Economic Profitability of Rejuvenated Robusta Coffee Intercropped with Banana

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Abstract

The economic profitability of rejuvenated Robusta coffee intercropped with banana gives significant impact to farmers specifically for coffee growers. The study aimed to evaluate the economic performance of coffee and banana; assess the quality of green beans and banana fruits as a result of intercropping banana in coffee at different distances; and compute its cost and return analysis. A randomized complete block design (RCBD) with four treatments (T_1-No intercropping; T_2-coffee+banana intercropped at 2m x 4m distance; T-coffee+banana intercropped at 2m x 6m; T_4-coffee+banana intercropped at 4m x 4m distance) was used replicated three times. Agronomic and economic data were obtained from the two crops. Fresh coffee berries weighed up to 2.95 ton/ha when intercropped with banana and yielded up to 1.65 tons/ha dried berries. Highest marketable yield was 0.99 ton/ha obtained by coffee + banana in 2m x 4m distance with percent recovery of 65.43%. Banana yielded up to 15.02 kg per bunch when intercropped at a distance of 2m x 6m. Highest yield per hectare was obtained when a banana was intercropped at a distance of 2m x 4m with value 12.51 tons. The Net Income and ROI was highest in coffee + banana intercropped at 2m x 4m distance Php217,455.00 while ROI was highest in coffee+banana at 4m x 4m distance of 84.51%. Intercropping is more profitable than monocropping. Intercropping banana in coffee trees at a distance of 2m x 4m performed best where it gave the highest combined net income.

Keywords: economic profitability, intercropping, coffee, banana

1. Introduction

Coffee has been one of the most important plantation crops in the Philippines. It is estimated that around 300,000 Filipinos are dependent on the coffee industry. It is highly valued in local and foreign markets, making

the country as one of the world's top ten coffee producers until 1980. The bulk of coffee production is found in Mindanao (PCARRD, 2008).

The old age of existing coffee trees contributes to low productivity. There is a need to convince more coffee growers that rejuvenation can significantly increase the production of their coffee trees.

The income of such commodity is one of the factors why farmers should produce. The major problems confronted by coffee producers can be solved by adding such technical knowledge to their plantation like intercropping their coffee trees of high valued crops such as banana to sustain their income for living. Intercropping is cultivating two or more crops at the same time on the same field or growing two or more crops in the same field with the planting of the second crop after the first one has completed its development. The most common goal of intercropping is to produce a greater yield on a given piece of land by making use of resources that would otherwise not be utilized by a single crop (Elkan, 2004). Intercropping of compatible plants also encourages biodiversity, by providing a habitat for a variety of insects and soil organisms that would not be present in a single-crop environment. This in turn can help limit outbreaks of crop pests by increasing predator biodiversity. Additionally, reducing the homogeneity of the crop increases the barriers against biological dispersal of pest organisms through the crop (Wikipedia.org).

Coffee and banana are commonly grown as intercrop. The crops complement one another in terms of socioeconomic benefits to growers and farm families. Bananas provide permanent food and income security, doubling as a primary food and cash crop, and providing a modest but continuous cash flow throughout the year. Coffee gives a cash boom twice a year, helping farmers acquire funds for more expensive items (International Institute of Tropical Agriculture IITA, 2009). Coffee+banana intercropping is much more beneficial than a banana or coffee mono-cropping and that agricultural intensification of food and cash crops should not solely depend on the mono-crop pathway (Asten*et al.*, 2011).

Banana is the most economically important fruit in the Philippines and the only locally grown fruit available year round. Bananas grow in diverse environments in the country, from the lowlands, flat and sloping uplands to the marginal hilly lands. Latundan, lakatan and sabaare most grown in the backyard or as a component in an intercropping scheme with minimum care and management (PCARRD-DOST, 2003).

