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GROWTH AND YIELD PERFORMANCE OF TRADITIONAL UPLAND RICE VARIETIES IN LOW ELEVATION UPLAND AGRO-ECOSYSTEM

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ABSTRACT

In answer to the Philippine's rice self-sufficiency goal, the expansion of production areas for upland rice and the propagation of traditional upland rice (TUR) varieties for local household food security are recommended. However, the encouragement and promotion given to upland rice production would pose ecological hazards to the upland agro-ecosystem and forest resources. Thus, in 2010 to 2011, agronomic evaluation of 42 traditional upland rice was conducted in low elevation (78-97 masl) uplands such as Lubbot and Payao in the City of Batac, Ilocos Norte, to identify high yielding TUR varieties for cultivation in lower elevation upland agro-ecosystem.

Based on growth and yield performance for two cropping years, 17 promising varieties were identified and dubbed as TUR 1, 3, 4, 5, 15, 17, 18, 28, 30, 34, 36, 39, 41, 42, 46, 47 and 50. These consistently produced yields of 3.34 to 4.67 t ha^{-1}, which are higher than what has been previously reported in similar agro-ecosystem. They are tall and low tillering, but have medium panicles, are fertile to highly fertile, and medium maturing. These entries also possess highly acceptable sensory qualities *i.e.* aroma, gloss, smoothness, and taste. Ten are pigmented varieties, which reportedly contain more health-promoting properties than the unpigmented ones.

Keywords: agronomic characteristics of rice, promising traditional upland rice varieties, rice self-sufficiency, rice sensory qualities, traditional upland rice

INTRODUCTION

Rice remains as the staple food of about 85% of the Philippine population, accounting for 35% of the total calorie intake per individual. With the continued fast-growing population, rice sufficiency is hardly attained. Yet, in the Philippine Food Staples Self-Sufficiency Program (FSSP), rice self-sufficiency takes center role (Department of Agriculture, 2012). One of the components of the program is anchored on production interventions, which include development of traditional upland rice varieties, and upland rice-based farming systems for household food security in upland areas.

Traditional upland rice (TUR) is usually cultivated through "slash and burn" in high- elevation, mountainous areas, despite

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prohibitions set by the government. Thus, the encouragement and promotion given to upland rice production would pose ecological hazards to the upland agro-ecosystem and forest resources as it brings about more massive forest clearing and destruction, reduced soil productivity, wider soil erosion and landslide, and disruption of habitat of key stone species in said ecosystem. Therefore, there is a need to identify less risk-prone areas *i.e.* lower elevation and marginal upland areas, for traditional upland rice production.

Considering the wide agro-ecological adaptability and resiliency of TUR varieties, these potentials could be harnessed for enhanced rice productivity in the above-mentioned areas. Additionally, these heirloom rice varieties possess traits such as good eating qualities, high nutritional value, long shelf life when cooked and substantial grain expansion when cooked. These characteristics usher in an increasing demand and higher market price for TUR varieties in urban communities.

The national average production of upland rice in the Philippines is low (~ 0.9 t ha^{-1}, De Datta, Faye and Mallick, 1974 as cited by Ortuoste, and Ortuoste, 2014). However, compared to other cereals including wheat, rice is a high yielding crop even under adverse conditions (Swaminathan, 1984 as cited by Ashraf and Lokanadan, 2017). Andal and Sana (2008) reported yield levels of traditional rice varieties ranging from 2.0 – 2.5 t ha^{-1} in the highlands and 3.0 to 3.5 t ha^{-1} in the lowlands. Hence, hand-in-hand with improved cultural management under upland conditions, the search for highly-adaptable and high-yielding varieties would contribute to increased productivity in upland rice farming. Additionally, utilization of less risk-prone areas *i.e.* lower-elevation and marginal upland, and conversion of less productive soil to become productive rice production areas would enhance the sustainability of upland rice production and the environment. Thus, a two-year rice adaptability trial was conducted in lower-elevation upland areas in the City of Batac, Ilocos Norte involving 42 TUR accessions.

METHODOLOGY

Locale of the Study

The study was conducted for two consecutive years, during the 2010 and 2011 wet seasons, in the City of Batac, Ilocos Norte.

From the swidden farms in high elevation uplands (~1,100 meters above sea level) (masl), the growing area was transferred to a study site situated at the low elevation uplands of Brgy. San Pedro, Sitio Lubbot and Brgy. Payao City of Batac, Ilocos Norte. Year 1 trial was established in Lubbot, while Year 2 was in Payao, using same set of accessions. Lubbot is located at 18° 01' 51.4 " N and 120° 37' 03.9" E at an elevation of 97 masl, while Payao is located at 18° 02' 8.16" N and 120° 34' 59.7" E at an elevation of 78 masl. Soil texture in Lubbot is clay loam while loamy sand in Payao. Weather conditions during the two-year trial varied particularly on the amount of solar radiation, rain events distribution, and typhoon occurrence (Figure 1-3).

Rainfall distribution was basically favorable for rice cultivation with total rainfall of 1068.1 mm in 2010 and 2196.6 mm in 2011. There were also more tropical cyclones in 2011 (8) than in 2010 (7). Temperature during the evaluation trial was at an average of 23.7 °C (minimum) and 32 °C (maximum) in 2010, and about 23.7 °C (minimum) to 31.6 °C (maximum) in 2011 (Figure 2). Rice requires fairly high temperature ranging from 20 °C to 40 °C, but an optimum level of 30 °C during day time and 20 °C during night time is most favorable for development and growth (Raindrops Basmati Rice, 2012). Temperature during the trial fell within the required temperature range.

