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Growth and yield performance of upland rice (*Oryza sativa* L. var. zambales) intercropped with mungbean (*Vigna radiata* L.) and peanut (*Arachis hypogaea* L.)

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Abstract

One way of increasing productivity per unit area per unit time is through intercropping. This study aimed to evaluate the growth and yield performance of upland rice intercropped with mungbean and peanut, determine the appropriate intercrop that would give optimum yield of upland rice, and assess the profitability of upland rice production intercropped with mungbean and peanut. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatments were designated as follows: T_0 = monoculture upland rice, T_1 = Upland rice + Mungbean var. Lg Mg 28–6–0, T_2 = Upland rice + Mungbean var. Pag–asa 7, T_3 = Upland rice + Peanut var. CVRC Pn 2011–002, and T_4 = Upland rice + Peanut var. Pn 06–34–3a. Results showed that intercropping upland rice var. Zambales with mungbean and peanut significantly affected the number of days from sowing to heading, days from sowing to maturity, leaf area index, fresh straw yield (t ha^{-1}), number of unfilled grains per panicle, and weight of grains per 0.50 linear meter. Monoculture upland rice (T_0) matured earlier and had the highest leaf area index and straw yield. Upland rice with peanut var. CVRC Pn 2011–002 (T_3) had more unfilled grains and higher weight of grains per 0.50 square meter, while upland rice with peanut var. CVRC Pn 2011–002 (T_4) had the highest LER value of 1.30 and ATER value of 1.93. Highest rice grain yield of 2.8 t ha^{-1} and highest gross margin of PhP 106,757.02 ha^{-1} were obtained from upland rice with peanut var. CVRC Pn 2011–002 (T_4), while lowest gross margin of PhP 13,727.14 ha^{-1} was obtained from the upland rice monoculture (T_0).

Key words: Intercropping scheme, crop productivity, area time equivalent ratio, land equivalent ratio

Introduction

Rice (*Oryza sativa* L.*)* is a major cereal crop cultured in tropical or temperate countries and the main source of income among Asian farmers (Jagadish et al., 2010). More than 90% is produced and consumed in Asia (Kumar and Ladha, 2011). It is the most important agricultural crop primarily developed and consumed by Filipinos being a good source of energy, protein, minerals and vitamins. It is the main staple food for Filipinos.

The Philippines has a total land area of 30 million hectares and out of the country land area, an estimated 14.9 % is classified as uplands (Tacio, 2005 as cited by Castillo, 2010). Upland areas are those with a slope ranging from 18 percent upward. In Eastern Visayas, upland areas are vastly degraded occupying about a 362,123.02 hectares (Tejada et al., 2008). Some of those areas are grown with upland rice. Upland rice is a kind of rice that is grown in unsaturated fields with water and its moisture mainly depends on rainfall. One significant characteristic of upland rice field is the absence of levees to hold water (Pagalan, 2003). George et al. (2002) reported that the normal yield of upland rice in Asia is only 1000 kg/ha. However, upland rice ecosystem is less affected by drought conditions compared to lowland rice condition.

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Farmers carry out different cropping systems to increase productivity and sustainability by intercropping annual cereals with legumes. Intercropping cereals with legumes has been a popular practice in the tropics (Tsubo et al., 2005) due to its benefits on soil conservation and weed control. It improves soil and water quality by providing year-round ground cover and minimized erosion by growing more than one crop at a time in the same field. Intercropping is the practice of planting two or more crops simultaneously at the same time in the same area, with or without a row arrangement. This practice has been found to be economical and profitable because the cost of weed control is reduced due to the shading effects of the canopy of the intercrop and the main-crop. In addition, the intercrop residues when incorporated in the soil after harvest and upon decomposition enhance the physical and chemical properties of the soil.

The popular grain legumes used in combination with cereal crops like upland rice are mungbean (*Vigna radiata* L.) and peanut (*Arachis hypogaea* L.*)*. Generally, planting legumes as intercrop to cereals has been found beneficial because of their capability to associate symbiotically with *Rhizobium* which fixes nitrogen from the atmosphere.

