BIBLIOGRAHY

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ABSTRACT

The study aimed to: determine the effect of the different planting distance on the growth and yield of the different varieties used, determine the best recommended distance of planting for our highland farmers with regard to the suitability of the variety used, determine the interaction effect between rice varieties and planting distance on the growth and yield of rice; and which treatment has the highest return on cash expense (ROCE).

Based on the results, the varieties significantly differed in all the growth and yield parameters such as initial height, tillering, panicle length, final height, ripening, number and weight of grains. Wagwag and Kamuros are resistant to whiteheads and lodging.

Planting distance had significant effect on the varieties in some growth parameters. Planting distance of 50 cm x 50 cm resulted in the highest number of productive and non productive tillers for all varieties. Further, the planting distance of 50 cm x 50 cm resulted in most grains for Tudoy and Wagwag and most filled grains per panicle for Kamuros and Wagwag. Tudoy was the earliest to ripen at 30 cm x 30 cm planting distance. Variety Kamuros and Wagwag were the earliest to ripen at 20 cm x 20 cm planting distance. Rice plants spaced at 20 cm x 20 cm produced the highest grain yield. All the varieties spaced at 50 cm x 50 cm, 40 cm x 40 cm, and 20 cm x 20 cm interact significantly in terms of maximum and productive tillers. All varieties produced the heaviest grain yield and early ripening for Kamuros and Wagwag at the traditional distancing of 20 cm x 20 cm. Tudoy ripened early at 30cm x 30 cm planting distance.

Return on cash expense was positive in all the planting distance used for variety Wagwag. The highest ROCE was obtained from Wagwag spaced at 40 cm x 40 cm planting distance.

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INTRODUCTION

The world's increasing population demands that every crop has its own role in the area of production technology to cope up with every single population need. In cereal production, the rice plant (*Oryza Sativa Linn*) is one of the well-known cultivated species of Genus Oryza belonging to the family Graminae and serve as one of the most important crops of Asia. Rice in general as compared to other grain crops is very important The New World Book Encyclopedia, 1984) for it is the pre-dominant staple food in at least 33 developing countries providing 27 % of dietary energy supply, 20% dietary protein and 3% dietary fat (IRRI, 2005). The Philippines for instance proves the importance of this crop, for over 80 % of Filipinos population makes rice as their staple food (PhilRice, 1992). Being the staple food of the Filipinos, rice is the main source of carbohydrates and proteins of most Filipino diet. In addition, rice can contribute nutritionally significant amounts of thiamine, riboflavin, niacin and zinc to the diet and smaller amounts of other micronutrients (IRRI, 2005).

Being an important crop it is widely cultivated through out the world where the two methods of planting are being practice. In most countries of the world, direct seeding is widely practiced just like in the case of eastern India where rice cultivation is often performed by direct seeding rather than transplanting (IRRI, 2005). Direct seeding is an appropriate method of growing rice if farmers want to reduce labor for it does away with seedbed preparation, seed care, pulling of seedlings and transplanting (PhilRice, 1992). However, direct seeding has a big problem on weed management (IRRI, 2005) and for Benguet farmers it is not acceptable due to cultural constraints. According to them, it is not appropriate because in direct seeding, they have to protect a large area against rats

(CECAP and Phil Rice, 2000). Due to these constraints, the transplanting method is widely adopted to highland farmers following the straight row planting where definite spacing is maintained between plants that enhances the attainment of optimum plant population and facilitates fertilizer application and weeding operations (PhilRice, 1992). For lowland rice production, spacing of 50 x50 cm between rows and hills are practice in the “Margate system” regardless of season, variety and soil fertility, while in the “masagana system” the seedlings are transplanted in straight rows with spacing varying with the season, variety and soil fertility. However, spacing between rows and hills in rows do not exceed 40 cm (UPCA, 1983). In the case of the highland rice production, a recommendation of proper planting distance is being practiced depending in the season of planting. During wet season, a 20 x 20 cm distance of planting is recommended to the advantage of slight sunlight and to prevent shading on the seedling; while during the dry season, it is advisable to let the spacing a bit closer with a distance of 20 x 15 cm (Gintong Ani, 1996).

In crop production one of the most considerable factors of production is the Total Cost of Production (TCP) which serves as their basis of adopting new introduced technologies. In rice production, the four most laborious operations include transplanting and weeding. Transplanting takes 18 % of the TCP (CECAP and Phil Rice, 2000) wherein they are following the distance regardless of variety and soil fertility, in this study, the use of different planting distance to evaluate tillering ability and yield performance of the different cultivars is implemented. Therefore, this study may serve as the basis of adopting new planting distance in correlation with the variety to be grown with lesser or minimum TCP with high or better yield than the traditional planting distance use.

The objectives of the study were to:

1. determine the effect of the different planting distance on the growth and yield of the different varieties used;

2. determine the best recommended planting distance for our highland rice farmers with regard to the suitability of the variety to be used;

3. determine the interaction effect between rice varieties and planting distance on the growth and yield of rice; and

4. determine which treatment has the highest Return on Cash Expenses (ROCE).

The study was conducted at Togoy, Ba-ayan, Tublay, Benguet from July 2007 to January 2008.

REVIEW OF LITERATURE

An advantage of rice is its high yield when it is cultivated properly. Because of its high yield, rice has long been a symbol of fertility (World Book Encyclopedia, 1991).

Most of our Benguet rice-farmers have their own choice of rice varieties to grow on their farm. Some of these varieties are traditionally grown while others are locally introduced into the farm but were adopted by the farmers.

Traditional rice varieties have broad genetic base, as they are products of continuous selection and purification through the years. Preferences for these traditional varieties is due to the following reasons: resistance to several insect pest and diseases, low fertilizer requirement, non-lodging, non-shattering, extended and long panicles for easy harvesting and storage, adoptable to low temperature, long awns to aerate seeds while in storage and to protect against birds and chickens, good eating quality, stability for wine making and are important in keeping with cultures and traditions such as ceremonial purposes- weddings and cañaos.

Traditional rice grains are generally long, medium shaped and awns possessing red, brown, white or black with stripped when hulled (PhilRice,1988).

Distance and Depth of Planting

One important factor to consider in transplanted rice is plant spacing. Rice planted closer than necessary increases the cost of transplanting and the chances of lodging. On the other hand, spacing wider than necessary may result in lower yield because the number of plant in the area maybe less than the optimum number needed for high yield (de Datta, 1981).

A straight row planting method during transplanting is recommended following a 20 x 20 cm, 15 x 15 cm or 10 x 15 cm spacing with 2-3 seedlings per hill at a depth of 2-3 cm for bed seedlings. There is no single spacing recommended for all varieties (Phil Rice, 1992).

Effect of Planting Distance

Different spacing of seedlings in rice production gives a variety of results. A wide spacing in rich soils gives maximum tillering but reduces the number of productive tillers per plant. It is also observed that the number of tillers per plant increases as the distance between plants increases (Arraudeau and Vergara, 1998).

Efferson (1952), stated that some varieties when properly spaced, produce as many as 50 productive tillers per plant, but the average for transplanted rice is 15 – 20 tillers per plant and for broadcast or drilled rice 5 – 8 tillers per plant.

Based on the study conducted by Aowat (1995) on the effect of planting distance on the growth and yield performance of native rice, he stated that plants spaced at 20 x 20 cm significantly produced better results as compared to other distances used on the study in terms of total plant weight. However, the distance (20 x 20 cm) resulted to higher weight of unfilled grains.

Trials on cotton production in Luzon, Visayas and Mindanao shows comparable seed cotton yield between the 3 varieties tested in accordance to distance of planting. CRDI-1 planted at 30 cm and 40 cm between hills produced significantly higher seed cotton yield in Tampakon, South Cotabato. More bolls were produced in wider hill spacing in Ampatuan, Maguindanao. In Panay, Capiz cotton planted either at 30 cm or 40 cm gave higher seed cotton yield compared at 50 cm between hills.

Determining the optimum spatial arrangement (row and hill) spacing of cotton in cowpea intercropping set up is a step to maximize productivity. In San Juan, Ilocos Sur plants spaced at 40 cm between hills produced more sympodial blades. However, 40 cm did not differ significantly from 20 cm and 30 cm hill spacing (CRDI, 1992-1993).

Planting in distance in vegetable such as onions and cabbage affects their final size up to a certain limit, allowing them more space means they grow larger. By reversing this and growing them more closely with less growing space, the result is vegetable of smaller size. In most cases, over all yields is also increased. Bulb onions illustrate the influence of spacing on size. For large bulbs, an equal spacing of 8 in x 8 in is ideal (Pears, 2002).

Tillering

According to Efferson (1952) tillers grows as in the true stem, the vertical and the lateral growth both of the stem and the tillers continuous to grow simultaneously. After some time a tiller may develop into independent stalks and along with the main stem mature and produce ear-heads. All tillers, however may not develop and produce ear-head at all. The size of the ear- head also varies, with the first formed tillers usually producing a larger head than the later ones.

Harvesting, Threshing, and Drying

Harvesting and its related handling operations are significant points in post production sequence where losses can be incurred (PCCARD, 2001). Basically, harvesting in the highlands is done by the use of rakem (PhilRice, 1988), however, about 97 % of Filipino farmers use the serrated sickle while other use both the serrated sickle and the yatao but an increasing number of farmers, particularly in the intensively cultivated rice areas and urban centers where labor is deficient are now using mechanical harvesting machines to be able to cope up with the labor shortages and delays caused by the peak seasonal demand for manual harvesting labor (PCARRD, 2001). In terms of maturity, rice is harvested when 80-90 % o cf the grains have finally passed the dough stage that is when the lowest grains in the panicle have hardened.

Threshing is the process of detaching or separating rice grains from the panicle. It's timing, availability, and efficiency greatly affects the quality of the grains produced (PCARRD, 2001). Threshing is usually done at least one day after harvest to allow the panicles to be readily threshed.

Another important post harvest of rice before storage which is done purposely to lower the moisture content if a newly threshed palay with the aim of reducing its susceptibility to mold infestation, prevent sprouting, prolong its shelf life and at the same time preserve its quality is drying up to 14 % MC (PCARRD, 2001). Most farmers rely on practically cheapest type of drying, this is the sun drying wherein the use of solar energy is used during the dry season, however during the wet season, the natural air movement or air drying is done. Another practice during rainy days is the "pausukan" where the rice bundles are placed over the fire place (UPCA, 1983).

Rice Production Cost and Returns

Cost of production and expected income per hectare are two important items to consider before going into rice production (UPCA, 1983).