Solar radiation ranged from 8.5 MJ to 29.2 MJ in 2010, and 8.5 MJ to 29.5 MJ in 2011 (Figure 3). Average solar radiation was generally lower in 2011 (18.98 MJ) than in

2010 (20.57 MJ), especially in late June to mid-July. This period coincided with the vegetative phase, hence, there could have been less photosynthetic activity in the crop at this period. Low solar radiation was again observed in early October 2011 (ripening phase). During the ripening phase, higher solar radiation is needed for the production of assimilates for the developing grains.

Selection of Varieties for Evaluation

A total of 42 entries were selected from the TUR germplasm collection of the MMSU Plant Genetic Resources Conservation Program. These were collected earlier from the different mountainous communities of 16 municipalities in the province of Ilocos Norte through the SEARCA SFRT-funded project in 2009-2010.

Crop Establishment and Maintenance

The experimental area was prepared thoroughly. It was plowed twice to eradicate emerging weeds, and harrowed to pulverize the soil before planting. Seeds were dibbled at the rate of 3 to 5 seeds per hill, spaced at 20 cm between hills and 30 cm between rows in plots measuring 1.5 m x 6 m each. The experiment was set up following Randomized Complete Block Design with three replications. Recommended rate of 90-30-30 kg N-P_2O_5-K_2O ha^{-1} was followed. Complete fertilizer 14-14-14 was applied basally at the rate of 60 kg ha^{-1}. Urea was topdressed at the rate of 30 kg N ha^{-1} applied in two splits; at 30 and 50 days after seedling emergence (ASE). The plots were hand-weeded and kept weed-free up to harvesting. Scarecrows were installed to protect the crop from bird damage. Insect pest damage and disease incidence were rated during the reproductive stage of the crop. Harvesting was done when 80% maturity of the grains was attained.

Data Gathering Procedures and Analysis

Agronomic data such as plant height, number of tillers per hill, and panicle length were gathered using 10 sample plants. Seed weight (g/1000 grains), days to maturity, grain yield, percent filled grains and insect pest damage and disease incidence were also recorded.

Data on *g*rain yield, percent filled grains, panicle length and seed size were analyzed using combined analysis across years to identify which varieties showed

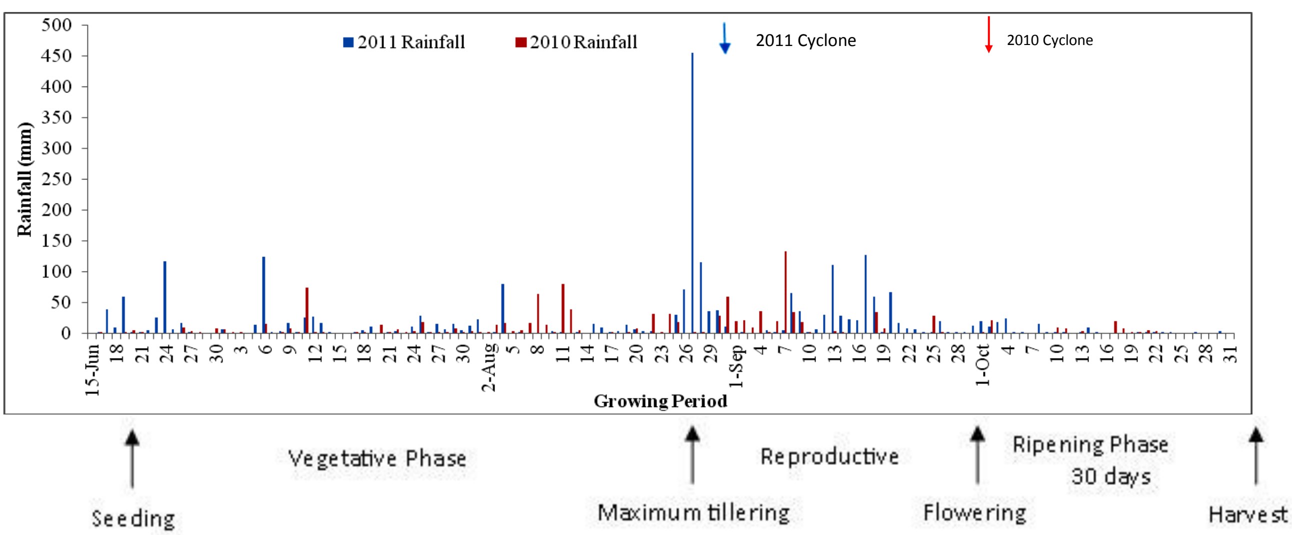

Fig. 1. Daily rainfall in Batac and tropical cyclones which affected Ilocos Norte from June to October 2010 and 2011, (Agrometeorological Station, MMSU-PAGASA, City of Batac) and growth phases of an upland rice plant (IRRI Rice Knowledge Bank).