Mungbean is a fast growing and early maturing grain legume crop that produce more herbage making it an excellent crop for intercropping. Likewise, peanut has bushy growth habit which makes it ideal for intercropping. It is also resistant to certain insect pests and diseases, and widely adapted to certain soil and climatic conditions.

The practice of intercropping increases the productivity per unit area with less inputs needed. However, improvements are needed to make this cropping system work successfully and efficiently, to increase productivity in upland rice farming. It is advisable to know the leguminous crops that will be grown in association with the maincrop to attain optimum productivity per unit area per unit time, hence this study was conducted to: 1) evaluate the growth and yield performance of upland rice intercropped with mungbean and peanut; 2) determine the appropriate intercrop that would give optimum yield of upland rice and; and 3) assess the profitability of upland rice production per hectare intercropped with mungbean and peanut.

Materials and Methods

An area of 263.5 m^2 was plowed and harrowed twice at weekly interval to remove the weeds, pulverize the soil, and improve soil structure. After the last harrowing, six (6) furrows at a distance of 0.75 m for intercropped and (9) nine furrows at a distance of 0.50 m for the monocultures.

Drainage canals were made around the experimental area and between replications to prevent waterlogging in the area especially during rainy days. Ten (10) soil samples were collected at random from the different points in the experimental area at a depth of 0-20 cm. The samples were mixed thoroughly, composited, air-dried, pulverized, and sieved using a 2 mm mesh. A 1 kg composite sample was brought to Central Analytical Services Laboratory (CASL), PhilRootCrops, Visayas State University Visca, Baybay, City, Leyte for the analysis of soil pH (1:2.5 soil water ratio, ISRIC 1995), % organic matter content (Modified Walkley Black method, PCARR 1980), total N (Modified Kjedahl Method, PCARR 1980), available phosphorus (Bray P_2 Method, 1945) and exchangeable potassium (Ammonium acetate Method, PCARR 1980). After harvest, five soil samples were collected from in each treatment plot for the final analysis of the same parameters mentioned above.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with (5) five treatments replicated three times. Each replication was divided into 5 plots, each measuring 3 m x 4.5 m (13.5 m^2). Alleyways of 1.0 m between replications and 0.5 m between treatment plots were provided to facilitate farm operations and data gathering. The treatments designated as follows: T_0 – monoculture upland rice, T_1 – Upland rice + Mungbean var. Lg Mg 28–6–0, T_2 – Upland rice + Mungbean var. Pag–asa 7, T_3 – Upland rice + Peanut var. CVRC Pn 2011–002, T_4 – Upland rice + Peanut var. Pn 06–34–3a.

The fertilizer was applied at the rate of 120-60-60 kg ha^{-1} N, P_2O_5, K_2O to upland rice. Half of the total amount of N and full amounts of P_2O_5 & K_2O fertilizers were evenly applied in the furrows on the day of planting upland rice. It was covered with 2 to 3 cm of soil to prevent the seeds from getting in contact with the fertilizer. The remaining half of N fertilizer was applied along the furrows 45 days after planting using urea fertilizer (46-0-0).

Mungbean and peanut was applied using complete fertilizer (14-14-14) at the rate of 30-30-30 kg ha^{-1} N, P_2O_5, K_2O. The fertilizer material was applied on the same day before planting, and was covered with a thin layer of soil to prevent the seeds from getting in contact with the fertilizer.

The upland rice seeds var. Zambales were drilled in the furrows at a rate of 60 kg ha^{-1} or 81 g per 13.5 m^2 plot, so monoculture had 81 g per 13.5 m^2 plot with 9 g per row and intercropped had 54 g per 13.5 m^2 plot with 9 g per row. The seeds were covered with thin layer of soil and slightly pressed to avoid drying up and to minimize damage due to vertebrate pests.