MOSCAT through its Research, Development and Extension Unit targeted to conduct a technology of intercropping banana (Lakatan) in rejuvenating Robusta coffee plantation on different distances of planting with the aim of increasing yield and profitability to help the development of the coffee industry and agriculture. This study aimed to evaluate the economic profitability of rejuvenated Robusta coffee intercropped with banana (lakatan) using different distances of planting. Specifically, it aimed to:

1. Evaluate the economic performance of coffee and banana intercropping systems;

2. Assess the influence of different planting systems on yield, quality of green beans and banana fruits; and

3. Conduct cost and return analysis on different treatment of rejuvenated robusta coffee intercropped with banana (lakatan).

2. Methodology

2.1 Experimental Design and Treatments

The study was carried out using Randomized Complete Block Design (RCBD) with four (4) treatments and three (3) replications. The rejuvenation of the 25 year old robusta coffee trees with 2 x 2 meters distance of planting per hill and the planting of bananas (lakatan) as intercrop were done simultaneously. After four (4) months, the rejuvenated coffee trees produced sprouts and only three stems were left and maintained for production purposes. The stems were cut and detopping was done upon reaching a vertical height of 1.5 meters, in order to produce more lateral branches.

The planting materials used for banana (lakatan) as intercrop were of high-yielding variety and disease-free suckers.

The following intercropping systems of rejuvenated coffee trees and bananas were considered as treatments:

T_1– Control, no intercropping

T_2 – 2m x 4m

T_3 – 2m x 6m

T_4 – 4m x 4m

There were a total of 2,500 coffee trees in one-hectare using a planting distance of 2 x 2 meters per hill. In Table 1, plant population density of banana per hectare as coffee intercrop is shown.

Table 1. Plant population density of banana per hectare as coffee intercrop

Treatments	64 m^2	10000 m^2
T_1– Control, no intercropping	0	0
T_2– 2m x 4m	8	1250
T_3– 2m x 6m	5	833
T_4– 4m x 4m	4	625

2.2 Care and Maintenance

Hand weeding and under-brushing weredone to control weeds both plants. No spraying was done throughout the study duration. Extra sprouts were removed, usually those weak, damaged and coming out of the side or bottom of the main stem. For banana deleafing were done quarterly during the growing stage.

2.3 Fertilizer Application

Soil sampling of the experimental area was done and the soil samples were submitted for analysis at the Soil Laboratory of the Department of Agriculture Region 10.

2.3.1 Coffee

Application of fertilizerwas done during the month of May at the start of the rainy season, the second applicationin the month of September which is the middle of the rainy season and the third application during the month of January, towards the end of the rainy season. A total of 60 bags chicken dung, 12 bags 16-20-0, 12 bags 0-0-60 per hectare were applied as recommended application for rejuvenated coffee trees. Nutrient maintenance

was supplemented by application of organic fertilizer consisting of two cans (standard size) of coffee pulp and another two cans of corn cobs per hill every six months. Three hundred grams of chicken manure per hill was applied every beginning of rainy season.

All nutrient sources were applied to the upper portion of the hills of coffee except the coffee pulp and corn cob which was spread out around the base of the hills/plants and served as mulch.

2.3.2 Banana

The recommended application rate of (N-P-K) of 14-14-14 complete fertilizer was applied to young banana plants at the rate of 2 kg and during the flowering stage at the rate 3 kg per hill.

2.4 Harvesting

2.4.1 Coffee

Harvesting of berries was done after 18 months from rejuvenation and yearly thereafter. During harvesting, matting with sewn unfolded empty sacks enough to occupy the noon-time shadow of one hill or tree canopy at ground level was done to facilitate harvesting of berries.

Emersion of harvested sample berries per treatment with tap water in the bucket was done to classify the marketable and non-marketable green beans. Each sample berries were de-pulped immediately, then dried and was placed in an empty bag per treatment. Classification of marketable and non-marketable green beans were done after drying the sample per treatment replication.

2.4.2 Banana

Harvesting was done when the last leaf turns to yellow and when the fruits have less prominent angles. The rounder the angle of the fingers, the more mature they are.