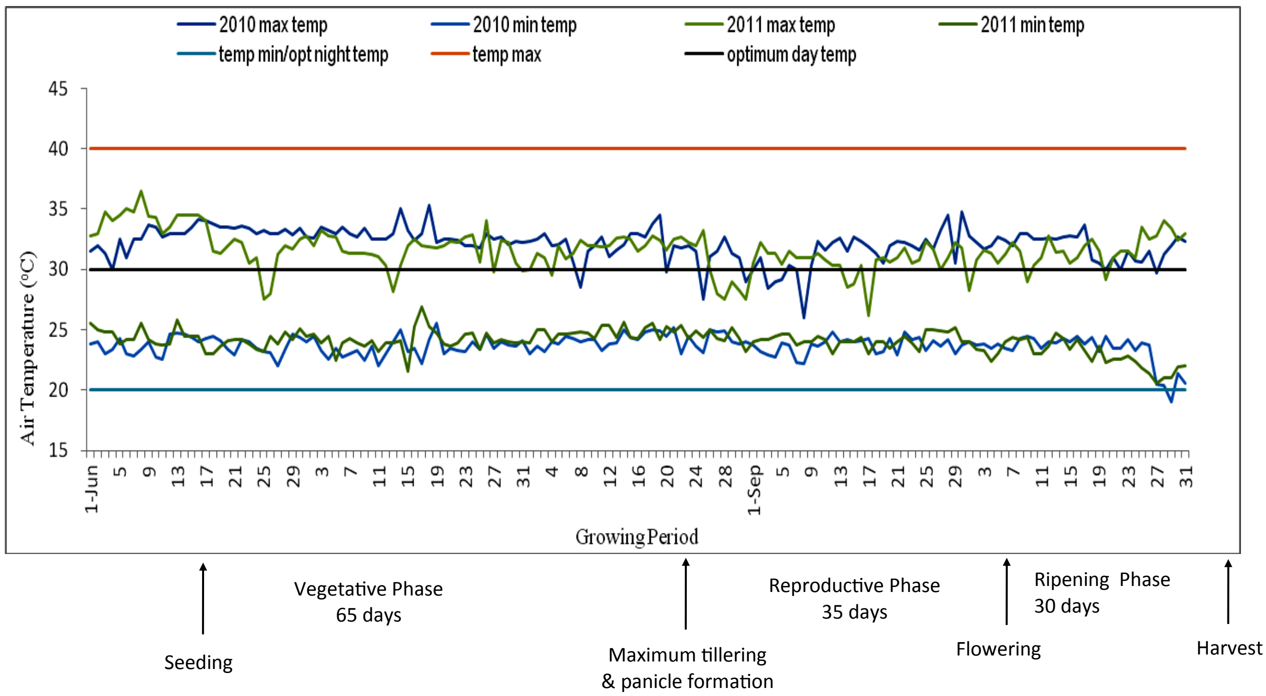

Fig. 2. Daily air temperature in Batac, Ilocos Norte from June to October 2010 and 2011 (Agrometeorological Station, MMSU-PAGASA, City of Batac) and growth phases of an upland rice plant (IRRI Rice Knowledge Bank).

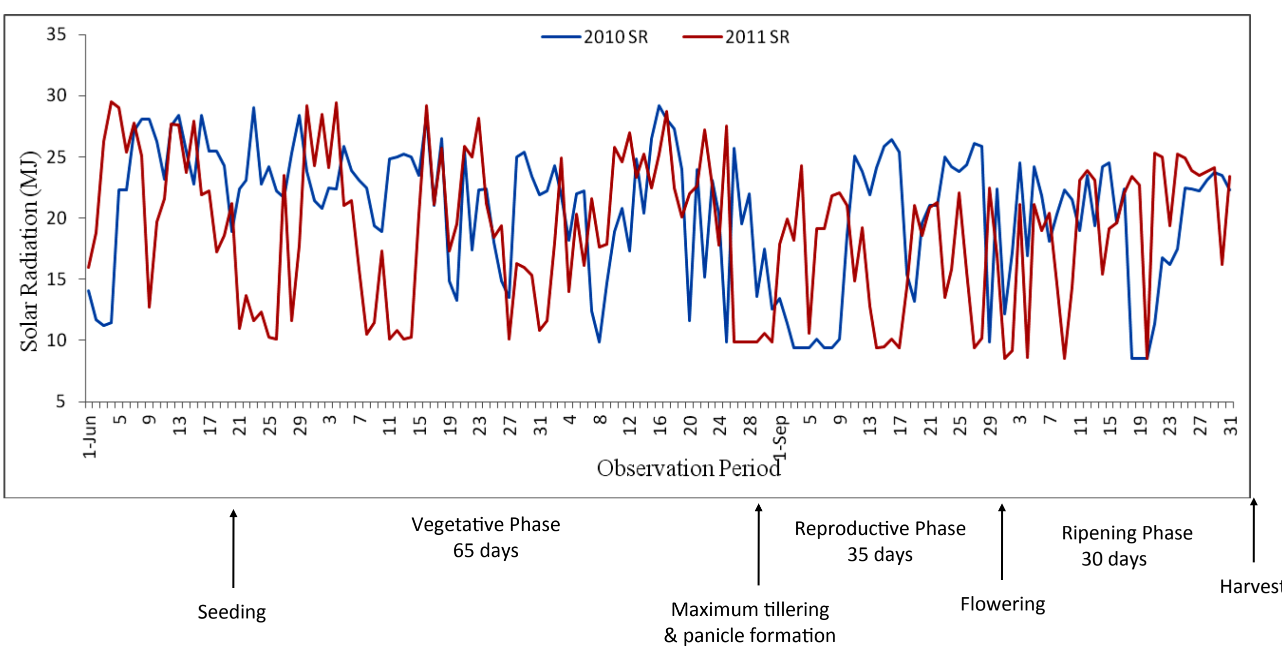

Fig. 3. Daily solar radiation in Batac, Ilocos Norte from June to October 2010 and 2011 (Agrometeorological Station, MMSU-PAGASA, City of Batac) and growth phases of an upland rice plant (IRRI Rice Knowledge Bank).

consistently high yield. The other characters were analyzed individually per year using Analysis of Variance in Randomized Complete Block Design.