Mungbean was drilled in between the six (6) rows of upland rice at the rate of 18 kg ha^{-1} or 24.3 g per 13.5 m^2 plot, so monoculture had 24.3 per 13.5 m^2 plot and 2.7 g per row and intercropped had 16.2 g per 13.5 m^2 plot with 2.7 g per row. Two (2) weeks after planting, the seedling was thinned to 15 plants per linear meter to attain a plant population of approximately 300,000 plants per hectare. Peanut was planted between the six (6) rows of upland rice with 3 seeds per hill at a distance of 20 cm and monoculture with nine (9) rows was also be planted at the rate of 3 seeds per hill at a distance of 20 cm. Two (2) weeks after planting the seedlings were thinned to 2 plants per hill to have a plant population of 200,000 plants per hectare.

Monocultures of upland rice, mungbean, and peanut were planted at a distance of 0. 50 m between rows. This was established for the determination of land equivalent ratio (LER) and area-time equivalency ratio (ATER).

To control insect pests, spraying three (3) times was done using Lannate (Methomyl active ingredient of 400 g kg^{-1} and inert ingredient of 600 g kg^{-1}) at the rate of 25 g 16 L^{-1} during heading stage to control rice bugs. Hilling up and hand weeding of all crops was done two weeks after planting to loosen the soil and enhance the development of the roots. Rat infestations was minimized by providing a ready to mix Racumin at the rate of 2-3 tbsp/bamboo slat and cleaning the alleyways and perimeter area. Upland rice was harvested when 90% of the grains had matured as manifested by yellow color and hard grains. Yield data was taken from the seven (7) rows for monocultures and four (4) for the intercropped harvestable rows per treatment plot, excluding the 2 border rows in each side and 0.4 m end plants in each end row. The panicles were harvested by cutting at the base with the use of sickle. The sample plants within the harvestable area (7.7 m^2) for monocultures and (6.6 m^2) for intercrops in each treatment plot were threshed and sundried separately. Weighing of grains was done after they are dried to about 14 % moisture content. While, mungbean was harvested by priming the mature pods for three (3) times in the harvestable area (7.7 m^2) for monocultures and (6.6 m^2) for intercrops within the nine (9) and five (5) harvestable rows per treatment plot, excluding the 2 border rows in each side and 0.4 m plants in each end row in each treatment plot. The harvested pods were sun-dried and threshed after which the pods were cleaned and the grains were weighed.

Peanut was harvested when 90% of the plants had reached maturity within the harvestable area (7.7 m^2) for monocultures and (6.6 m^2) for intercrops within the nine (9) and five (5) harvestable rows per treatment plot, excluding the 2 border rows in each side and 0.4 m plants at each end of the row in each treatment plot. At this stage, the leaves turned yellow and the seeds inside the pod was became firmed. This was done by uprooting all plants in each treatment plot with the aid of a bolo.

Data Gathered

For agronomic characteristics of upland rice were evaluated; days from sowing to heading; days from sowing to maturity; plant height (cm); Leaf Area Index (LAI) and fresh straw yield (t ha^{-1}) using the formula below.

$$\text{Fresh straw yield (t ha}^{-1}) = \frac{\text{Plot yield (kg)}}{\text{Harvestable area (7.7m2)mono, (6.6m2)inter}} \text{ x } \frac{10{,}000 \text{ m}^2\text{ha}^{-1}}{1000 \text{ kg ton}^{-1}}$$

For the yield and yield components: number of productive tillers per square meter; weight of panicles per square meter; number and weight of unfilled grains per panicle; number and weight of filled grains per panicle; percentage filled grains (%); weight of grains per square meter; weight (g) of 1000 grains; grain yield (t ha^{-1}). The grains per plot were converted into per hectare using the formula:

$$\text{Grain yield (t ha}^{-1}) = \frac{\text{Plot yield (kg)}}{\text{Harvestable area } (7.7m2)mono, (6.6m2)nter} \text{ x } \frac{10{,}000 \text{ m}^2 \text{ ha}^{-1}}{1000 \text{ kg ton}^{-1}}$$