Harvesting needs two people to serve as the cutter and the backer. It involves cutting deep into the middle of the trunk and letting the top fall gradually until the bunch will be reached by the backer. The peduncle was cut long enough to facilitate handling. Shoulder pad was used to protect fruits. Dropping of fruits was avoided.

2.5 Data Gathering

2.5.1 Agronomic Data of Coffee

The following were the procedures for obtaining the agronomic agronomic date of coffee: (a) The weight of fresh berries was recorded as the weight of ripe coffee berries after harvest; (b) weight of dried berries is the weight of the berries after drying at 14% moisture content; (c) marketable yield was obtained by weighing the marketable fruits taken after sorting the berries into marketable and non-marketable and; (d) percent recovery is the total of marketable and non-marketable yield over the total yield of dried berries multiplied by 100.

2.5.2 Agronomic Data of Banana

The following were the procedures for obtaining the agronomic agronomic date of banana: (a) Number of fingers are counted per bunch; (b) yield per bunch is the weight of banana bunch after harvest and; (c) marketable yield of banana is the weight of banana per bunch multiplied by the plant population density per treatment.

2.6 Data Analysis

The data were subjected to data analysis using the statistical software Asistat. Analysis of variance was used to test the significance and Tukey test for comparing the means.

3. Results and Discussion

The study was conducted in three-year duration. The results presented were for one cropping or harvesting only.

3.1 Yield and Yield Components of Coffee Intercropped with Banana at Different Distances

Table 2 shows the yield of coffee intercropped with banana in different distances. The weight of fresh berries was taken after harvest. The weight of the coffee berries varies significantly per treatment. It ranges from 1.80

Table 2. Yield and yield components of coffee intercropped with banana at different distances

Treatments	Weight of fresh berries ton/ha	Weight of dried berries ton/ha	Marketable Yield ton/ha	Percent Recovery % (Fresh Weight)
T_1- Control, No intercropping	1.80b	1.53[ab]	0.86[b]	59.70
T_2- Coffee +banana intercrop at 2m x 4m distance	2.92[a]	1.65[a]	0.99[a]	65.43
T_3- Coffee+banana intercrop at 2m x 6m distance	2.95[a]	1.65[a]	0.91[b]	59.81
T_4- Coffee+banana intercrop at 4m x 4m distance	1.80[b]	1.36[b]	0.85[b]	64.43
F-Test	**	*	**	Ns
CV (%)	9.19	5.52	3.02	5.36

ton/ha to 2.95 ton/ha. The coffee intercropped with banana at a distance of 2m x 6m (T3) had the heaviest fresh berries of 2.95 ton per hectare followed by intercropping banana at 2m x 2m distance (T2) of 2.92 tons/ha. Lightest weight of fresh berries per hectare was attained in coffee intercropped with banana at 4m x 4m distance (T4) and in coffee planted as monocropping (T1). The fresh weight of coffee berries intercropped with banana differs significantly with that of the coffee planted as monocropping or no intercrop.

The weight of dried berries was taken by weighing the coffee berries, dried at 14% MC. Statistical analysis revealed a significant difference between treatment means. Coffee intercropped with banana at a distance of 2m x 4m and 2m x 6m had the heavy weight of 1.65 ton/ha but not significantly different with the coffee planted in monocropping.

The marketable yield was taken by selecting the quality of the dried beans. The different distances of intercropping banana in coffee greatly affected the marketable yield of coffee as shown in Figure 1. The highest marketable yield was 0.99 ton/ha obtained by intercropping coffee with banana at 2m x 4m distance, whereas the lowest marketable yield was 0.85 ton/ha obtained in coffee-banana intercropping at 4m x 4m but not significantly different with the no intercropping.