RESULTS AND DISCUSSION

Plant Height

The entries evaluated were intermediate (90-125 cm) to tall (>125 cm), 90% of which were tall (Table 1). The tallest among the entries was TUR 29 while the shortest was TUR 6. The average plant height in 2010 was 137.18 cm and134.92 cm in 2011.

Shorter rice plant is more advantageous in upland farming, especially in high elevation areas, considering their exposure to wind on mountainous areas. The tallness of most of the entries would be less disadvantageous if they were planted in lower elevation uplands. Tall stature, however, makes rice more competitive with weeds and hence, is considered desirable in weedy upland conditions (Yoshida, et al. 1982 as cited online in March 2012). Moreover, long culm is sometimes preferred by some farmers because the rice hay is utilized as mulch for dry season crops and for animal fodder.

Tiller Count

The tillering ability of the entries also varied in both years. However, TUR 48 consistently had the most tillers (Table 1).

On the average, the entries had more tillers in 2011 (8 tillers) than in 2010 (6 tillers). Likewise, more entries (8) were medium tillering in 2011 than in 2010. Despite the interspersed dry spells in 2011, there was higher total rainfall in the month of August 2011 (916.8 mm) than in August 2010 (436.5 mm), which must have favored tiller production. Most of the entries (92.86%) were rated with low tillering ability (with 5-9 tillers/plant), which is typical of upland varieties.

Table 1. Plant height and tiller count of the 42 Traditional Upland Rice (TUR) entries evaluated during 2010 and 2011 WS, City of Batac, Ilocos Norte

ACCESSION	PLANT HEIGHT[1] (cm)		TILLER COUNT[2]	
	2010	2011	2010	2011
1	148.26 a-f	149.60 abc	6.00 cd	9.80 c-f
3	145.86 a-g	136.55 a-g	6.00 cd	9.73 c-g
4	139.33 a-h	141.40 a-f	4.93 cd	8.33 c-h
5	146.06 a-g	149.93 abc	6.33 c	8.80 c-g
6	135.73 b-h	127.53 d-g	6.33 c	7.53 d-h
7	153.07 a-e	150.53 ab	6.67 c	10.13 cde
9	143.30 a-g	147.60 a-d	6.33 c	7.60 d-h
10	136.13 b-h	140.33 a-f	6.33 c	8.27 c-h
12	139.53 a-h	135.87 a-g	5.33 cd	7.53 d-h
13	129.97 fgh	128.47 d-g	5.33 cd	7.93 c-h
15	134.60 c-h	139.53 a-f	6.67 c	8.13 c-h
16	145.00 a-g	138.20 a-g	7.00 bc	7.27 d-h
17	137.37 a-h	133.80 a-g	6.33 c	8.00 c-h

Table 1 continued

ACCESSION	PLANT HEIGHT[1] (cm)		TILLER COUNT[2]	
	2010	2011	2010	2011
18	137.60 a-h	138.33 a-g	6.00 cd	7.60 d-h
19	143.43 a-g	131.26 b-g	6.67 c	3.93 h
20	133.73 c-h	133.93 a-g	6.67 c	7.80 c-h
21	132.90 e-h	128.13 d-g	6.33 c	7.53 d-h
22	145.67 a-g	127.73 d-g	6.00 cd	5.60 e-h
23	136.67 b-h	117.80 g	7.00 bc	5.33 fgh
24	145.83 a-g	129.20 c-g	5.83 cd	7.13 d-h
25	157.43 a	145.20 a-e	6.67 c	5.60 e-h
26	131.23 fgh	135.60 a-g	6.00 cd	7.67 d-h
28	136.07 b-h	141.07 a-f	6.33 c	8.00 c-h
29	155.00 ab	154.20 a	6.33 c	7.80 c-h
30	153.57 a-d	150.53 ab	6.33 c	9.60 c-g
31	127.77 gh	122.93 fg	3.67 d	5.93 d-h
32	101.73 i	80.00 h	10.00 a	14.27 b
34	153.80 abc	145.60 a-e	6.33 c	6.20 d-h
35	145.57 a-g	139.67 a-f	5.67 cd	5.67 e-h
36	140.03 a-h	131.93 b-g	6.00 cd	8.06 c-h
37	138.07 a-h	142.133 a-f	7.00 bc	7.13 d-h
38	137.93 a-h	143.00 a-f	7.00 bc	6.4 d-h
39	139.43 a-h	141.00 a-f	5.00 cd	8.13 c-h
41	130.37 fgh	131.53 b-g	5.00 cd	6.73 d-h
42	133.33 d-h	131.13 b-g	4.67 cd	5.13 g-h
44	127.63 gh	135.60 a-g	4.90 cd	5.80 d-h
45	122.80 h	131.87 b-g	5.33 cd	9.00 c-g
46	132.07 fgh	136.87 a-g	7.00 bc	7.53 d-h
47	131.37 fgh	135.00 a-g	5.67 cd	6.73 d-h
48	101.83 i	89.07 h	11.00 a	19.33 a
49	120.20 h	125.47 efg	9.00 ab	12.33bc
50	136.00 b-h	151.47 ab	7.00 bc	10.33 bcd
Significance	**	**	**	**
CV (%)	7.4	7.8	20.1	28.9

** - highly significant at 1% level

Means marked having the same letter in a column are not significantly difference using HSD.