Harvest Index (HI) This was indicated the efficiency of the plants to convert the absorbed nutrients and product of photosynthesis into grains (economic yield). High harvest index means that there was high grain yield in proportion to straw yield. On the other hand, low harvest index means that straw yield was higher in proportion to the grains formed. Harvest index was computed the formula below:

$$\text{HI} = \frac{\text{Dry grain yield}}{\text{Dry grain yield} + \text{Dry straw yield}}$$

Land Equivalent Ratio (LER) is the sum of the fraction of the yield under intercropping relative to the monoculture yield. This was determined by getting the ratio of the yield of the crop combination and the yield of monoculture under the same level of management. This was computed based on the following formula:

$$\text{LER} = \frac{X_1}{X_2} + \frac{Y_1}{Y_2}$$

Where: X_1 = yield of rice as intercrop, X_2 = yield of rice in monoculture Y_1 = yield of intercrop as intercrop and Y_2 = yield of intercrop in monoculture. An LER of more than 1.0 means that the practice of intercropping is more productive than the sole cropping, and LER less than 1.0 indicates that monocropping is more advantageous than the intercropping scheme. LER of 1.0 means that the practiced of intercropping and sole cropping were the same in productivity.

Area Time Equivalent Ratio (ATER): This parameter measures the efficiency and productivity of the crop to utilize the land utilized by the component crops. ATER was calculated using the formula developed by Hiebsch (2017).

$$\text{ATER} = \frac{(\text{RYa x Ta}) + (\text{RYc x Tc})}{\text{T}}$$

Where: RYa = relative yield of upland rice in mixture, Ta = duration (in days) of upland rice RYb = relative yield of mungbean in mixture, Tb = duration (in days) of mungbean , RYc = relative yield of peanut in mixture, Tc = duration (in days) of peanut, T = total duration of the intercropping system (in days).

Gross margin was also determined by subtracting from the gross income the total expenses using the formula: Gross Income = Yield (kg ha^{-1}) x price of each crop per kg. Gross margin = Gross Income – Total Expenses. All data collected were analysed using Statistical Tool for Agricultural Research (STAR). Comparison of means was done using Fisher's test or Least Significant Difference (LSD).

Results and Discussion

Soil Chemical Analysis

Table 1 presents the initial and final soil analysis of the experimental area. The soil in the area had an initial soil pH of 6.47 with 1.226 % organic matter, 0.119 % total nitrogen and 9.632 mg kg^{-1} available P contents and 0.641 (m 100 g^{-1}) exchangeable potassium. These means that the area was slightly acidic, with very low amount of organic matter, low in total nitrogen, low in available phosphorus and high amount of exchangeable K (Landon, 1991).

Table 1. Soil test results before and after planting of upland rice intercropped with mungbean and peanut

Treatment	Soil pH (1:2.5)	OM (%)	Total N (%)	Available P (mg kg^{-1})	Exchangeable K (me 100 g^{-1})
Initial Analysis	6.47	1.22	0.11	9.63	0.64
Final Analysis					
T_0 – Monoculture upland rice	6.29	1.31	0.07	8.84	1.32
T_1 – UR + Mg var. Lg Mg 28–06-0	6.21	1.34	0.06	5.82	1.57
T_2 – UR + Mg var. Pag–asa 7	6.14	1.30	0.08	6.56	1.42
T_3 – UR + Pn var. CVRC Pn 2011–002	6.16	1.41	0.10	6.80	1.40
T_4– UR + Pn var. Pn 06–34–a	6.18	1.37	0.07	6.66	1.34
Mean	6.20	1.35	0.08	6.94	1.41

UR-Upland Rice

In the final soil analysis, slight increase in organic matter and exchangeable K (me 100 g^{-1}) were noted while a decrease in soil pH, available P (mg kg^{-1}) and total N were observed. The decrease of soil pH in the soil from 6.14 % could be due to application of inorganic fertilizer and production of carbonic acid. However, the decrease of total N in the soil from 0.11-0.06 % could be due to heavy rainfall that caused leaching of nitrogen (Tosas, 1988).

