominent mottles. The texture of the subsoil is sandy loam to sandy clay loam. The reaction of the soil is strongly acidic (pH 5.0 – 5.5). The base saturation of the subsurface soil is greater than 35%. Organic carbon content in the surface soil is generally less than 1% under natural conditions (Mapa, 2005).

The coconut plantation of this site was 60 years old and planted at each corner of square systems (8 m × 8 m) with a density of 158 trees/ha. All the coconut palms in the experiment were fertilized with 3 kg of adult palm fertilizer mixture (800 g Urea, 600 g Rock Phosphate and 1,600 g Muriate of Potash) and 1,000 g of Dolomite/palm/year. Fertilizer applications were carried out as per the recommendations given by the Coconut Research Institute of Sri Lanka. To conserve soil moisture, mulching and husk-burying practices were done on all the coconut palms in the experiment. The field was ploughed leaving 6 feet manure circle around the palm. Planting holes (1 ft × 1 ft × 1 ft) were prepared according to the experimental plan. One kg of organic manure was added per planting hole and 15 cm long well-matured CO-3 fodder grass cuttings were planted according to the experiment plan with the onset of monsoon rains. Planting spacing is 2 ft × 2 ft. All the CO-3 treatment plots were fertilized with Cattle manure and Poultry manure two times per year. Irrigation was done during the drought periods. Randomized Complete Block Design with three replicates was used. Each plot had six effective coconut palms (four coconut squares were separated by a coconut row). The treatments were constituted with a 2 × 3 factorial experiment and control as shown below:

| Factor 1-No of CO-3 planting rows | Factor 2-Lopping interval (days) |
|---|---|
| Three CO-3 rows between coconuts palms ($R_1$) | 30 ($M_1$) |
| Five CO-3 rows between coconuts palms (R2) | 45 ($M_2$) |
| | 60 ($M_3$) |

The treatments are coded as $T_1(R_1M_1)$; $T_2(R_1M_2)$; $T_3(R_1M_3)$; $T_4(R_2M_1)$; $T_5(R_2M_2)$; $T_6(R_2M_3)$; and T7 (Control - no CO-3 planting)

When the study began, the mean shrub height was 1.5 m. All the plants were initially cut back to the designated cutting height (30 cm) and the lopping frequency treatments were subsequently applied. At each subsequent cutting, all the lopped biomass was cut back to within 1 cm of the stump. Sub-samples from each treatment plot were taken, and oven dried at 85°C to a constant weight. The percentage dry weight of the original fresh weight was used to determine the total plot dry weight and finally calculate the total biomass per hectare.

### *Coconut Yield*

Total nut yield was assessed every two months and used to calculate the total nut production per palm per year.

### *Data analysis*

Data on biomass production, nut yield, and soil moisture content were analyzed using Analysis of Variance (ANOVA) and the significance of the differences between means was tested using Least Significant Differences (LSD) at P = 0.05. Software SAS was used for analysis (SAS, 1999).

## Results and discussion

### *Effect of different CO-3 growing systems on total CO-3 dry biomass production*

The effect of plant density and lopping interval on dry fodder biomass production are presented in Table 1. Planting density and lopping interval have a significant effect on CO-3 dry biomass production. The highest CO-3 biomass was produced when five CO-3 rows were planted between coconut rows and harvested in 30-day lopping intervals. According to the experiment results, when lopped at 30 and 45-day intervals higher fodder biomass productions were recorded compared to the biomass production recorded when lopped at 60 days intervals. This result indicates that when the grass is managed with a cutting interval of 30 days, it has more tender leaves and therefore provides a better quality of grass for animal feeding. The material obtained with a cutting interval of 60 days had a greater amount of stem, a component of the plant that confers more fiber to the material produced. When this grass is lopped at 60-day intervals, it is more suitable for energy production.

The high biomass yield at five CO-3 rows with 30 days lopping interval ($T_4$) treatment was attributed to high plant populations that allowed the fodder crop to thrive well in terms of nutrient uptake from soil and solar interception. Results from research in Bangladesh (Rahman et al., 1993) and in India (Bangarwa et al., 1988) indicated that a high seeding rate produces high plant populations and enhanced plant growth due to higher nitrogen uptake by the plant. The highest planting density corresponded to the peak production of fodder. Cuomo et al. (1998) also found that the highest planting density produced the most biomass. Thus, at high planting densities maize fodder production is a promising practice and may be extended to forage-based animal production.