[1]Plant height at maturity (for upland): Semidwarf, < 90 cm; Intermediate, 90-125 cm; Tall, > 125 cm

[2]Basis for tillering ability: Very high, >25 tillers/plant; Good, 20-25 tillers/plant;
Medium, 10-19 tillers/plant; Low, 5-9 tillers/plant; Very low, <5 tillers/plant

Maturity

The maturity of the rice entries also differed significantly from each other. It ranged from 107 to 123 days in 2010 and 93 to 127 days in 2011. Most of the entries matured faster in 2011 with 23 early maturing, 18 medium maturing and one late maturing entries/entry. In 2010, four entries were late maturing and the rest of the entries were medium maturing. Such observation could be attributed to trace amount of rainfall coupled with high temperature during the ripening phase in 2011 (Figure 1-2).

Panicle Length

Panicle length significantly differed among entries in both cropping years. In 2010 cropping, TUR 29 had the longest panicles (30.2 cm) but comparable with 17 other entries whose panicles ranged from 26.7 cm to 29.6 cm (Table 2). All entries produced medium panicles in 2010.

Meanwhile, TUR 38 and five other entries had the longest panicles in 2011. Majority had medium panicles, while six entries had long and one had short panicles. Long panicles are 31 cm to 40 cm long; medium, 21 cm to 30 cm; and short, 11 cm to 20 cm long (Bioversity, IRRI and WARDA, 2007).

TUR 48 consistently had the shortest panicles in the 2010 (21.5 cm) and 2011 cropping (21.53 cm).

Seed weight

Seed weight, which was measured in terms of weight (g) of 1000 grains, also varied significantly among entries evaluated (Table 2). TUR 24 consistently produced the heaviest grains with 35.9 g and 34.73 g in 2010 and 2011, respectively. It was, however, comparable with TUR 26 and TUR 50 in 2010 and TUR 26 and TUR 5 in 2011.

Meanwhile, TUR 49 which was identified as Ballatinao, consistently produced the lightest seeds. Its seeds weighed 19.13 g/1000 grains (Table 2).

Generally, rice grains were heavier during the 2011 cropping (Table 2). This could be attributed to the higher temperature and solar radiation (Figure 2-3) in the month of October during which the rice crop was at ripening stage. As reported earlier, an optimum temperature of 30 ^{o}C at day and 20 ^{o}C at night is most favorable for rice growth and development, and high solar radiation during ripening enhances carbohydrate development in the grains.

Table 2. Maturity, panicle length and seed size of the 42 traditional upland rice entries evaluated during 2010 and 2011 WS, City of Batac, Ilocos Norte

ACCESSION	MATURITY^{2} (days)		PANICLE LENGTH (cm)		SEED WEIGHT (g/1000 seed)	
	2010	2011	2010	2011	2010	2011
1	116.33 d-h	114.67 bc	29.60 ab	28.60 d-j	26.23 rst	26.33 l-o
3	112.33 i-h	98.33 hij	25.27 d-m	25.60 k-n	32.37 c-f	33.50 b-e
4	111.00 lmn	93.00 l	25.87 b-m	27.46 f-m	27.97 l-s	26.23 l-o
5	111.33 k-n	97.67 h-k	27.27 a-h	27.20 f-m	33.47 bcd	34.77 ab
6	107.67 o	97.00 ijk	27.93 a-e	29.00 b-l	29. 53 i-o	30.00 ghi
7	112.33 i-n	94.00 k-l	27.40 a-g	28.86 d-l	32.60 cde	33.53 b-e
9	113.67 h-m	94.67 k-l	26.97 a-l	28.93 c-l	32.03 c-h	33.00 b-e

Table 2 continued

ACCESSION	MATURITY^2 (days)		PANICLE LENGTH (cm)		SEED WEIGHT (g/1000 seed)	
	2010	2011	2010	2011	2010	2011
10	118.00 c-f	113.33 bcd	25.40 d-m	27.73 e-m	28.30 l-s	28.50 ijk
12	107.33 o	95.00 jkl	25.87 b-m	26.13 h-n	30.33 el	30.73 fgh
13	114.67 f-k	95.00 jkl	22.73 l-o	24.93 mn	26.90 p-s	27.57 jkl
15	118.33 cde	113.33 bcd	25.97 b-m	29.07 b-h	26.93 p-s	27.57 jkl
16	115.67 e-l	99.67 hi	27.73 a-f	30.73 a-d	27.03 o-s	33.00 b-e
17	109.67 n-o	100.00 hi	23.20 j-o	26.07 i-n	29.77 g-m	31.97 def
18	118.33 cde	112.33 b-e	25.60 c-m	31.80 ab	27.20 n-s	27.13 k-n
19	110.00 no	105.33 g	29.27 abc	30.53 a-e	25.73 stu	28.00 jkl
20	118.00 c-f	111.33 cde	26.03 b-m	29.20 b-g	27.90 l-s	27.37 j-m
21	118.00 c-f	115.67 b	24.23 e-o	27.27 f-m	26.27 rst	25.23 nop
22	109.67 no	95,00 jkl	24.13 f-o	24.87 mn	28.97 j-q	28.67 ijk
23	111.67 k-n	100.67 h	22.97 k-o	23.80 no	31.00 d-k	32.10 c-f
24	107.33 o	95.00 jkl	27.67 a-f	26.33 g-n	35.90 a	35.00 ab
25	112.0 j-n	99.33 h-l	28.70 a-d	29.07 b-h	32.37 c-f	32.43 c-f
26	114.667 f-k	95.67 jkl	24.64 e-n	25.66 j-n	35.27 ab	36.30 a
28	117.67 c-f	111.00 d-e	26.97 a-l	28.53 d-k	27.10 n-s	28.13 i-l
29	114.00 q-l	110.33 d-e	30.20 a	29.47 b-f	33.03 bcd	34.73 ab
30	112.67 i-n	94.67 k-l	26.93 a-j	27.27 f-m	31.73 c-l	33.70 bcd
31	110.33 mno	97.67 h-k	23.63 h-o	25.73 j-n	23.83 u	25.33 nop
32	119.67 bcd	115.67 b	20.57 o	17.73 p	24.43 tu	23.90 p
34	117.00 d-h	94.00 k-l	27.47 a-g	28.07 d-l	32.50 c-f	34.13 bc
35	115.67 ei	94.00 k-l	26.53 a-k	28.47 d-k	32.37 c-f	33.23 b-e
36	112.33 i-n	94.33 k-l	23.80 g-o	27.27 f-m	29.60 h-n	32.43 c-f
37	120.33 abc	105.33 g	29.30 abc	31.73 abc	28.23 l-s	32.50 c-f
38	121.67 ab	106.67 f-g	28.50 a-d	32.53 a	31.37 c-j	33.93 bcd
39	117.33 c-g	110.33 d-e	26.43 b-l	30.67 a-d	29.37 i-p	27.93 jkl
41	113.67 h-m	127.67 a	22.43 mno	28.00 d-l	27.03 o-s	26.63 k-n
42	115.33 ej	104.00 g	24.47 e-n	26.93 f-m	27.30 m-s	24.40 op
44	113.00 i-n	96.67 ijk	23.27 i-o	25.73 j-n	26.73 q-t	29.33 hij