Agronomic Characteristics of Upland Rice

The agronomic characteristics of upland rice var. Zambales intercropped with mungbean and peanut are shown in Table 2. Analysis of variance revealed that intercropping different varieties of mungbean and peanut significantly affected the number of days from sowing to heading, days to maturity, leaf area index and fresh straw yield (t ha^{-1}) of upland rice. This means that the different varieties of mungbean and peanut as intercrops caused variation on the above mentioned parameters of upland rice over the monoculture stand.

Upland rice intercropped with either mungbean (Mg var. Lg Mg 28-6-0 (T_1), or Mg var. Pag-asa 7 (T_2), and peanut (Pn var. CVRC Pn 2011-002 (T_3) or Pn var. Pn 06-34-3a (T_4) headed and matured later than the monoculture (T_0). The early heading and maturity of monoculture stand (T_0) could be due to less competition of water, light and nutrients. On the other hand, intercropped upland rice (T_1, T_2, T_3, and T_4) headed and matured longer probably due to competition between upland rice and legume intercrop (mungbean and peanut), lowered their photosynthetic activity. Al-Dalain (2009) reported that competition between crops delays heading and maturity.

Higher leaf area index (LAI) was obtained in monoculture (T_0) due to more number of upland rice plants with more number of leaves per unit area. This result confirmed the findings of Aguelo (2003) that the higher leaf area index of upland rice is observed with more number of plants per unit area.

Moreover, fresh straw yield (t ha^{-1}) of upland rice was significantly affected by intercropping mungbean and peanut. The highest fresh straw yield (t ha^{-1}) was obtained in monoculture stand (T_0). This could be attributed to more plants harvested per unit area (Lawrence and Gohain, 2011).

Table 2. Agronomic characteristics of upland rice intercropped with mungbean and peanut

Treatment	No. of days from sowing to		Plant height (cm)	Leaf Area Index	Fresh Straw yield (t ha^{-1})
	Heading	Maturity			
T_0 – Monoculture upland rice	93.00b	120.67b	137.83	3.01a	23.16a
T_1 – UR + Mg var. Lg Mg 28–6 –0	97.67a	123.00a	130.40	2.12b	10.05b
T_2 – UR + Mg var. Pag–asa 7	96.00a	122.33a	131.25	2.33b	13.15b
T_3 – UR + Pn var. CVRC Pn 2011–002	97.00a	122.67a	134.70	2.06b	14.35b
T_4– UR + Pn var. Pn 06–34–3a	95.67a	122.67a	134.22	2.23b	14.45b
CV (%)	1.58	0.45	3.24	8.25	26.31

UR-Upland Rice

Yield and Yield Components, Harvest Index of Upland Rice

Tables 3, 4, 5 present the yield and yield components, harvest index and LER of upland rice intercropped with mungbean and peanut. Results revealed that among the parameters evaluated only the number of unfilled grains panicle^{-1} and weight of grains (0.50m^{-1}) were significantly affected by the different treatments.

Upland rice intercropped with peanut var. CVRC Pn 2011-002 (T_3) had more unfilled grains panicle^{-1}, however, it was comparable to those intercropped with mungbean var. Pag–asa 7 (T_2). This could be due to competition for nutrients, water and other environmental factors, thus lesser amounts of photosynthates were translocated to the reproductive parts for grain filling (Mandal, 2014).