Rice production costs have increased steadily by annual average of 18 % while returns nominally grew by 9 % from 1985-1991, the later being largely a function of yield growth and fluctuation in farms price.

Labor cost have historically dominated production cost across all farm types and season although recent years also show faster growth in the cost share for materials composed of fertilizer, pesticide, and seed. Labor cost in 1991 accounted to P11, 089.00 per hectare or P3, 513.00 per meter.

Regardless of farm types, production cost during the dry season was observed to be higher due to higher expenditures on fertilizers, pesticides and seeds as well as the corresponding higher harvesting labor associated with higher dry season yields. Transplanted rice generally incurs higher cost relative to direct seeded attributable to the transplanting labor differential although the later has higher material and maintenance cost during the dry season (Serrano, and *et al*., 1995).

MATERIALS AND METHODS

Planting Materials and Equipment

Three varieties of rice seeds such as Kamuros, Wagwag, and Tudoy were used as planting materials. T-14 was applied as fertilizer at the rate of 490 kg / ha for 20 cm x 20 cm, 417 kg / ha for 30 cm x 30 cm, 260 kg / ha for 40 cm x 40 cm, 156 kg / ha for 50 cm x 50 cm and Karate was sprayed for crop protection. Thorough land preparation was done with the use of plow, harrow and level (wood) before planting and string was use to follow straight row with different distances per treatment.

Land Preparation and Experimental Design

An area of 345.6 m^2 was thoroughly plowed, harrowed, and leveled. It was divided into three blocks with 3 replication composing of 12 plots each block measuring 1.6 x 6 m following 3 x 4 factor factorial using randomized complete block design (RCBD). Seedlings were transplanted at one seedling per hill.

Treatments

The experiment consisted of 12 treatments involving 2 factors: A and B. Factor A consist of 3 varieties (V) while the different planting distance (D) serves as Factor B.

Factor A	Factor B
V_1-Kamuros	D_1-20 cm x 20 cm (check)
V_2-Tudoy	D_2-30 cm x 30 cm
V_3-Wagwag (check)	D_3-40 cm x 40 cm
	D_4-50 cm x 50 cm

Data gathered

1. Initial seedling height (cm). The heights of seedlings were measured before transplanting.

2. Number of days from transplanting to tillering. This was recorded when 50% of the total plants per treatment start to produce tillers.

3. Number of maximum tillers at tillering stage. This was counted and recorded when 50% of the total plants in each plot produce their flag leaf using 10 sample hills.

4. Total number of productive tillers. The total numbers of productive tillers were recorded at heading

. 5. Number of days from transplanting to heading. The number of days from transplanting to heading of the plants was recorded. The time of heading was recorded when 50% of the rice plants produced heads.

6. Number days from transplanting to maturity. It was recorded when 80% of the grains in the panicle turned yellow using 10 sample hills selected per treatment.

7. Length of panicle (cm). The length of the panicle was measured from the base of the panicle to the tip of the panicle excluding awn using 10 sample panicles selected at random per treatment at harvest.

8. Final height. This was measured from the soil surface to the tip of the longest panicle excluding awn.

9. Total number of grains per panicle. The total number of grains using 10 panicles from 5 sample hills taken at random was recorded before harvest.

10. Number of filled grains per panicle. The number of filled grains was recorded from data no.4.

11. Grain yield per treatment. (g) (9.6 m^2). The total weight of winnowed grains was recorded after sun drying for 5 days.

12. Computed grain yield per hectare (tons). Grain yield per treatment (9.6 m^2) was converted to yield per hectare using ratio and proportion as shown below.

$$\frac{\text{Yield}}{9.6\ m^2} \times \frac{\text{Yield}}{10{,}000\ m^2}$$

13. Return On Cash Expenses. This was determined to find out which practice gives the highest ROCE.

14. Stem borer (White heads). Evaluation of stem borer expressed as white heads was done at heading time.

The following standard scale was used: (PhilRice, 1996)

Rating Index	Description	% Whiteheads
1	Resistant	1-5
3	Moderately Resistant	6-10
5	Intermediate	11-15
7	Moderately Susceptible	16-25
9	Susceptible	26 and above

15. Lodging Resistance. Lodging resistance was recorded two weeks after heading and maturity using the following scale (PhilRice, 1996).

Scale	Description	Remarks
1	All plants were erect	Resistant
3	Plants were leaning at an angle of 90°	Moderate resistant
5	Plant was leaning at about 45º; more than 50 % of population affected	Intermediate
7	Plants were leaning at an angle of 30º; more than 50% of the population is affected	Moderate Susceptible
9	All plants had fallen on the ground	Susceptible

A. Basic Land preparation (plowing)

B. Harvesting of rice plants

Figure 1.Some basic operations in rice production

RESULTS AND DISCUSSION

Meteorological Data during the Conduct of the Study

Environmental factors for rice production such as temperature, relative humidity, amount of rainfall, and sunshine duration were presented on Table 1 covering the duration of the study from July to December. Temperature mean ranged from 15.5 ºC to 22.5 ºC. Relative humidity has a mean of 84% while rainfall recorded a mean of 15.3 mm which is very low as compared to the monthly rainfall requirement as stated by Schiller et. al. (2006) that 200mm of monthly rainfall for lowland rice and 100mm of rainfall for upland rice during the establishment phase and a minimum monthly rainfall of 125 mm at vegetative stage. Sunshine duration had an average mean of 317.6 kj. Rice can be grown successfully in regions that have a mean of temperature of about 22 ºC or above duration the entire growing season of four to six months (Martin, *et al*.)

Table 1. Temperature, relative humidity, amount of rainfall and sunshine duration during the conduct of the study

MONTHS	TEMPERATURE		RELATIVE HUMIDITY (%)	RAINFALL AMOUNT (mm)	SUNSHINE DURATION (kj)
	MAX	MIN			
July	23.8	16.5	82	6.6	42.8
August	19.5	14.3	77	45.0	141.3
September		16.1	85	12.3	793.9
October	22.3	16.0	86	21.8	329.6
November	22.6	14.6	88	16.4	229.3
December	24.3	15.5	88	1.9	368.8
MEAN	22.5	15.5	84	15.3	317.6

Initial Height of Seedlings

Effect of variety. At 29 days after sowing (DAS) Wagwag was significantly the tallest with 36.32 cm followed by Tudoy while Kamuros with seedling height of 27.97 cm, respectively. Initial height of seedlings is important, for taller seedlings are desirable in the wet season due to sudden floods that may cause damage to the rice crop during the early stage (de Datta, 1981).

Effect of planting distance. Statistical analysis showed no significant differences on the initial height of seedlings as affected by the different planting distance used.

Interaction effect. Table 2 presents the initial height of seedlings at 29 DAS, showing no significant interaction between the two factors; Varieties (A) and Planting Distance (B).

Number of Days from Transplanting to Tillering

Effect of variety. Data on the number of days from transplanting to tillering are presented on Table 3. It was observed that check variety Wagwag reached the tillering stage earlier at 17 days than the two other varieties. Kamuros follows 5 days later while Tudoy starts tillering at 25 days from transplanting. Results showed highly significant differences among varieties tested. This could be due to their varietal differences.

Effect of planting distance. Results on the number of days from transplanting to tillering as affected by planting distance shows that rice planted at wider spacing produced tillers earlier by one day than those planted at closer spacing. However, statistical analysis revealed no significant differences.

Interaction effect. Although results on the effect of varieties shows highly significant differences on the number of days from transplanting to tillering, it was statistically proven that their were no significant interaction on both factors.

Table 2. Initial height of seedlings (29 DAS)

TREATMENT	INITIAL HIEGHT (cm)
Variety(A)	
Kamuros	27.97 [c]
Tudoy	30.67 [b]
Wagwag (check)	36.28 [a]
Planting Distance	
20 cm x 20 cm (check)	31.83
30 cm x 30 cm	31.30
40cm x 40 cm	32.22
50cm x 50 cm	31.23
Ax B	ns
CV%	4.06

Means followed by common letters are not significantly different at 5% level of DMRT.

Table 3. Number of days from transplanting to tillering

TREATMENT	NUMBER OF DAYS FROM TRANSPLANTING TO TILLERING.
Variety(A)	
Kamuros	22[b]
Tudoy	25[a]
Wagwag (check)	17[c]
Planting Distance	
20 cm x 20 cm (check)	22
30 cm x 30 cm	22
40cm x 40 cm	21
50cm x 50 cm	21
Ax B	ns
CV%	3.44

Means followed by common letters are not significantly different at 5% level of DMRT.

Number of Maximum Tillers at Tillering Stage

Effect of variety. In terms on the number of maximum tillers at tillering stage, highly significant differences were observed. The check variety (Wagwag) significantly produced the highest number of tillers. This could be due to its varietal characteristics. Numerically, Tudoy produced the lowest number of tillers, however statistical analysis reveals that Kamuros with a higher number of tillers than Tudoy is not significantly different.

Effect of planting distance. The different planting distance used in the study was observed to have a highly significant effect on the number of maximum tillers at tillering stage. The highest number of tillers (15) at maximum tillering produced were counted at the widest planting distance used (50 x 50 cm), followed by 40 x 40 cm planting distance with 12 tillers, 9 tillers at 30 x 30 cm and the lowest (5 tillers) were counted at the traditional distancing of 20 x 20 cm. Higher number of tillers were observed on wider planting distance rather than on the traditional planting distance due to their ability to compensate for missing hills (de Datta, 1981) on wider spacing.

Interaction effect. Results on Table 4 shows highly significant interaction effect on the number of tillers at maximum tillering stage on both factors. Different planting distances used in the study were observed to interact significantly with the check variety Wagwag. Figure 1 shows that as the planting distance becomes wider the number of maximum tillers in Wagwag also increases. On the other hand Kamuros slightly increased in tiller numbers on the two planting distances as based on the tillers produced by plants on the traditional distancing, while Tudoy shows an increase on 30 x 30 cm and produced the same number of tillers even on the following wider planting distance. Data on the maximum number of tillers reveals that the check variety can be planted on wider spacing to achieve maximum tillers while Kamuros achieved maximum tillers at 40 x 40 cm and Tudoy may obtain the highest number of tillers at a distance of 30 x 30 cm.

Table 4. Number of maximum tillers at tillering stage

TREATMENT	NUMBER OF MAXIMUM TILLERS
Variety(A)	
Kamuros	6[b]
Tudoy	5[b]
Wagwag (check)	20 [a]
Planting Distance	
20 cm x 20 cm (check)	5[d]
30 cm x 30 cm	9[c]
40cm x 40 cm	12[b]
50cm x 50 cm	15[a]
Ax B	.**
CV%	12.26

Means followed by common letters are not significantly different at 5% level of DMRT.