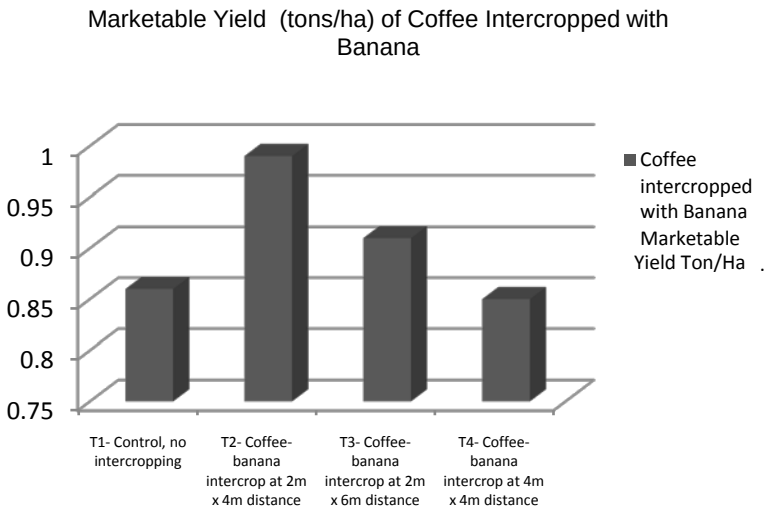

Figure 1. Marketable yield (tons/ha) of coffee intercropped with banana

The percent recovery of coffee beans was computed as the total of marketable and non-marketable yield over the total yield of dried berries multiplied by 100. Statistical analysis shows no significant difference in the percent recovery of all treatments, however, highest percent recovery was 65.43% (T_2) and lowest percent recovery was 59.70 (T_1).

3.2 Yield of Banana Intercropped at Different Distances

The banana was planted in different distances as intercropped with coffee. Yield parameters like average number of fingers, yield per bunch and yield in ton/ha (marketable and non-marketable) were taken.

In Table 3, the average number of fingers varies significantly with the different planting distances. It ranges from 101 to 130 per bunch. Banana intercropped at 4m x 4m distance had the most number of fingers whereas banana intercropped at 2m x 4m distance had the least number of fingers per bunch.

The yield of banana per bunch was obtained by weighing the bunch after harvest. Banana intercropped at a distance of 2m x 6m had the highest yield per bunch of 15.02 kg followed by banana intercropped at a distance of 4m

Table 3. Yield data of banana as coffee intercrop

Treatments	Average number of fingers per bunch	Yield per bunch (kg)	Yield (ton/ha)
T_1- Control, No intercropping	-	-	-
T_2- Coffee+banana intercrop at 2m x 4m distance	101 [b]	9.65 [b]	12.06[b]
T_3- Coffee +banana intercrop at 2m x 6m distance	130 [a]	15.02 [a]	12.51[a]
T_4- Coffee +banana intercrop at 4m x 4m distance	131 [a]	14.68 [a]	9.18[c]
F-Test	*	*	**
CV (%)	7.97	12.48	8.93

x 4m lowest yield was obtained in banana intercropped in coffee at a A distance of 2m x 4m. The reason, perhaps to the attainment of the lowest yield in the bunch is the plant population density of the banana. Too close spacing affected the yield performance of the banana.

The yield of banana per hectare was computed with the assumption that the plant population density (PPD) per treatment is complete, that is for T2 the PPD per hectare is 1,250; T3 is 833 and T4 is 625. The yield was taken from the weight of banana per bunch multiplied with the PPD per treatment. Figure 2 shows treatment 2 had the highest yield per hectare of 12.51tons, which is significantly higher compared to other treatments. Lowest yield was 9.18 tons obtained by T4.