Table 2 continued

ACCESSION	MATURITY² (days)		PANICLE LENGTH (cm)		SEED WEIGHT (g/1000 seed)	
	2010	2011	2010	2011	2010	2011
45	115.33 ej	97.00 ijk	23.00 k-o	25.20 lmn	32.23 c-g	31.60 efg
46	116.67 d-h	109.33 ef	26.77 a-j	29.60 b-f	28.67 k-r	27.13 k-n
47	111.33 k-n	97.00 ijk	24.23 e-o	27.33 f-m	26.80 p-t	28.43 ijk
48	123.33 a	112.67 b-e	21.50 n-o	21.53 o	30.03 f- l	25.40 m-p
49	123.33 a	114.67 bc	25.50 d-m	25.60 k-n	20.13 v	19.13 q
50	111.67 k-n	95.00 jkl	27.00 a-l	27.40 f-m	33.76 abc	33.73bcd
Sig	**	**	**	**	**	**
CV (%)	1.6	1.9	7.3	5.4	4.5	3.6

**- significant at 1% level
Means marked having the same letter in a column are not significantly difference using HSD.
[1]Panicle length: Very short,<11 cm; Short, 11 -20 cm; Medium, 21-30 cm; Long; 31-40 cm; Very long, >40 cm
[2]Maturity: Early maturing, <90-100 days; Medium maturing, 101-120 days; Late maturing, >120 days

Percent Filled Grains, Panicle length, 1000 seed weight and Grain Yield.

Combined analysis across years showed no significant interaction of year and variety on percent filled grains. However, heavier seeds were observed among the varieties and between years. The same trend was observed with respect to panicle length and seed size. There was a significant interaction on variety, year, and year and variety (Table 3). There was a highly significant interaction of variety and year on grain yield. Among the entries evaluated in the City of Batac. 17 entries consistently produced high yields of more than 3.0 t ha^{-1} during the two-year evaluation trial as shown in Table 5. These include: five accessions collected from Vintar with farmer's variety Isek namely: TUR 5, TUR 17, TUR 30, TUR 36, and TUR 50 ; three accessions from Solsona, TUR 1 (Isek), TUR 18 (Isek), and TUR 46 (Wagwag); two accessions from Pasuquin, TUR 4 (Isek) and TUR 30 (Isek); one accession each were collected from the towns of Dingras, TUR 15 (Maluit); Pagudpud, TUR 3 (Isek); Adams, TUR 28 (Pamplona); Nueva Era, TUR 39 (Azucena); Payao, TUR 41 (Tallingo); Banna, TUR 42 (Maluit); and Agaga, Burgos, TUR 47 (Limon). The non-significant difference across years means that the accessions were already stable. However, some selected accessions were considered promising even though they have significant difference across years because of their consistent yield of 3.0 t ha^{-1} in the individual year. Furthermore, the high yield of these entries was partly attributed to their consistently high filled grains (spikelet fertility), although not necessarily producing the most fertile spikelets, longest panicles and heavier seeds among the entries.

Comparison of the mean percent filled grains of the entries showed that only 14% of them were considered highly fertile, majority (83%) were fertile, and one entry was partly sterile. Highly fertile entries have >90% filled grains; fertile entries have 75% to 89% filled grains, while partly sterile entries have 50% to 74% filled grains (IRRI, 2014). The accessions which obtained the highest percentage filled grains were TUR25, 9, 6 and 50 with 91.95%, 91.8%, 91.3% 91.1%, respectively. However, these are comparable to 33 entries with percentage filled grains ranging from 84.55% to 90.69% (Table 4). Percentage filled grains was significantly higher in 2010 (89%) than in 2011 (85.26%).