Number of Productive Tillers

Effect of variety. Data on productive tillers shows that check variety Wagwag with 12 tillers had highly significant difference as compared to Tudoy and Kamuros having the lowest number of tillers. Gamsawen, (2006) stated that the five traditional cultivar that he had tested on his study at Maligcong, Bontoc spaced at 20 x 20 cm had produced a mean of three productive tillers per plant.

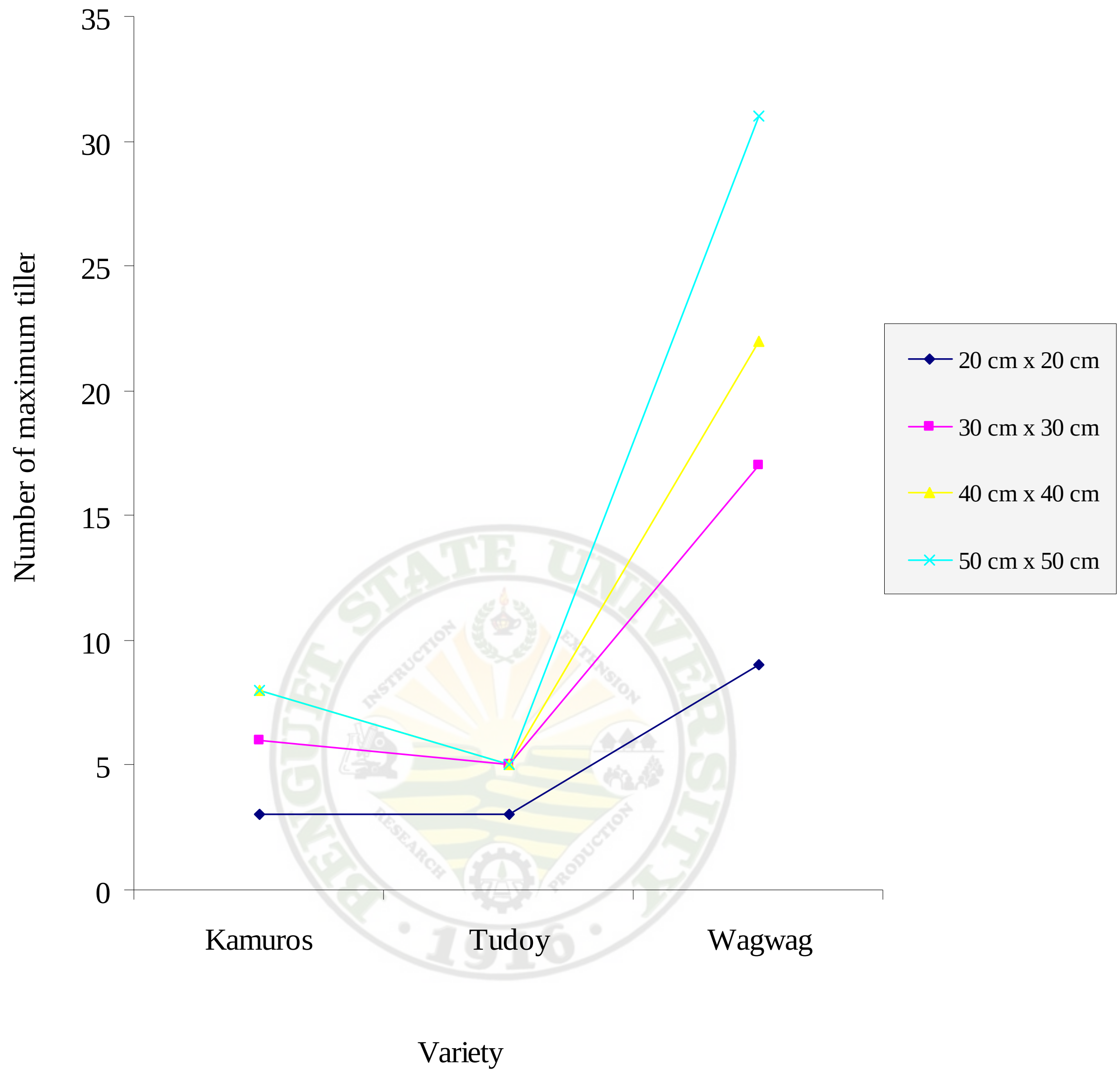

Figure 2. Interaction effect on the number of maximum tillers at tillering stage

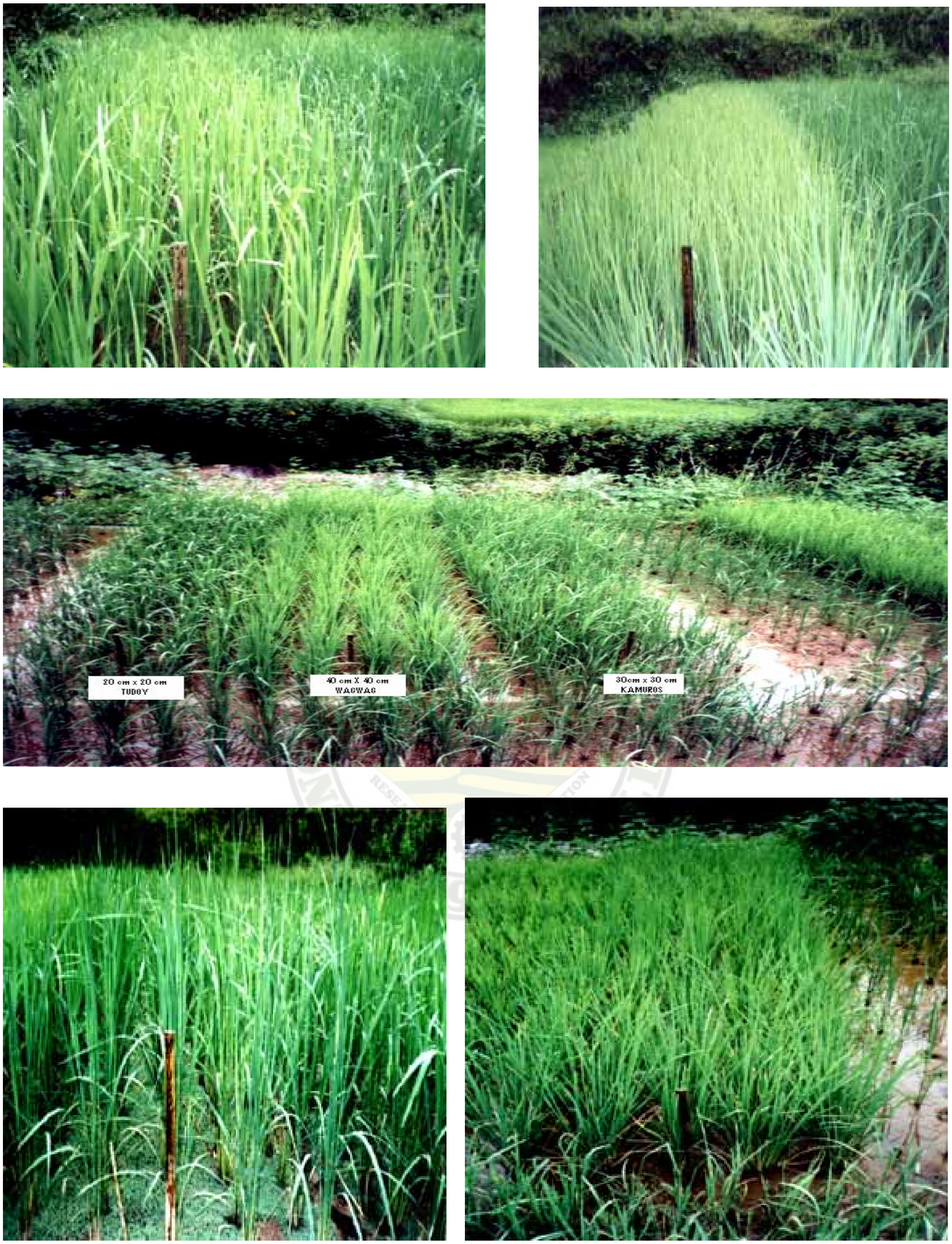

Figure 3. Different treatments at maximum tillering stage

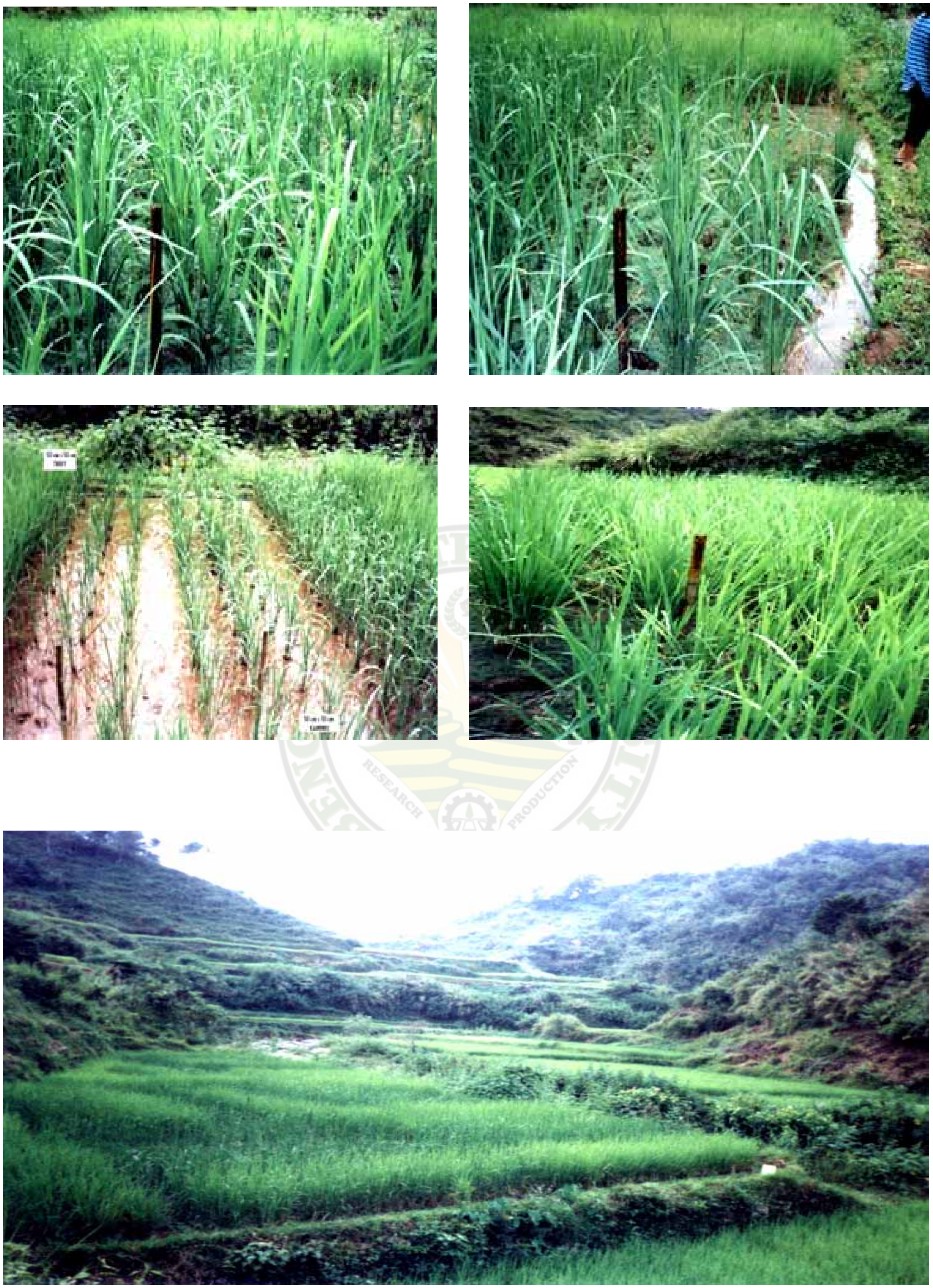

Figure 4 . Rice plants at maximum tillering stage per treatment (top, center)and over view (bottom)

Effect of planting distance. Rice plants grown at 50 cm x 50 cm 9 productive tillers shows highly significant difference on the number of productive tillers over the other planting distances used. Crops distanced at 20 cm x 20 cm produced the least number of productive tillers due to the higher number of panicles with unfilled grains. Aowat (1995) stated that crops distanced at 20 cm x 20 cm resulted also to higher weight of unfilled grains.

Interaction effect. Highly significant interaction effect was observed on the check variety (Wagwag). Planting distance had greatly affected the total number of productive tillers on Wagwag. As the planting distance becomes wider the total number of tillers also increases. Slight interaction results were observed in Kamuros and Tudoy. This interaction effect can be significant in choosing the proper planting distance for each tested varieties to produce maximum productive tillers that may provide higher yield. According to Efferson (1952) some varieties when properly spaced, produced as many as 50 productive tillers but the average for transplanted rice is 15- 20 tillers per plant. It was noted that the check variety- Wagwag had achieved 20 productive tillers under 50 cm x 50 cm planting distance as shown on Figure 4.

Number of Days from Transplanting to Heading

Effect of variety. Data on the number of days from transplanting to heading shows highly significant differences among the different varieties (Table 6). Significantly, Kamuros with 84 days was the earliest to produce heads followed by Tudoy with 91 days. On the other hand the check variety- Wagwag was the latest reaching 114 days from transplanting to heading. Significant differences could be attributed to their varietal differences.

Table 5. Number of productive tillers

TREATMENT	NUMBER OF PRODUCTIVE TILLERS
Variety(A)	
Kamuros	4[b]
Tudoy	3[b]
Wagwag (check)	12[a]
Planting Distance	
20 cm x 20 cm (check)	3[c]
30 cm x 30 cm	5[c]
40cm x 40 cm	8[b]
50cm x 50 cm	9[a]
Ax B	**
CV%	13.14

Means followed by common letters are not significantly different at 5% level of DMRT.

Effect of planting distance. Results shows almost the same number of days from sowing to heading on the different planting distance used (96 days) except for the widest planting distance a mean of 97 days. Statistical results showed no significant differences among the different planting distance used.