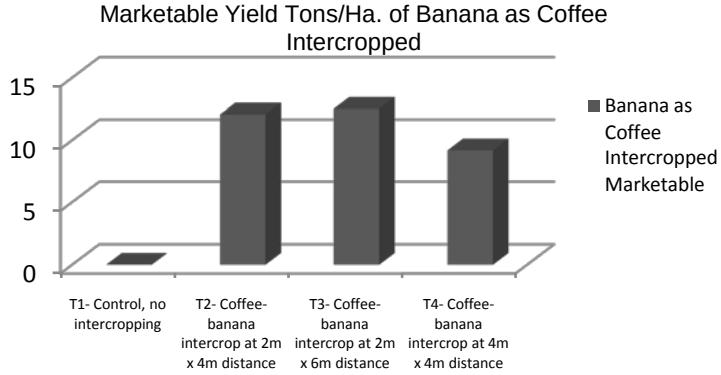

Figure 2. Marketable yield tons/hectare of banana as coffee intercropped

3.3 Cost and Return Analysis of One Hectare Coffee Intercropped with Banana

Table 4 and Table 5 show the cost and return per hectare of coffee +banana intercropped was computed based on the prevailing market price of coffee and banana in the area. The computed cost of production per hectare was deducted from the gross income to obtain the net income per hectare. The combined cost and return analysis of one hectare coffee+banana intercropped was also computed that is shown in Table 6.

Table 4. Cost and return analysis of one hectare coffee intercropped with banana

Treatments	Coffee ton/ha	Banana ton/ha	Gross income Php	Total Cost of Production	Net Income Php	% ROI
T_1- Control, no intercropping	0.86	_	68,800.00	23,000.00	45,800.00	66.57
T_2- Coffee +banana intercrop at 2m x 4m distance	0.99	12.06	260,100.00	42,995.00	217,105.00	83.47
T_3- Coffee +banana intercrop at 2m x 6m distance	0.91	12.51	260,450.00	39,155.00	211,295.00	81.14
T_4- Coffee +banana intercrop at 4m x 4m distance	0.85	9.18	205,700.00	31,875.00	173,825.00	84.51

Table 5. Cost and return analysis of one hectare banana as coffee intercropped planted in different distances

Treatments	GY ton/ha	GY kg/ha	Gross Income Php80.00/kg	Total Cost of Production	Net Income Php	% ROI
T_1- Control, no intercropping	0.86	860.00	68,800.00	23,000.00	45,800.00	65.57
T_2- Coffee+banana intercrop at 2m x 4m distance	0.99	990.00	79,200.00	23,000.00	56,200.00	70.96
T_3- Coffee+banana intercrop at 2m x 6m distance	0.91	910.00	72,800.00	23,000.00	49,800.00	68.41
T_4- Coffee+banana intercrop at 4m x 4m distance	0.85	850.00	68,000.00	23,000.00	45,000.00	68.18

Table 6. Combined cost and return analysis of one hectare coffee+banana intercropping

Treatments	GY in kg/ha	Gross Income Php15.00/kg	Total Cost of Production	Net Income Php	% ROI
T_1- Control, no intercropping	-	-	-	-	-
T_2- Coffee +banana intercrop at 2m x 4m distance	12,060.00	180,900.00	19,995.00	160,905.00	88.95
T_3- Coffee +banana intercrop at 2m x 6m distance	12,510.00	187,650.00	16,155.00	171,495.00	91.39
T_4- Coffee +banana intercrop at 4m x 4m distance	9,180.00	137,700.00	8,875.00	128,825.00	85.48

The prevailing price of coffee and banana during the conduct of the study was Php80.00 per kg and Php15.00 per kg, respectively on the local market of Claveria.

Based on the combined cost and return analysis, coffee+banana intercropping regardless of the planting distances had higher net income and ROI compared to coffee grown as monocropping. Comparing the net income and ROI within intercropping, the coffee intercropped with banana 2m x 6m had the highest combined net income of Php217, 105.00. Highest ROI was 84.55% obtained by T4. Coffee intercropped with banana at 4m x 4m distance had the lowest net income of Php173, 825.00.