Table 3. Results of the combined analysis across years of percent filled grains, panicle length, weight of 1000 seeds and grain yield

SV	(FILLED GRAINS)	(PANICLE LENGTH)	(WEIGHT OF 1000 SEEDS)	(YIELD)
Year (Y)	3791.18**	62.82**	11.22**	11084.57**
Variety (V)	1591.08**	22.64**	59.05**	1.48*
YxV	0.41ns	1.66**	3.59**	22.81**

ns – not significant
*- significant at 5% level
** - significant at 1% level

Table 4. Percent filled grains of the 42 traditional upland rice entries evaluated during 2010 and 2011 WS, City of Batac, Ilocos Norte

ACCESSION	FILLED GRAINS[1] (%)		
	2010	2011	Mean
1	88.76 abc	92.63 a	90.69 ab
3	88.98 abc	85.52 a-e	87.25 ab
4	92.14 ab	86.99 a-e	89.56 ab
5	89.78 ab	90.68 abc	90.22 ab
6	92.89 a	89.85 abc	91.36 a
7	90.84 ab	88.79 a-e	89.81 ab
9	93.10 a	90.53 abc	91.81 a
10	86.31 abc	89.93 abc	88.12 ab
12	89.48 ab	87.39 a-e	88.43 ab
13	91.04 ab	83.06 a-f	87.05 ab
15	91.46 ab	87.97 a-e	89.72 ab
16	87.13 abc	88.63 a-e	87.87 ab
17	90.14 ab	86.45 a-e	88.12 ab
18	92.07 ab	83.52 a-f	87.81 ab
19	90.80 ab	79.02 d-h	84.91 ab
20	88.71 abc	82.89 a-f	85.79 ab
21	88.01 abc	85.39 a-e	86.72 ab
22	88.91 abc	80.20 c-h	84.55 ab
23	92.18 a	84.25 a-f	88.21 ab

Table 4 continued

ACCESSION	FILLED GRAINS[1] (%)		
	2010	2011	Mean
24	89.43 abc	86.00 a-e	87.71 ab
25	92.15 ab	91.75 ab	91.95 a
26	89.67 ab	87.25 a-e	88.46 ab
28	91.65 ab	81.61 b-g	86.63 ab
29	86.63 abc	83.50 a-f	85.06 ab
30	87.61 abc	89.41 a-d	88.51 ab
31	87.85 abc	78.11 e-h	82.97 bc
32	71.78 d	72.71 g-h	72.24 d
34	89.90 ab	83.29 a-f	86.59 ab
35	89.81 ab	86.64 a-e	88.22 ab
36	88.18 abc	86.20 a-e	87.18 ab
37	88.61 abc	84.20 a-f	85.74 ab
38	87.73 abc	86.78 a-e	87.25 ab
39	89.28 abc	85.90 a-e	87.59 ab
41	89.02 abc	84.86 a-f	86.94 ab
42	91.76 ab	87.89 a-e	89.82 ab
44	91.05 ab	84.89 a-f	87.96 ab
45	90.82 ab	85.23 a-e	88.02 ab
46	90.36 ab	88.60 a-e	89.48 ab
47	90.64 ab	89.14 a-d	89.89 ab
48	82.34 bc	71.50 h	76.92 cd
49	79.66 cd	74.39 fgh	77.02 cd
50	93.00 a	89.18 a-d	91.09 a
Mean	89.08	85.30	87.17
Significance	*	**	**
CV (%)	5.5	6.3	6.4

*- significant at 5% level
** - significant at 1% level
Means marked having the same letter in a column are not significantly difference using HSD.
[1] Basis for spikelet fertility: Highly fertile, >90% filled grains; Fertile, 75-89% filled grains; Partly sterile; 50-74% filled grains; and Highly sterile <50% to trace filled grains

Among the 42 entries evaluated, more than half (26 entries) in 2010 and 19 entries in 2011 yielded higher than 3.0 t ha^{-1} (Table 5). This yield level surpassed the average yield of 2.0 to 2.5 t ha^{-1} reported from traditional varieties grown in upland ecosystems in Nueva Viscaya (Andal and Sana, 2008). A much lower yield of 1.5 t ha^{-1} was reported by De Datta (1975), as cited by Sarimong, 2015) from their trials on upland rice in Asia.

Additionally, the yield of the high-yielding entries in Batac also surpassed the reported yield of modern upland rice varieties (*i.e*. PSB Rc1, PSB Rc7, PSB Rc3, PSB Rc5, PSB Rc9, NSIC Rc11 and NSIC Rc192) which produced 2.4 to 2.9 t ha^{-1} (FLAR, 2010).

Table 5 . Grain yield (t ha^{-1}) of the 42 traditional upland rice entries evaluated during 2010 and 2011 WS, City of Batac, Ilocos Norte

ACCESSION	GRAIN YIELD (t ha^{-1})			
	2010	**2011**	**Mean**	**Difference**
1	3.65 ef	4.57 c	4.11	0.92**
3	3.67 ef	4.76 b	4.21	1.09**
4	3.63 ef	3.70 gh	3.67	0.08 ns
5	4.02 c	3.17 k	3.60	-0.85**
6	4.30 b	2.73 n	3.51	-1.57**
7	3.78 d	2.57 op	3.17	-1.21**
9	2.95 jk	2.87 m	2.91	-0.08 ns
10	2.99 jk	3.29 j	3.14	0.30*
12	2.45 n	1.84 u	2.14	-0.61*
13	2.62 m	2.70 no	2.66	0.08 ns
15	3.76 de	3.09 k	3.42	0.67*
16	2.72 l	2.81 mn	2.76	0.10 ns
17	3.69 e	3.21 i	3.45	0.48*
18	3.25 i	4.13 e	3.69	0.88*
19	2.92 kl	1.71 v	2.31	-1.21**
20	3.60 f	2.73 n	3.16	0.87*
21	3.58 fg	2.12 s	2.85	-1.46**
22	3.73 de	2.07 s	2.90	-1.66**
23	4.07 c	1.94 t	3.00	-2.13**
24	3.17 i	2.05 s	2.61	-1.12**
25	3.51 g	1.75 v	2.63	-1.75**
26	2.72 i	2.61 op	2.67	-0.11 ns
28	3.72 de	3.81 fg	3.76	-0.09 ns
29	2.69 lm	3.92 ef	3.31	-1.22**
30	3.26 hi	5.62 a	4.44	-2.36**
31	2.09 op	4.00 ef	3.04	-1.90**
32	2.93 k	2.26 r	2.59	-0.67*