Interaction effect. Statistical analysis reveals no significant interaction effect on the different varieties (A) and different planting distance (B) used in the study on the number of days from transplanting to heading.

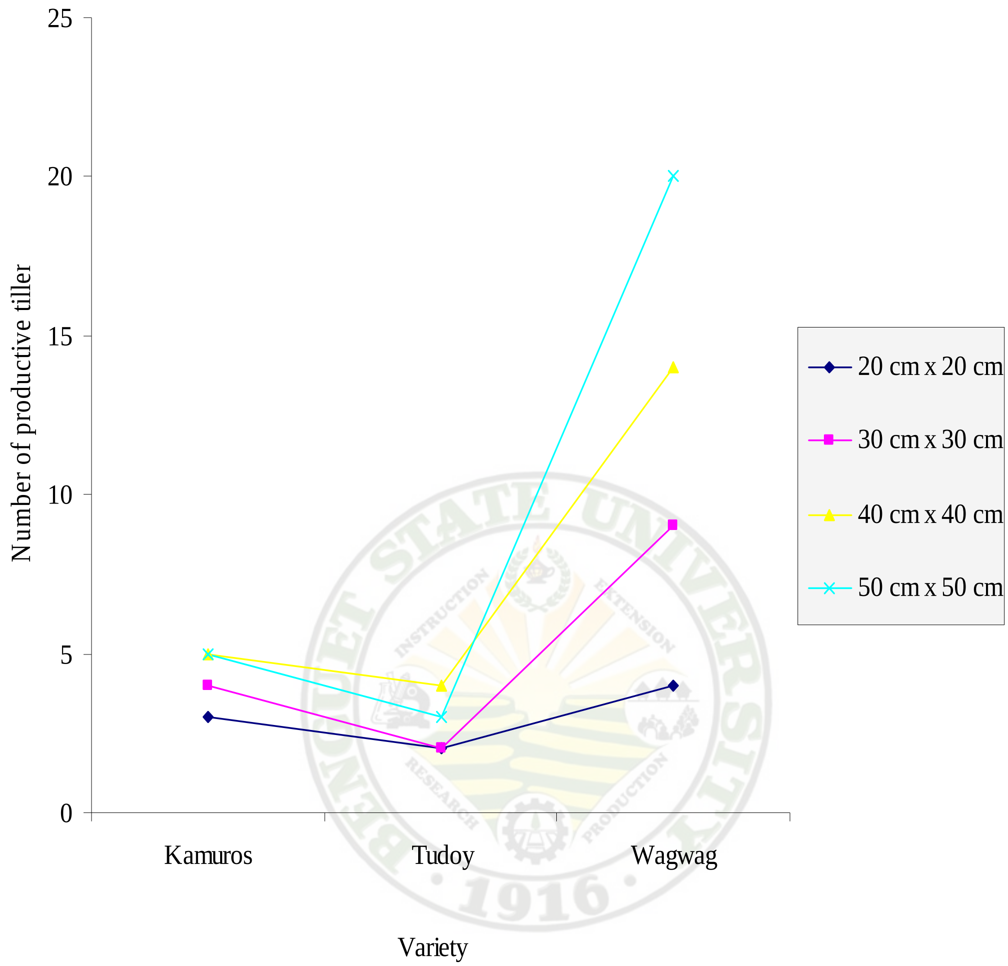

Figure 5. Interaction effect on the number of productive tillers

Table 6. Number of days from transplanting to heading

TREATMENT	NUMBER OF DAYS FROM TRANSPLANTING TO HEADING
Variety(A)	
Kamuros	84[c]
Tudoy	91[b]
Wagwag (check)	114[a]
Planting Distance	
20 cm x 20 cm (check)	96
30 cm x 30 cm	96
40cm x 40 cm	96
50cm x 50 cm	97
Ax B	ns
CV%	1.49

Means followed by the same letters are not significantly different at 5% level of DMRT.

(a)

(b)

Figure 6. Different varieties at booting stage (a), Tudoy variety at ripening stage (b)

Number of Days from Transplanting to Ripening

Effect of variety. Highly significant results were recorded on the number of days from transplanting to ripening as shown in Table 7. It was observed that the check variety Wagwag was the earliest to ripen at 123 days followed by Kamuros with 132 days and the latest was Tudoy that reached its ripening at 140 DAT. Days of maturity is significant in the production of rice for it's the most important physiological character used in classifying commercial rice varieties (Efferson, 1952). Results shows that Wagwag belongs to early maturing groups while Kamuros and Tudoy both belongs to medium maturing variety as to relative maturity grouping (Efferson, 1952). Maturity is also important for local farmers especially for those who are planting rice the whole year for most of them select varieties which are early maturing to be able to catch up with the two cropping season.

Effect of planting distance. Maturity days of rice plants were observed to be highly significant as affected by different planting distance. Statistical analysis reveals that plants under the traditional distancing of 20 cm x 20 cm were the ones that mature earlier than those plants of the other distances. Latest maturity were observed on the widest distancing 50 cm x 50 cm. Results could be associated to the fact that plants on 20 cm x 20 cm had a shorter length of vegetative phase due to lesser number of tillers while plants on 50 cm x 50 cm had a longer vegetative phase due to longer time of maximum tillering stage.

Interaction effect. Highly significant interaction effect were observed on the number of maturity days for Tudoy as affected by the different planting distance used (Fig. 4). Results shows that as the distances were increased the number of maturity days also increases while Kamuros grown under the traditional planting distance matured earlier than the other distances used which shows constant number of maturity days. On the other hand wigwag shows stable number of maturity days.

Table 7. Number of days from transplanting to ripening

TREATMENT	NUMBER OF DAYS FROM TRANSPLANTING TO RIPENING
Variety(A)	
Kamuros	132[b]
Tudoy	140[b]
Wagwag (check)	123[c]
Planting Distance	
20 cm x 20 cm (check)	129[b]
30 cm x 30 cm	131[ab]
40cm x 40 cm	132[ab]
50cm x 50 cm	135[a]
Ax B	**
CV%	2.04

Means followed by common letters are not significantly different at 5% level of DMRT.