Table 3. Yield and yield component characteristics of upland rice intercropped with mungbean and peanut

Treatment	No. of productive tiller (0.50 m^{-1})	Wt. of panicles (0.50 m^{-1})	Number of grains panicle $^{-1}$	
			Filled	Unfilled
T_0 – Monoculture upland rice	55.67	179.33b	180.00	24.20c
T_1– UR + Mg var. Lg Mg 28–6–0	43.67	183.00b	224.37	28.73bc
T_2– UR + Mg var. Pag–asa 7	46.33	181.33b	237.73	35.37ab
T_3– UR + Pn var. CVRC Pn 2011–002	49.33	233.67a	238.46	42.30a
T_4– UR + Pn var. Pn 06–34–3a	52.00	194.67b	222.30	28.90bc
CV (%)	21.90	28.22	11.64	17.13

UR-Upland Rice

Table 4. Yield component characteristics of upland rice intercropped with mungbean and peanut

Treatment	Weight (g) of grains panicle $^{-1}$		% filled grains	Wt. (g) of grains 0.50 m^{-1}
	Filled	Unfilled		
T_0 – Monoculture upland rice	52.77	1.87	88.12	139.67b
T_1 – UR + Mg var. Lg Mg 28–6–0	57.33	1.80	88.64	137.33b
T_2 – UR + Mg var. Pag–asa 7	54.60	2.10	86.11	129.33b
T_3 – UR + Pn var. CVRC Pn 2011–002	64.17	3.13	84.92	205.33a
T_4 – UR + Pn var. Pn 06–34–3a	57.63	2.33	88.63	161.33b
CV (%)	14.65	39.24	2.20	15.30

UR-Upland Rice

Table 5. Yield component characteristics and harvest index of upland rice intercropped with mungbeaan and peanut

Treatment	Wt. (g) of 1000 seeds	Seed Yield (t ha^{-1})	Harvest Index (HI)
T_0 – Monoculture upland rice	35.33	2.82	0.28
T_1 – UR + Mg var. Lg Mg 28–6–0	36.33	1.64	0.24
T_2 – UR + Mg var. Pag–asa 7	34.00	1.72	0.27
T_3 – UR + Pn var. CVRC Pn 2011–002	36.67	2.04	0.31
T_4 – UR + Pn var. Pn 06–34–3a	35.67	2.19	0.26
CV (%)	4.69	20.80	19.29

UR-Upland Rice

Monoculture upland rice (T_0) produced the lowest number of unfilled grains per panicle due to the absence of interplant competition for nutrients, light and water, however, it was comparable to T_1 (Upland rice + Mungbean var. Lg Mg 28–6–0) and T_4 (Upland rice + Peanut var. Pn 06–34–3a). This could due to the more efficient utilization of environmental resources such as water, light, soil and nutrients under intercropping system (Lithourgidis and Yiakoulaki, 2006).

Furthermore, upland rice intercropped with peanut var. CVRC Pn 2011-002 (T_3) had significantly produced the heaviest (g) grains per 0.50 linear meter compared to the other treatments. This could be due to the source-sink relationship wherein the peanut var. CVRC Pn 2011-002 (T_3) had better bushy growth habit and structure compared to peanut var. Pn 06-34-3a (T_4) thus maincrop (upland rice) had better opportunity to utilize the available growth factors within the intercrops (peanut) with minimal competition (Jensen, 2001). Szumigalski and Van-Acker (2008) added that under intercropping system, light, water and nutrients resources is enhanced thus plants will have heavier grains.

Land Equivalent Ratio (LER) and Area Time Equivalent Ratio (ATER)

Table 6 shows the LER values on the intercropping scheme. Results revealed that the higher LER value of (1.30) was obtained in T_4 (Upland rice + Peanut var. Pn 06–34–3a). The high LER value in this treatment was probably due to the higher yield obtained from the component crops (upland rice and peanut). However, LER value of 1.22 was obtained in T_2 (Upland rice + Mungbean var. Pag-asa 7). These results imply that peanut planted as intercrop seemed to be a good cropping combination to maximize land utilization for increased production. The LER value of 1.30 in this treatment implies that 0.30% (3000m^2) and 0.22% (2200m^2) more land is needed in monoculture to give the same yield of upland rice, mungbean, and peanut under intercropping system. The result confirmed the findings of Alcober**,** et al. (2014) that growing crops in association is more productive than using the crop in pure stand.