### *Effect of different CO-3 growing systems on coconut yield*

According to Table 2, there is no significant effect of planting density and lopping interval on the yield of the coconut palms throughout the experiment period. The effect of fodder grass intercropping on the yield of coconuts has been doubted because grasses are vigorously growing and exhaust the nutrients. The data from the experiment for the period 1972-1978 at Kasaragod showed that, when the management practices for both crops were adequate, the yield of the main crop did not decline. Since, the palms were already under proper management, as reflected in the high yield (Subramanian et al., 2008). The data obtained from the field experiment on mixed farming initiated in 1975 also indicated that the production of female flowers, the percentage of female flower sets, and the yield of coconut were not adversely affected by raising fodder crops in the interspaces of coconut palms,

Table 1. Effect of different CO-3 growing systems on total CO-3 dry biomass production (mt/ha/year) from 2013 to 2018

| Treatments | Dry biomass production (mt/ha/year) | | | | | |
|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| $T_1$ | 9.97 | 9.7 | 16.41 | 13.78 | 12.96 | 13.21 |
| $T_2$ | 4.79 | 5.32 | 9.92 | 8.20 | 10.6 | 8.34 |
| $T_3$ | 2.84 | 4,12 | 4.97 | 3.95 | 8.61 | 5.41 |
| $T_4$ | 15.02 | 14.89 | 20.71 | 20.05 | 22.82 | 19.61 |
| $T_5$ | 8.32 | 9.63 | 15.25 | 12.13 | 16.19 | 13.3 |
| $T_6$ | 4.61 | 8.38 | 8.12 | 7.42 | 11.39 | 9.57 |
| $T_7$ | - | - | - | - | - | - |
| Significance | * | * | * | * | * | * |
| LSD (P<0.05) | 3.24 | 4.85 | 4.18 | 5.72 | 8.45 | 6.22 |

* Significantly different at P=0.05

Table 2. Effect of different CO-3 growing systems on coconut yield (nuts/palm/year) from 2012 to 2017 at Potthukulama

| Treatments | Coconut yield (nuts/palm/year) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| $T_1$ | 46 | 60 | 72 | 86 | 81 | 41 |
| $T_2$ | 43 | 55 | 70 | 86 | 91 | 59 |
| $T_3$ | 50 | 67 | 68 | 88 | 78 | 50 |
| $T_4$ | 45 | 61 | 82 | 88 | 79 | 56 |
| $T_5$ | 44 | 58 | 66 | 79 | 78 | 43 |
| $T_6$ | 59 | 66 | 85 | 91 | 89 | 51 |
| $T_7$ | 46 | 48 | 55 | 73 | 88 | 59 |
| Significance | ns | ns | ns | ns | ns | ns |
| | - | - | - | - | - | - |

ns - Not significant

both under rain fed and irrigated conditions (Subramanian et al., 2010). These results indicate that when maintained proper spacing between the manure circle and the CO-3 plants and the proper density of CO-3 plants, the yield of the coconut palms will not get any negative effects.

## Conclusion

The results from this study have confirmed the potential of growing CO-3 fodder grass as an intercrop under coconut and can be included in the existing cropping system for intensive and semi-intensive livestock farming systems in coconut plantations in wet and intermediate zones to improve overall productivity. According to the experimental results, the highest CO-3 biomass was produced by $T_4$ treatment means five CO-3 rows of CO-3 planting with 30 days lopping interval and no significant effect of CO-3 planting densities and lopping intervals on the nut yield of coconut with proper management conditions of both plants. CO-3 cuttings should be planted at 1 m × 1 m spacing for a maximum of five rows in between two coconut rows leaving the manure circles unutilized. All these crop management techniques need to be adopted in an integrated manner to improve the productivity of this system. Because CO-3 grass is a heavy yielder, it requires high doses of soil nutrients and moisture. Therefore, proper agronomic practices should be followed to conserve soil moisture as well as to maintain soil fertility in the coconut CO-3 fodder grass mix cropping system.

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