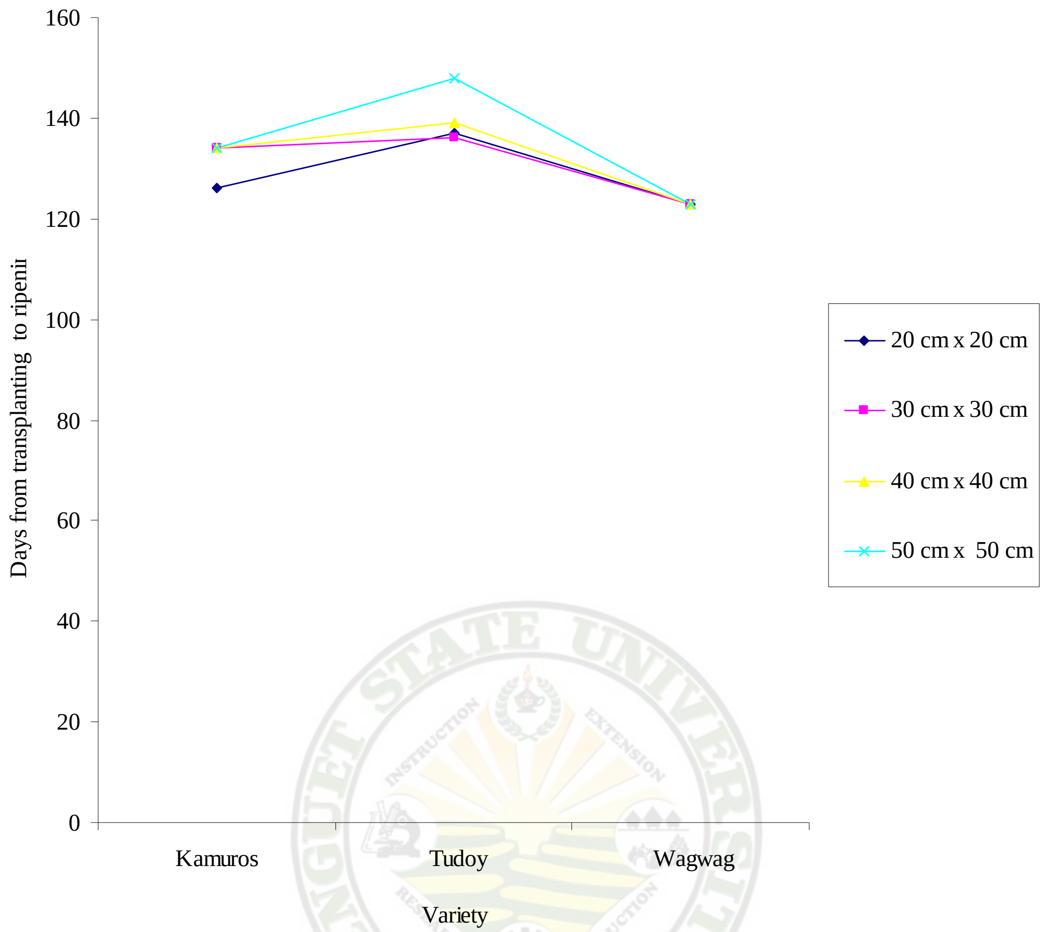

Figure 7. Interaction effect on the number of days from transplanting to ripening

KAMUROS

WAGWAG

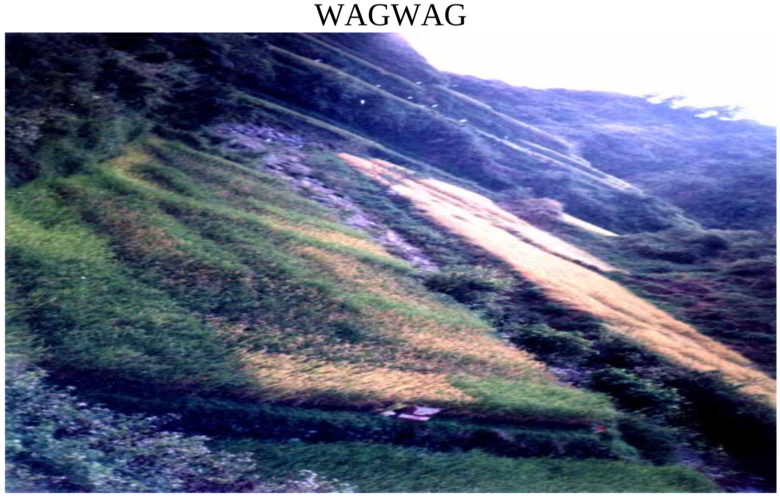

Figure 8. Rice varieties and overview at ripening stage

(a) (b) (c)

Figure 9. Some of the harvested rice plants per variety: (a) Kamuros, Tudoy (b), Wagwag (c)

Length of Panicle

Effect of variety. Statistically, highly significant differences were observed on the length of panicles (Table 8). According to Efferson (1952), the size and shape of the panicles vary widely in the different varieties. Results shows that longest panicles were measured from Tudoy with a mean of 77.56 cm followed by the check variety 69.68 cm long and the shortest was measured from Kamuros, however numerical differences on Kamuros and Tudoy were not significantly different as per statistical analysis. Size and shape of panicles are included as the most commonly used morphological characters for classification of rice varieties (Efferson, 1952). One general characteristic of traditional rice varieties are extended and long panicles for easy harvesting and storage (PhilRice, 1988).

Effect of planting distance. Results show numerical differences on the length of panicle as affected by planting distance. The longest panicle as affected by planting distance measures 73.93 cm on 50 cm x 50 cm followed by 73.13 cm, 70.99 cm, and 67.88 cm in order of decreasing planting distance but was not significantly different as per statistical basis.

Interaction effect. No significant interactions were observed on the length of panicle on Factor A (variety) and Factor B (planting distance).

Final Height

Effect of variety. Table 8 shows highly significant differences on the final height of the rice plant at maturity. It was observed that tallest plants were measured from Tudoy which has the longest panicle length of 45 cm followed by the check variety

(Wagwag) measuring 134 cm and the shortest was Kamuros with 124 cm. Differences in height could be due to their varietal differences.

Effect of planting distance. Plants on 40 cm x 40 cm measured the tallest plants with 137 cm while plants on traditional spacing- 20 x 20 cm were the shortest but were comparable to plant heights at 30 cm x 30 cm and 40 cm x 40 cm.

Interaction effect. Statistically, no significant interactions were observed from the two factors on final height.

Table 8 . Length of panicle and final height

TREATMENT	LENGTH OF PANICLE	FINAL HIEGHT
Variety(A)		
Kamuros	67.21[b]	124[b]
Tudoy	77.56[a]	145[a]
Wagwag (check)	69.68[b]	134[b]
Planting Distance		
20 cm x 20 cm (check)	67.88	132[b]
30 cm x 30 cm	70.99	134[ab]
40cm x 40 cm	73.13	137[a]
50cm x 50 cm	73.93	135[ab]
Ax B	ns	ns
CV%	4.77	4.90

Means followed by common letters are not significantly different at 5% level of DM

Number of Grains per Panicle

Effect of variety. Table 9 showed that Wagwag with an average grains of per panicle of 202 and Tudoy having 210 average grains both produced significantly higher grains over Kamuros with only 180 grains this result could be attributed to their varietal characteristics.

Effect on planting distance. Table 9 presents the effect of planting distance on the total number of grains per panicle. Data shows that the total number of grains were significantly higher as planting distance increased from 30 cm x 30 cm over plants distanced at 20 cm x 20 cm. However, significant results do not exist among wider distances such as: 30 cm x 30 cm; 40 cm x 40 cm and 50 cm x 50 cm. The significant result could be attributed to the fact that as the plants are distanced wider, the panicle becomes longer as in Table 9, length of panicle shows. It seems that the longer the panicle, the more grains it produces.

Interaction effect. Significant interaction effect on the total number of grains per panicle was observed between the two factors; variety and planting distance. Results show that the check variety responded well to planting distance. Figure 5 shows that there is a corresponding increase on the total number of grains as planting distance were made wider. On the other hand Tudoy had an increasing number of grains on 30 x 30 cm and 50 x 50 cm but a slight decrease were observed on 40 cm x 40 cm as compared to the grain numbers on 30 cm x 30 cm. For Kamuros constant numbers of grains were not affected by the changes in planting distance. It was also noted that total number of grains had declined greatly in the widest planting distance used. Significantly results show that the highest total number of grains for Tudoy and Wagwag were obtained on 50 x 50 cm which could be adopted by farmers to help them increase yield and reduce labor and cost of seedlings.

Number of Filled Grains per Panicle

Effect of variety. The number of filled grains per panicle shows significant differences on the varieties tested. As shown in Table 9 check variety (Wagwag) had the highest number of filled grains (172) which is significant over Tudoy with 120 grains but not significant over Kamuros with 145 grains. Tudoy and Wagwag are not significantly different from each other.

Effect of planting distance. Number of filled grains as affected by planting distance shows highly significant results. 40 cm x 40 cm significantly produced higher number of filled grains than the traditional distancing of 20 x 20 cm, a difference of 46 grains was counted. 30 cm x 30 cm had produced 149 filled grains while 50 cm x 50 cm had 140 filled grains which are both comparable to the number of grains in 20 cm x 20 cm and 40 cm x 40 cm. It seems that the best planting distance under the condition of this study to produce higher number of filled grain is 40 cm x 40 cm. Results could be associated to the amount of solar energy received from as early as panicle initiation until crop maturation most during grain production (de Datta, 1981) wherein 20 cm x 20 cm planting distance encounters possible shading as compared to plants in the wider distances.

Interaction effect. Highly significant interactions were observed on the number of filled grains. All the varieties had a consistent increase on the number of filled grains per panicle as distancing became wider, however when they reached the widest distancing of 50 x 50 cm, Kamuros increased slightly with 4 grains, Tudoy had declined greatly in number which was due to heavy infestation of whiteheads that resulted to a higher number of unfilled grains than filled grains. On the other hand Check variety Wagwag tapered down when it reached the widest distancing.

Table 9. Number of grains per panicle and number of filled grains per panicle

TREATMENT	NUMBER OF	
	GRAINS PER PANICLE	FILLED GRAINS PER PANICLE
Variety(A)		
Kamuros	180^{b}	145^{ab}
Tudoy	210^{a}	120^{b}
Wagwag (check)	202^{a}	172^{a}
Planting Distance		
20 cm x 20 cm (check)	168^{b}	123^{b}
30 cm x 30 cm	200^{ab}	149^{ab}
40cm x 40 cm	203^{ab}	169^{a}
50cm x 50 cm	230^{a}	140^{ab}
Ax B	*	*
CV%	11.63	17.60

Means followed by common letters are not significantly different at 5% level of DMRT.