Table 6 presented the ATER values of intercropping system. Results revealed that the highest ATER value was obtained in T_4 for peanut and T_2 for mungbean. This means that intercropping scheme under T_4 and T_2 is more advantageous than the sole cropping. This further suggests that upland rice intercropped with mungbean var. Pag–asa 7 (T_2), peanut var. CVRC Pn 2011-002 (T_3) and peanut var. Pn 06-34-3a (T_4) are good combination to maximize the yield per unit per unit time.

Table 6. Land Equivalent Ratio (LER) and Area Time Equivalent Ratio (ATER) of upland ricintercropped with mungbean and peanut

Treatments	LER	ATER
T_0 – Monoculture upland rice	-	-
T_1– UR + Mg var. Lg Mg 28–6–0	1.13	1.29
T_2– UR + Mg var. Pag–asa 7	1.22	1.42
T_3– UR + Pn var. CVRC Pn 2011–002	1.19	1.84
T_4– UR + Pn var. Pn 06–34–3a	1.30	1.93

UR-Upland Rice

Gross Margin Analysis
Table 7 presents the gross margin analysis of upland rice production intercropped with mungbean and peanut. Among the intercropping schemes, T_4 (Upland rice + Peanut var. Pn 06-34-3a) gave the highest gross margin of Php 106,757.02 ha^{-1}. This could be attributed to the highest grain yield obtained from upland rice. Although, T_4 incurred the higher variable cost Php 58,662.98 ha^{-1} but still obtained the highest gross margin of Php 106,757.02 ha^{-1} followed by (T_3) with Php 89,407.02 ha^{-1}, (T_2) Php 45,157.02 ha^{-1}, and (T_1) Php 37,917.04 ha^{-1}.
On other hand, monoculture upland rice (T_0) obtained the lowest gross margin of Php 13,727.14 ha^{-1} due to low production per hectare and absence of intercrop that could have added to the gross margin per hectare.

Table 7. Gross margin analysis of upland rice intercropped with mungbean and peanut

Treatment	Grain Yield ($t\ ha^{-1}$)		Total Gross Income (PhP)	Total Variable Cost (PhP)	Gross margin (PhP)
	Maincrop	Intercrop			
T_0	2.89	-	52,020.00	40,292.86	13,727.14
T_1	1.64	0.80	85,520.00	47,602.98	37,917.02
T_2	1.72	0.89	93,260.00	48,102.98	45,157.02
T_3	2.04	1.58	147,320.00	57,912.98	89,407.02
T_4	2.19	1.80	165,420.00	58,662.98	106,757.02

Calculation of gross income is based on the current price of dried palay @ PhP 18.00 per kg, peanut @ PhP 70.00 per kg, and mungbean @ PhP 70.00 per kg.

Conclusion
Based on the results of the study, the following conclusions can be drawn:

1. Upland rice intercropped with mungbean and peanut significantly delayed the number of days from sowing to heading which consequently delayed the maturity. Moreover, leaf area index and fresh straw yield ($t\ ha^{-1}$) of upland rice were reduced under intercropping scheme. The highest number of unfilled grains $panicle^{-1}$ was observed in Upland rice plated with Peanut var. CVRC Pn 2011–002 (T_3) but still obtained the heaviest grains per 0.50 linear meter.
2. Peanut var. Pn 06-34-3a (T_4) as intercropped to upland rice is the appropriate combination that would give an optimum yield of 1.80 $t\ ha^{-1}$.
3. Upland rice intercropped with peanut var. Pn 06-3-4-3a (T_4) is the most profitable combination that would give the highest gross margin of Php 106,757.02 ha^{-1}.

Recommendations
1. It is recommended to use peanut as intercrop to upland rice var. Zambales.
2. It is recommended to conduct similar study at different locations under different climatic conditions to compare the result obtained.

Conflict and Interest
Authors declare no conflict and interest.