4. Conclusions and Recommendations

Intercropping is a very common practice for smallholder farmers not only in the Philippines but also in other countries. It has been used by developing countries due to its advantages like risk minimization, effective use of available resources, and others. Coffee- banana intercropping system is the

most widespread farming practices. A study to assess the profitability of coffee intercropped with banana in different planting distances was conducted at MOSCAT Research site in a three-year duration. The study was carried out using Randomized Complete Block Design (RCBD) with four (4) treatments (T_1 – Control, no intercropping; T_2 – coffee+banana intercropped at 2m x 4m distance; T_3 – coffee+banana intercropped at 2m x 6m; T_4 – distance coffee+banana intercropped at 4m x 4m distance) replicated three times.

Data on the weight of fresh berries, weight of dried berries, marketable yield and percent recovery were taken. The weight of fresh berries ranges from 1.80 tons/ha to 2.95 ton/ha. The coffee intercropped with banana at a distance of 2m x 6 m (T_3) had the heaviest fresh berries of 2.95 ton per hectare while the light weight of fresh berries per hectare was attained in coffee intercropped with banana at 4m x 4m distance (T_4) and in coffee planted as monocropping (T_1). The fresh weight of coffee berries intercropped with banana differs significantly with that of the coffee planted as monocropping or no intercrop. Coffee intercropped with banana at a distance of 2m x 4m and 2m x 6 m had the heaviest dried berries of 1.65 tons/ha but not significantly different with the coffee planted in monocropping. The different distances of intercropping banana in coffee greatly affected the marketable yield of coffee. The highest marketable yield was 0.99 ton/ha obtained by intercropping coffee with banana at 2m x 4m distance, whereas the lowest marketable yield was 0.85 ton/ha obtained in coffee-banana intercropping at 4m x 4m but not significantly different with the no intercropping. The percent recovery of coffee beans was computed as the total of marketable and non-marketable yield over the total yield of dried berries multiplied by 100. No significant difference was observed in the percent recovery of all treatments, however, highest percent recovery was 65.43% (T_2) and lowest percent recovery was 59.70 (T_1).

The banana was intercropped in coffee in different distances. Yield parameters like average number of fingers, yield per bunch and yield in ton/ha were taken into consideration. The average number of fingers varies significantly with the different planting distances. It ranges from 101 to 130 per bunch. Banana intercropped at 4m x 4m distance had the most number of fingers whereas banana intercropped at 2m x 4m distance had the least number of fingers per bunch.Banana intercropped at a distance of 2m x 6m had the highest yield per bunch of 15.02 kg lowest yield was obtained in banana intercropped with coffee at a distance of 2m x 4m. The yield of

banana per hectare was computed with the assumption that the plant population density (PPD) per treatment is complete, that is for T_2 the PPD per hectare is 1,250; T_3 is 833 and T_4 is 625. The yield was taken from the weight of banana per bunch multiplied with the PPD per treatment. Treatment 2 had the highest yield per hectare of 12.51tons, which is significantly higher compared to other treatments. Lowest yield was 9.18 tons obtained by T_4.

The cost and return per hectare of coffee-banana intercropped was computed based on the prevailing market price of coffee and banana in the area. The computed cost of production per hectare was deducted from the gross return to obtain the net return per hectare. The combined cost and return analysis of one hectare coffee-banana intercropped was also computed as shown in Table 5.

The combined cost and return analysis shows that coffee+banana intercropping regardless of the planting distances had higher net income and ROI compared to coffee grown as monocropping. Comparing the net income and ROI within intercropping, the coffee intercropped with banana at 2m x 6m had the highest combined net income of Php 217, 105.00. Coffee intercropped with banana at 4m x 4m distance had the lowest net income of Php173, 825.00.

Based on the above findings, intercropping is more profitable as a result of the more efficient use of the applied inputs, labor and others than monocropping.Intercropping banana in a distance of 2m x 6m performed best in where it gave the highest combined net income and ROI of Php217, 105.00.Moreover, further study is recommended to verify results from the recent study obtained data for one harvesting or cropping only.

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