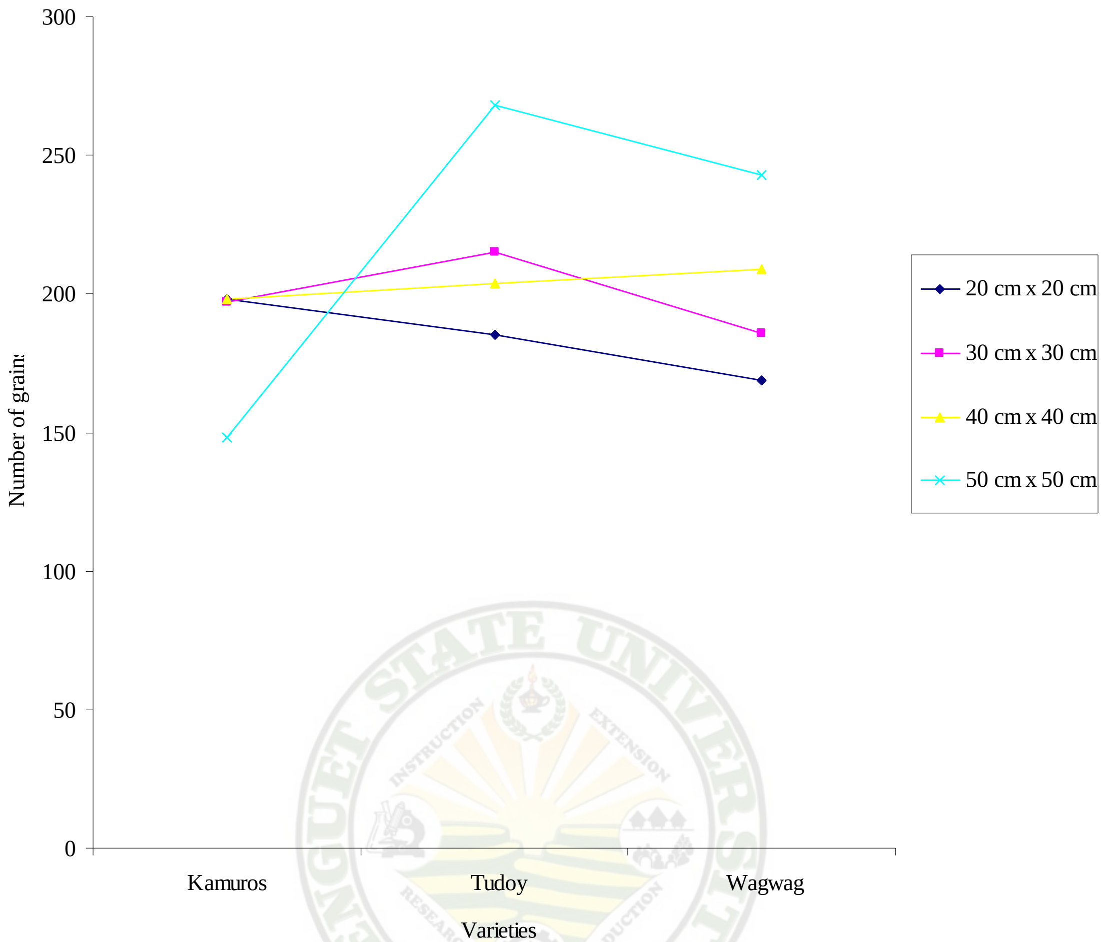

Figure 10. Interaction effect on the number of grains per panicle

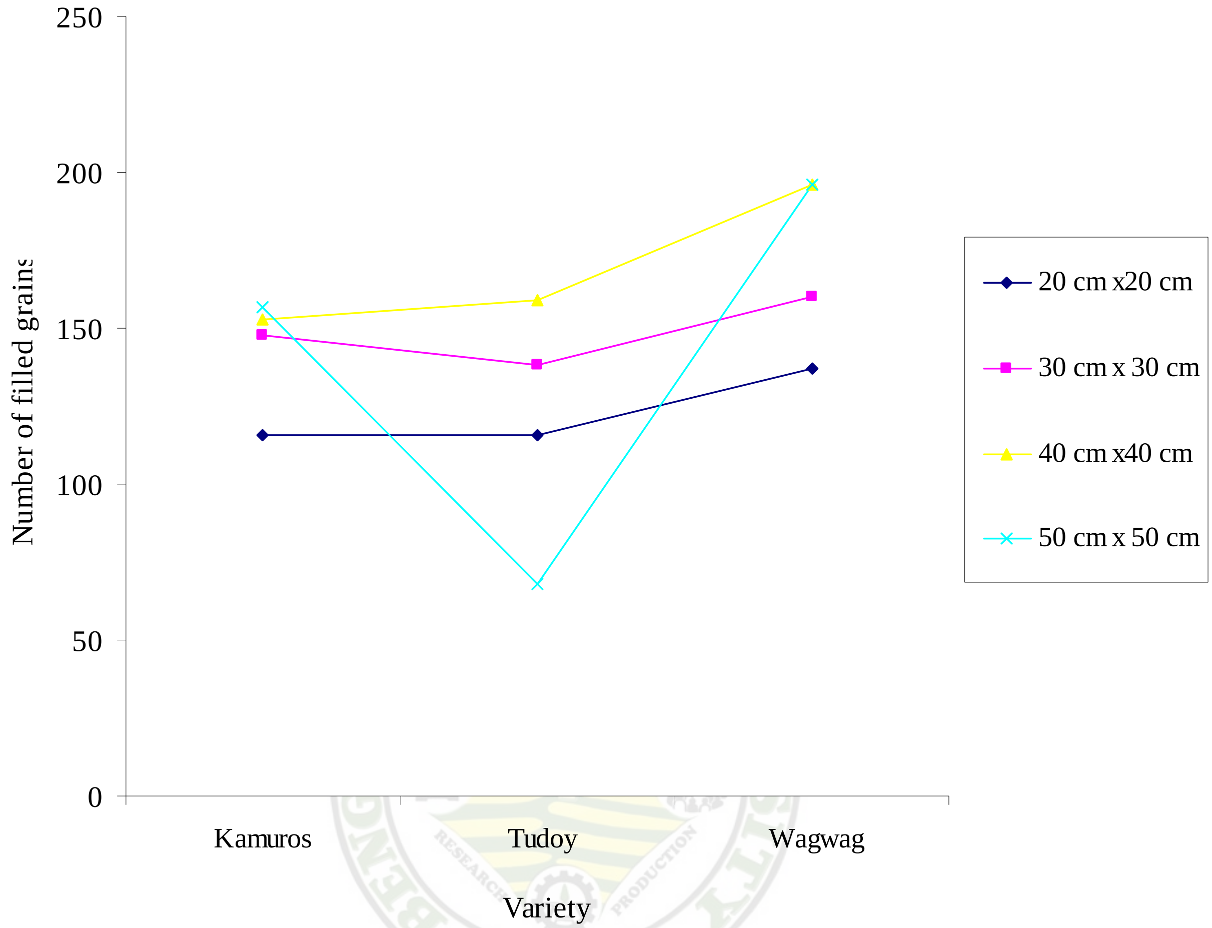

Figure 11. Interaction effect on the number of filled grains per panicle

Grain Yield per Treatments

Effect of variety. Check variety Wagwag significantly had the heaviest weight in terms of grain yield per treatment (3,735 g) which is significantly higher than both Kamuros (1,235 g) and Tudoy (1,010 g), respectively. Kamuros and Tudoy did not differ significantly. Numerically, Wagwag had the highest number of grains and filled grains over the two other varieties (Table 10). This further explains the significant differences aside from their varietal characteristics.

Effect of planting distance. As shown in Table 10, rice planted at a planting distance of 20 cm x 20 cm, 30 cm x 30 cm and 40 cm x 40 cm did not differ significantly from each other. Plants distanced at 50 cm x 50 cm significantly produced lower grains over plants both planted at 20 cm x 20 cm but not significantly higher than those planted on 40 cm x 40 cm distance. De Datta (1981), states that spacing wider than necessary result in lower yield because the number of plants in the area may be less than the optimum number needed for high yield. This statement may explain the results of the study on the weight of grain yield as affected by planting distance.

Interaction effect. Statistically, no significant interaction was observed on the weight of grains per treatment.

Computed Yield per Hectare (tons)

Effect of variety. Check variety Wagwag significantly had the heaviest computed grain yield of 3.89 tons / ha which is significantly higher than both Kamuros (1.28 tons / ha) and Tudoy (1.05 tons / ha), respectively. Numerically, Wagwag had the heaviest grain yield per treatment over the two other varieties (Table 10). This further explains the significant differences in the computed yield per hectare.

Effect of planting distance. Computed grain yields of rice planted at a planting distance of 20 cm x 20 cm, 30 cm x 30 cm and 40 cm x 40 cm did not differ significantly from each other. Plants distanced at 50 cm x 50 cm significantly had the lowest computed grain yield over the plants both planted at 20 cm x 20 cm but not significantly higher than those planted on 40 cm x 40 cm distance.

Interaction effect. Statistical analysis shows no significant interaction besides highly significant difference on variety and planting distance alone.

Table10. Grain yield per treatment and computed yield per hectare

TREATMENT	GRAIN YIELD PER TREATMENT (g / 9.6 m^2)	COMPUTED YIELD (tons / ha)
Variety(A)		
Kamuros	1,235[b]	1.29[b]
Tudoy	1,010[b]	1.05[b]
Wagwag (check)	3,735[a]	3.89[a]
Planting Distance		
20 cm x 20 cm (check)	2,579[a]	2.86[a]
30 cm x 30 cm	2,196[a]	2.29[a]
40cm x 40 cm	1,921[ab]	2.00[ab]
50cm x 50 cm	1,277[b]	1.33[b]
Ax B	ns	ns
CV%	21.59	21.62

Means followed by common letters are not significantly different at 5% level of DMRT

KAMUROS

TUDOY

WAGWAG

Figure 12. Grain yields of the different varieties

Return on Cash Expense

Effect of variety. Computed return on cash expense (ROCE) shows negative results except for the check variety (Wagwag) that has an ROCE of 72.64 %. Results shows that higher negative ROCE was computed from Tudoy which has the lowest grain yield because of heavy infestation of whiteheads and lodging, while Kamuros had a better yield however still obtained negative ROCE.

Effect of planting distance. Computed results on ROCE as affected by planting distance shows that the traditional planting distance (20 cm x 20 cm) commonly used by our farmers gives negative ROCE while 30 cm x 30 cm and 40 cm x 40 cm had given low however positive ROCE. On the other hand the widest planting distance of 50 cm x 50 cm had resulted to a much higher negative ROCE. Results show that 40 cm x 40 cm is a better distancing to be adopted by our local farmers for the traditional varieties.

Interaction effect. Results per treatment combination show that the check variety shows positive interaction effect on distancing. Computed results shows a corresponding increase in ROCE as spacing became wider however it was noted that 40 cm x 40 cm had higher ROCE than 50 cm x 50 cm. On the other hand the two varieties tested provided negative results on ROCE.