References

Alcober, E. A. L, Ratilla, M. D., Capuno, O. M., Valenzona, J. S. (2014). Evaluation of different cropping systems for marginal uplands in Inopacan, Leyte. Visayas State University, Visca, Baybay City, Leyte. Annals of Tropical Research, 36 (Supplement):124-138.

Al-Dalain, S. A. (2009). Effect of intercropping of zea maize with potato Solanum tuberosum, L. on potato growth and on the productivity and land equivalent ratio of potato and zea maize. *Agric. J., 4*: 164-170.

Aguelo, G. C. (2003). Spatial arrangement of sorghum-peanut combination under intercropping scheme. Undergrad Thesis. LSU, Visca, Baybay City, Leyte. 23 pp.

Castillo E. T. (2010). A Research Compedium for Marginal Uplands. Department of Environment and Natural Resources, Ecosystem Research and Development. Accessed August 24, 2018.

Hiebsch, C. K. (2017). Principles of intercropping: effect of nitrogen fertilization, plant population and crop duration on equivalency ratio in interculture vs monoculture, Ph.D. Thesis, North Carolina. 28-30 pp.

ISRIC, (1995). International Soil Reference and Information Center. Procedure for Soil Analysis (L. P. van Reuuwijk, ed.) Wageningen. The Netherlands. 206 pp.

Jagadish, S. V. Cairns, K., J. Lafitte,R. S. Wheeler, T. R. Price, A. H. and Craufurd. P. Q. (2010). Genetics analysis of heat tolerance at anthesis in rice. *Crop Sci. 50*:1627-1641.

Jensen, E.S. (2001). Grain yield, symbiotic N2 fixation and interspecific competition for inorganic N in pea-barley intercrops. *Plant and Soil, 182*: 25-38.

Kumar, V. and J. K. Ladha. (2011). Direct seedling of rice: Recent development and future research needs. *Adv. Agron.* 111:297-413.

Landon, J. R. (1991). Booker Tropical Soil Manual. Longman Scientific and Technical/Booker Tate, Harlou. pp 478.

Lawrence, H. and Gohain. T. H. (2011). Intercropping of green gram (*Vigna radiata* L.) with upland rice (*Oryza sativa* L.) under Rainfed Condition of Nagaland. *Indian J.Hill Farm. , 24* (2). pp. 25-28.

Lithourgidis, S. A. and. Yiakoulaki. M. D. (2006). Forage yield and quality of common vetch mixtures with oat and triticate in tow seedling ratios. *Field Crops Res. 99*: 106-113.

Mandal, K. M. (2014). Evaluation of Cereal-Legume Intercropping Systems through Productivity and Competition Ability. *Asian Journal of Science and Technology, 5* (3): pp. 233-237.

Pagalan, L. V. (2003). Response of upland rice to time of green manure incorporation and levels of inorganic N fertilizer. Master of Science Thesis. LSU, Visca, Baybay City, Leyte. pp 12.

PCARR, (1980). *Standard Methods of Analysis for Soil, Plant Tissues, Water and Fertilizer*. Philippine Council for Agriculture and Research. Los Baños, Laguna, Philippines. 164 pp.

Szumigalski, A.R. and Van-Acker, R.C. (2008). Intercropping: Land equivalent ratios, light interception, and water use in annual intercrops in the presence or absence of in-crop herbicides. *American Agronomy Journal, 100*:1145-1154.

Tejada, S.Q. Carating, R.B. Manguera, J. B. Samalca, I. N. and Retamar. L.R. (2008). Land degradation and desertification in the Philippines. Accessed on 04 September 4, 2018 http.fao.org/nr/lada/index.php.

Tosas, D. M. (1988). Performance of sweet corn at varying time of mungbean intercropping. Undergrad Thesis. LSU, Visca, Baybay Leyte. 20 pp.

Tsubo, M. L., Walker, S. T. and Ogindo, H.O. (2005). A simulation model of cereal–legume intercropping systems for semi-arid regions. II. Model application. Field Crops Res.