Stem borer Damage Evaluation

Visual rating was used to evaluate the occurrence of whiteheads caused by stem borers that was done at heading time. Rating shows that the check variety was resistant to stem borer while Tudoy were susceptible and it had resulted to a very low yield. On the other hand, Kamuros were found to be moderately resistant.

Most of the planting distance used had an intermediate effect on stem borer.

Table 11. Return in cash expense

TREATMENT	SEED YIELD (kg)	TOTAL COST OF PRODUCTION (pHp)	GROSS INCOME (pHp)	NET INCOME (pHp)	ROCE %
Variety(A)					
V_1- Kamuros	14.82	337.77	207.48	-130.29	-30.57
V_2- Tudoy	12.13	332.57	169.82	-162.75	-48.94
V_3- Wagwag (check)	44.83	363.55	627.62	264.07	72.64
Distancing					
D_1-20 cm (check)	23.22	332.14	325.08	-7.06	-2.13
D_2 -30 cm	19.16	270.67	276.64	5.97	2.21
D_3 – 40cm	17.3	235.07	242.20	7.13	3.03
D_4 – 50cm	11.5	196.01	161.00	-35.01	-17.86

- Total cost of production includes labor (such as plowing, harrowing, leveling, cleaning, spraying, chemical application, and harvesting), seedlings, fertilizer, and chemicals.
- Seedlings were priced at 3 cents per seedling.
- Grains were priced 14 pHp per kg

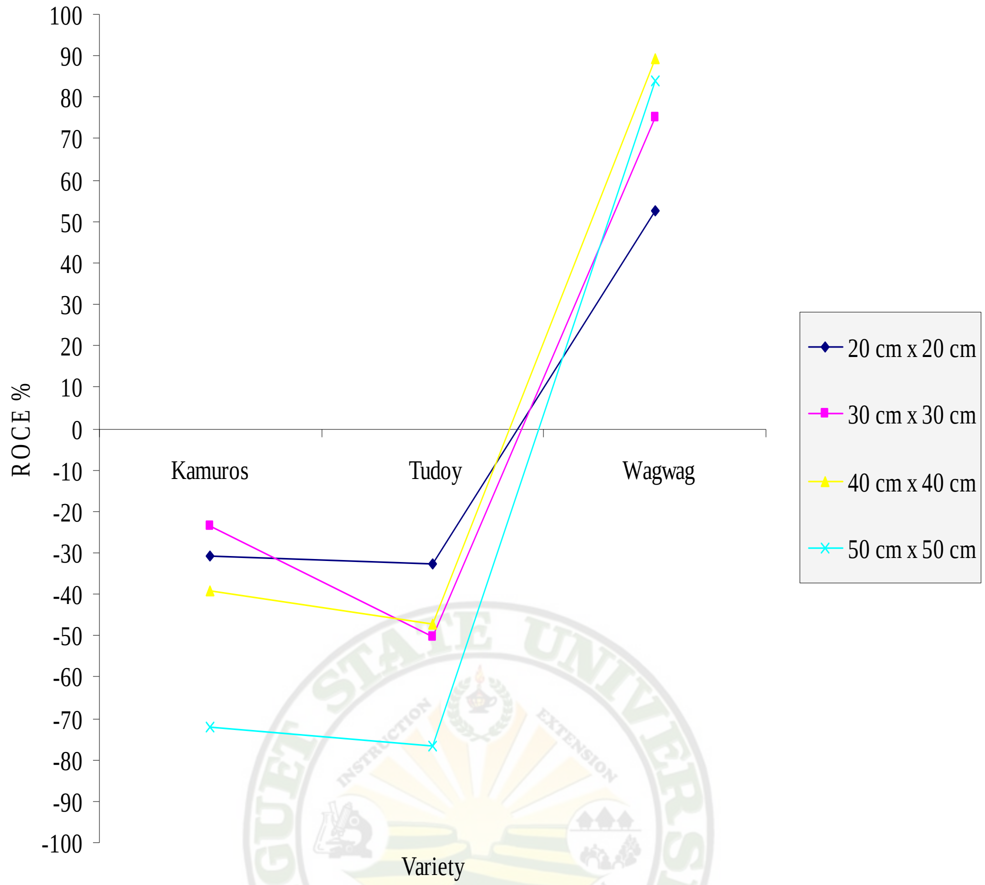

Figure 13. Return on cash expenses (%)

Table 12. Stem borer evaluation (Whiteheads)

TREATMENT	STEMBORER (WHITE HEADS)
Variety(A)	
V_1- Kamuros	Moderately Susceptible
V_2- Tudoy	Susceptible
V_3- Wagwag (check)	Resistant
Distancing	
D_1-20 cm (check)	Intermediate
D_2 -30 cm	Intermediate
D_3 – 40cm	Intermediate
D_4 – 50cm	Susceptible

1-Resistant, 3- Moderately Resistant, 5- Intermediate, 7- Moderately Susceptible
9-Susceptible

Figure 14. Tudoy variety attacked with stem borer (white heads)

Lodging Resistance

Lodging was been recorded at maturity by visual rating and observations. It was observed that check variety Wagwag were resistant to lodging effect while Kamuros were moderately resistant. On the other hand Tudoy were moderately susceptible to lodging which could be associated to its height and long panicles. Distancing shows moderate resistant to lodging

Table 13. Lodging resistance

TREATMENT	LODGING RESISTANCE
Variety(A)	
V_1- Kamuros	Moderate Resistant
V_2- Tudoy	Moderate Susceptible
V_3- Wagwag (check)	Resistant
Distancing	
D_1-20 cm (check)	Moderate Resistant
D_2 -30 cm	Moderate Resistant
D_3 – 40cm	Moderate Resistant
D_4 – 50cm	Moderate Resistant

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at Togoy, Ba-ayan, Tublay, Benguet to determine the effect of different planting distance in the growth and yield of the different varieties used, determine the best recommended distance of planting for our highland rice farmers with regards to the suitability of the variety to be used, determine the interaction effect between rice varieties and planting distance on the growth and yield of rice and to determine which treatment has the highest Return on Cash Expense.

Results show that Wagwag performs best than the two other varieties in most growth parameters such as highest number of tillers at tillering stage, productive tillers and were the earliest to produce tillers. Yield components such as highest total number of grains, most filled grains and highest grain yield were also recorded from the same variety.

Visual rating was also done for the evaluation of stem borer (white heads) and lodging resistance. Kamuros and Wagwag are resistant to stem borer and lodging while Tudoy was susceptible to whiteheads and lodging.

Positive ROCE was computed from variety Wagwag of 72.64 %.

Numerical differences were observed on the effect of planting distance in terms of initial height, transplanting to ripening, transplanting to heading, and panicle length, however statistical analysis reveals no significant effect.

Treatment combinations of both factors show significant interaction effect on growth and yield. Highest number of tillers at maximum tillering stage, productive tillers, and most filled grains per panicle were counted from Wagwag spaced at 50 cm x

50 cm. Wagwag recorded early ripening on all the planting distance used. Significant total number of grains per panicle was counted from Tudoy spaced at 50 cm x 50 cm.

Positive ROCE were computed in all the distances combined with variety Wagwag. Rice plants spaced at 40cm x 40 cm gives the highest ROCE of 89.21 %.

Conclusion

Based on the results of the study Wagwag spaced at 50 cm x 50 cm planting distance had the highest tillers at maximum tillering stage and had the most productive tillers. Most filled grains per panicle were produced from rice plants grown at 40 cm x 40 cm planting distance. Heaviest grain yield were produced from rice plants at 20 cm x 20 cm planting distance. Highest possible ROCE can be obtained from Wagwag spaced at 40 cm x 40 cm planting distance.

Recommendation

Based on results of the study, the best recommended planting distance for variety Wagwag is 40 cm x 40 cm. Spacing of 50 cm x 50 cm may also be adapted as planting distance for Wagwag.

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APPENDICES

APPENDIX TABLE 1. Initial height of seedlings (29 DAS) cm

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	27.38	29.79	26.43	83.60	27.87
D_2	27.82	28.12	26.95	82.89	27.63
D_3	28.72	28.84	27.75	85.31	28.44
D_4	28.02	27.82	28.04	83.88	27.96
V_2D_1	35.52	32.07	28.76	96.35	32.12
D_2	31.11	29.83	30.93	91.87	30.62
D_3	32.07	30.24	30.07	92.38	30.79
D_4	28.9	28.56	30.02	87.48	29.16
V_3D_1	35.66	36.07	34.77	106.50	35.50
D_2	36.38	35.09	35.45	106.92	35.64
D_3	36.63	38.52	37.17	112.32	37.44
D_4	35.81	38.5	35.41	109.72	36.57

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	1.994	3.997			
Treatment						
Variety (A)	2	431.830	215.915	131.01**	3.27	5.27
Planting Distance(B)	3	5.938	1.979	1.20^{ns}	2.87	4.40
A x B	6	15.614	2.602	1.58^{ns}	2.37	3.37
Error	22	36.241	1.647			
TOTAL	35	497.616				

**- Highly significant

^{ns}-not significant

Coefficient of Variance= 4.06

APPENDIX TABLE 2. Number of days from transplanting to tillering

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	22	22	23	67	22
D_2	22	22	24	68	23
D_3	21	22	23	66	22
D_4	22	22	23	67	22
V_2D_1	22	25	26	75	25
D_2	24	25	26	75	25
D_3	23	24	26	73	24
D_4	24	23	26	73	24
V_3D_1	18	17	17	52	17
D_2	18	17	17	52	17
D_3	17	17	17	51	17
D_4	17	17	17	51	17

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	8.722	176.778			
Treatment						
Variety (A)	2	353.556	0.630	325.60**	3.27	5.27
Planting Distance(B)	3	1.889	0.074	1.16^{ns}	2.87	4.40
A x B	6	0.414	0.543	1.14^{ns}	2.37	3.37
Error	22	11.944				
TOTAL	35	376.56				

**- Highly significant
^{ns}- not significant

Coefficient of Variance= 4.06

APPENDIX TABLE 3. Number of maximum tillers at tillering stage

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	4	2	4	10	3
D_2	6	6	7	19	6
D_3	7	8	8	23	8
D_4	6	7	10	23	8
V_2D_1	3	2	3	8	3
D_2	6	4	6	16	5
D_3	7	4	4	15	5
D_4	3	5	6	14	5
V_3D_1	8	10	10	28	9
D_2	18	16	16	50	17
D_3	21	22	23	66	22
D_4	30	33	31	94	31

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	4.500	2.250			
Treatment						
Variety (A)	2	1702.167	851.083	548.01**	3.27	5.27
Planting Distance(B)	3	425.444	141.815	91.31**	2.87	4.40
A x B	6	396.722	66.120	45.57**	2.37	3.37
Error	22	34.167	1.553			
TOTAL	35	2563.000				

**- Highly significant

Coefficient of Variance= 4.06

APPENDIX TABLE 4. Number of productive tillers

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	3	3	2	8	3
D_2	4	5	3	12	4
D_3	6	6	4	16	5
D_4	6	5	5	16	5
V_2D_1	2	2	3	7	2
D_2	2	2	2	6	2
D_3	3	4	5	12	4
D_4	2	2	4	8	3
V_3D_1	4	3	4	11	4
D_2	10	8	9	27	9
D_3	15	14	14	43	14
D_4	20	20	19	59	20

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	0.500	0.250			
Treatment						
Variety (A)	2	543.167	271.583	402.80**	3.27	5.27
Planting Distance(B)	3	219.417	73.139	108.48**	2.87	4.40
A x B	6	228.833	38.139	56.57**	2.37	3.37
Error	22	14.833	0.674			
TOTAL	35	1006.750				

**- Highly significant

Coefficient of Variance= 4.06

APPENDIX TABLE 5. Number of days from transplanting to heading

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	80	82	85	247	82
D_2	82	85	87	254	85
D_3	82	85	86	253	84
D_4	82	85	86	253	8/4
V_2D_1	87	92	93	272	91
D_2	85	92	93	270	90
D_3	87	92	92	271	90
D_4	92	92	95	279	93
V_3D_1	114	115	115	344	115
D_2	114	114	114	344	114
D_3	112	114	114	340	113
D_4	114	114	114	342	114

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	82.056	41.020			
Treatment						
Variety (A)	2	936.722	968.361	1142.30**	3.27	5.27
Planting Distance(B)	3	8.386	2.769	1.34^{ns}	2.87	4.40
A x B	6	21.278	3.546	1.72^{ns}	2.37	3.37
Error	22	45.278	2.058			
TOTAL	35	6093.639				

**- Highly significant
$^{ns-}$ not significant

Coefficient of Variance= 4.06

APPENDIX TABLE 6. Number of days from transplanting to ripening

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	123	128	128	379	126
D_2	128	136	138	402	134
D_3	130	136	137	403	134
D_4	130	136	136	402	134
V_2D_1	133	138	139	410	137
D_2	133	138	136	407	136
D_3	133	140	144	417	139
D_4	144	144	156	444	148
V_3D_1	123	123	123	369	123
D_2	123	123	123	369	123
D_3	123	123	123	369	123
D_4	123	123	123	369	123

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	150.000	79.000			
Treatment						
Variety (A)	2	1704.667	852.333	118.19**	3.27	5.27
Planting Distance(B)	3	188.222	62.741	8.70**	2.87	4.40
A x B	6	232.444	38.741	5.37 **	2.37	3.37
Error	22	158.667	7.212			
TOTAL	35	2422.000				

**- Highly significant

Coefficient of Variance= 4.06

APPENDIX TABLE 7. Length of panicle

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	61.15	65.05	60.08	187.00	62.33
D_2	66.25	67.03	66.60	200.15	66.72
D_3	67.00	69.75	71.25	208.00	69.33
D_4	70.15	81.85	69.40	221.40	73.80
V_2D_1	76.00	72.50	72.02	220.52	73.51
D_2	81.90	82.50	67.65	232.05	77.35
D_3	75.80	77.90	85.20	238.90	79.63
D_4	80.20	82.99	76.30	239.49	79.83
V_3D_1	68.15	67.05	68.30	203.50	67.83
D_2	71.05	70.20	65.45	206.70	68.90
D_3	72.15	69.60	69.80	211.55	70.52
D_4	71.60	70.00	72.90	214.50	71.50

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	19.958	9.979			
Treatment						
Variety (A)	2	700.32	350.161	30.11**	3.27	5.27
Planting Distance(B)	3	197.368	65.789	2.66^{ns}	2.87	4.40
A x B	6	21.078	3.513	0.30^{ns}	2.37	3.37
Error	22	255.876	11.631			
TOTAL	35	1194.876				

**- Highly significant
$^{ns-}$ not significant

Coefficient of Variance= 4.06

APPENDIX TABLE 8. Final height (cm)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	106	126	11	349	116
D_2	135	119	7119	373	124
D_3	125	132	120	377	126
D_4	127	128	129	384	128
V_2D_1	154	146	139	439	146
D_2	157	149	140	446	149
D_3	143	143	144	430	143
D_4	143	149	132	424	141
V_3D_1	130	132	134	396	132
D_2	126	139	126	391	130
D_3	153	136	133	22	144
D_4	137	134	133	404	135

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	261.056	130.528			
Treatment						
Variety (A)	2	2730.889	1365.444	31.50**	3.27	5.27
Planting Distance(B)	3	114.992	38.324	0.88^{ns}	2.87	4.40
A x B	6	395.111	65.852	1.52^{ns}	2.37	3.37
Error	22	953.611	43.346			
TOTAL	35	4455.639				

**- Highly significant

^{ns}- not significant

Coefficient of Variance= 4.06

APPENDIX TABLE 9. Total number of grains per panicle

TREATMENT	BLOCK I	BLOCK II	BLOCK III	TOTAL	MEAN
V_1D_1	147	134	167	595	198
D_2	197	209	186	592	197
D_3	175	230	188	593	198
D_4	172	176	185	533	148
V_2D_1	194	175	187	556	185
D_2	239	217	189	645	215
D_3	187	218	206	611	204
D_4	256	299	250	805	268
V_3D_1	167	171	170	508	169
D_2	225	190	144	559	186
D_3	230	185	212	627	209
D_4	219	289	222	730	243

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	1461.056	730.528			
Treatment						
Variety (A)	2	8533.722	4266.861	7.87**	3.27	5.27
Planting Distance(B)	3	17303.639	5767.880	10.64**	2.87	4.40
A x B	6	8023.611	1337.269	2.47*	2.37	3.37
Error	22	11923.611	541.982			
TOTAL	35	47245.639				

**- Highly significant
*- Significant

Coefficient of Variance= 4.06

APPENDIX TABLE 10. Number of filled grains per panicle

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	133	98	118	349	116
D_2	158	157	131	446	148
D_3	137	192	129	458	153
D_4	126	230	115	471	157
V_2D_1	141	112	95	348	116
D_2	151	139	124	414	138
D_3	139	191	147	477	159
D_4	85	87	33	205	68
V_3D_1	136	130	145	411	137
D_2	193	172	115	480	160
D_3	200	213	174	587	196
D_4	168	228	191	587	196

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	7840.222	3120.111			
Treatment						
Variety (A)	2	16122.056	8060.028	12.20**	3.27	5.27
Planting Distance(B)	3	9871.639	3290.546	4.98**	2.87	4.40
A x B	6	14278.611	2379.769	3.60**	2.37	3.37
Error	22	14535.778	660.717			
TOTAL	35	62646.306				

**- Highly significant

Coefficient of Variance= 4.06

APPENDIX TABLE 11. Grain yield per treatment (g) ($9.6m^2$)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	2473	1628	1260	5361	1787
D_2	2117	1597	1128	4843	1614
D_3	1203	1287	855	3346	1115
D_4	320	461	490	1271	424
V_2D_1	2522	1820	765	5108	1703
D_2	1400	1320	381	3101	1034
D_3	1055	920	902	2877	959
D_4	439	480	119	1038	346
V_3D_1	4030	4325	4390	12745	4248
D_2	4507	3700	3615	11822	3941
D_3	3390	4765	2910	11065	3688
D_4	2912	3570	2705	9187	3062

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	2430576.056	1215288.0			
Treatment						
Variety (A)	2	54897134.222	27448567	148.26**	3.27	5.27
Planting Distance(B)	3	8120748.306	2706914.7	14.62**	2.87	4.40
A x B	6	293827.111	48971.185	0.26ns	2.37	3.37
Error	22	4072924.611	132.937			
TOTAL	35	69812506.306				

**- Highly significant
ns- not significant

Coefficient of Variance= 4.06

APPENDIX TABLE 12. Computed grain yield per hectare (tons / ha)

TREATMENT	BLOCK			TOTAL	MEAN
	I	II	III		
V_1D_1	2.58	1.70	1.31	5.59	1.86
D_2	2.21	1.66	1.18	5.04	1.68
D_3	1.25	1.34	0.89	3.47	1.16
D_4	0.33	0.48	0.51	1.32	0.44
V_2D_1	2.62	1.90	0.78	5.32	1.77
D_2	1.46	1.38	0.40	3.23	1.07
D_3	1.10	0.96	0.94	3.00	1.00
D_4	0.45	0.50	0.12	1.08	0.36
V_3D_1	4.20	4.51	4.57	13.28	4.43
D_2	4.70	3.85	3.77	12.32	4.11
D_3	3.53	4.96	3.03	11.53	3.84
D_4	3.03	3.72	2.82	9.57	3.19

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	COMPUTED F	TABULATED F	
					0.05	0.01
Block	2	2618.0165	1309.000			
Treatment						
Variety (A)	2	59675.226	29837.612	148.20**	3.27	5.27
Planting Distance(B)	3	8758.972	2919.657	14.50**	2.87	4.40
A x B	6	1308.343	51.390	0.26^{ns}	2.37	3.37
Error	22	4429.219	201.328			
TOTAL	35	75789.770				

**- Highly significant
$^{ns-}$ not significant

Coefficient of Variance= 4.06

APPENDIX TABLE 13. Return on cash expense

TREATMENT	TOTAL COST OF PRODUCTION (pHp)	SEED YIELD (g)	GROSS INCOME (pHp)	NET INCOME (pHp)	ROCE %
V_1D_1	108.48	5.36	75.04	-33.44	-30.83
D_2	88.77	4.84	67.75	-21.01	-23.66
D_3	76.91	3.35	46.9	-30.01	-39.02
D_4	63.61	1.27	17.78	-45.83	-72.04
V_2D_1	106.54	5.11	71.54	-35	-32.85
D_2	87.33	3.10	43.4	-43.93	-50.30
D_3	76.25	2.88	40.32	-35.93	-47.12
D_4	62.45	1.04	14.56	-47.89	-76.69
V_3D_1	117.12	12.75	178.5	-61.38	52.41
D_2	94.57	11.82	165.48	70.91	74.98
D_3	81.91	11.07	154.98	73.07	89.21
D_4	69.95	9.19	128.66	58.71	83.93