Table 5 continued

ACCESSION	GRAIN YIELD (t ha^{-1})			
	2010	**2011**	**Mean**	**Difference**
34	4.35 b	3.00 l	3.67	-1.34**
35	3.44 g	2.59 op	3.01	-0.85**
36	4.79 a	4.54 c	4.67	0.25*
37	3.02 j	2.60 op	2.81	-0.42*
38	3.22 i	2.39 q	2.81	-0.83**
39	3.34 h	4.17 e	3.76	0.83**
41	3.47 g	4.39 d	3.93	0.92**
42	3.44 g	3.25 jk	3.34	-0.19 ns
44	3.03 j	2.62 o	2.82	-0.40*
45	2.04 p	2.73 n	2.38	0.69*
46	3.29 hi	3.39 i	3.34	0.10 ns
47	3.47 g	3.25 jk	3.36	-0.22 ns
48	2.16 o	2.55 op	2.36	0.39*
49	3.34 h	2.53 p	2.93	0.81**
50	3.46 g	3.73 g	3.59	0.27*
Significance	*	*		
cv (%)	6.35	10.38		

ns – not significant
*- significant at 0.05
**- significant at 0.01
Means marked having the same letter in a column are not significantly difference using HSD.

Further, the consistently high yield of above entries indicates their adaptability for cultivation in low-elevation upland agro-ecosystems like that of City of Batac, Ilocos Norte.

Good eating qualities are an added advantage of the 17 high-yielding entries. Based on an earlier sensory evaluation (Antonio *et al,* 2011), the entries have been found to be are moderately aromatic to aromatic, moderately glossy, slightly smooth to smooth, and tasty. Exactly 10 of the identified promising are pigmented varieties, represented by TUR 36, 4, 42 and 47 (Figure 4) which are reportedly more nutritious and healthful than their non-pigmented counterparts due to higher fiber and mineral content (Fe, Zn) and possessing antioxidant properties (Romero, 2009).

In general, the 42 entries evaluated showed good yield performance in the lower elevation upland ecosystem of Lubbot and Payao in City of Batac, producing yields which exceeded rice yield in farmer's field at high-elevation upland ecosystem in Ilocos Norte. The average yield of the 42 entries evaluated in the City of Batac was 3.32 t ha^{-1} in 2010 WS and 3.07 t ha^{-1} in 2011 WS, in contrast to an average of 2.2 t ha^{-1} (2010 WS) recorded on-farm from 18 farmers' varieties (Table 6) in Sitio Bucarot in the Municipality of Adams, Ilocos Norte. The Municipality of Adams is a high elevation upland area (~1100 masl) and is reportedly the center of upland rice farming in the province for having the widest production area and harboring the greatest diversity of traditional varieties (Antonio *et al*, 2011). Average on-farm yield recorded from Adams using farmers' varieties (Table 6) are within the yield range reported by Andal and Sana (2008). Of the 42 varieties, 17 yielded more than 3 t ha^{-1}. The highest yields were obtained from varieties Limon or Orto (4.7 t ha^{-1}), Sinayawan (3.9 t ha^{1}), Azucena (3.8 t ha^{-1}), Inu nudan (3.2 t ha^{-1}) and Baruyan (3.1 t ha^{-1}) while the lowest were from Duy-duyan (0.75 tha^{-1}), At-attay (0.63 t ha^{-1}) and Ginaang (0.63 t ha^{-1}).

There was generally a decrease in yield of the 42 entries from 3.32 t ha^{-1} in 2010 to 3.07 t ha^{-1} in 2011. The inconsistency in yield across years was partly attributed to the weather conditions during the cropping seasons (Figure 1 and 3). High rainfall during the late part of August 2011 coincided with the booting and early flowering stages (Figure 1), thus resulting to the abortion of the emerging flowers. In mid-September of the same year, high rainfall again occurred, which affected the developing grains. Meanwhile, the low points in the solar radiation during the vegetative and reproductive phases in cropping year 2011 (Figure 3) was not beneficial to the rice plants. Solar radiation is most critical during the ripening phase at which higher bright sunshine is needed in the development of carbohydrates in the grains. Additionally, the strong winds brought about by more tropical cyclones (8) during the 2011 cropping, especially during the months of August, September and October which coincided with the reproductive and ripening phases, was detrimental to the growth and development of the rice plants. The detrimental effects of above weather conditions was evident on lower average spikelet fertility in cropping year 2011, thus contributing to lower yield.

Insect Pest Damage and Disease Incidence

Almost half (40%) of the entries, such as TUR 3, 5, 16, 18, 19, 20, 22, 23, 32, 41, 42, 44, 45, 47, 48, 49, 50 showed symptoms of yellowing in the three lower leaves of the plant. The yellow spots occupied

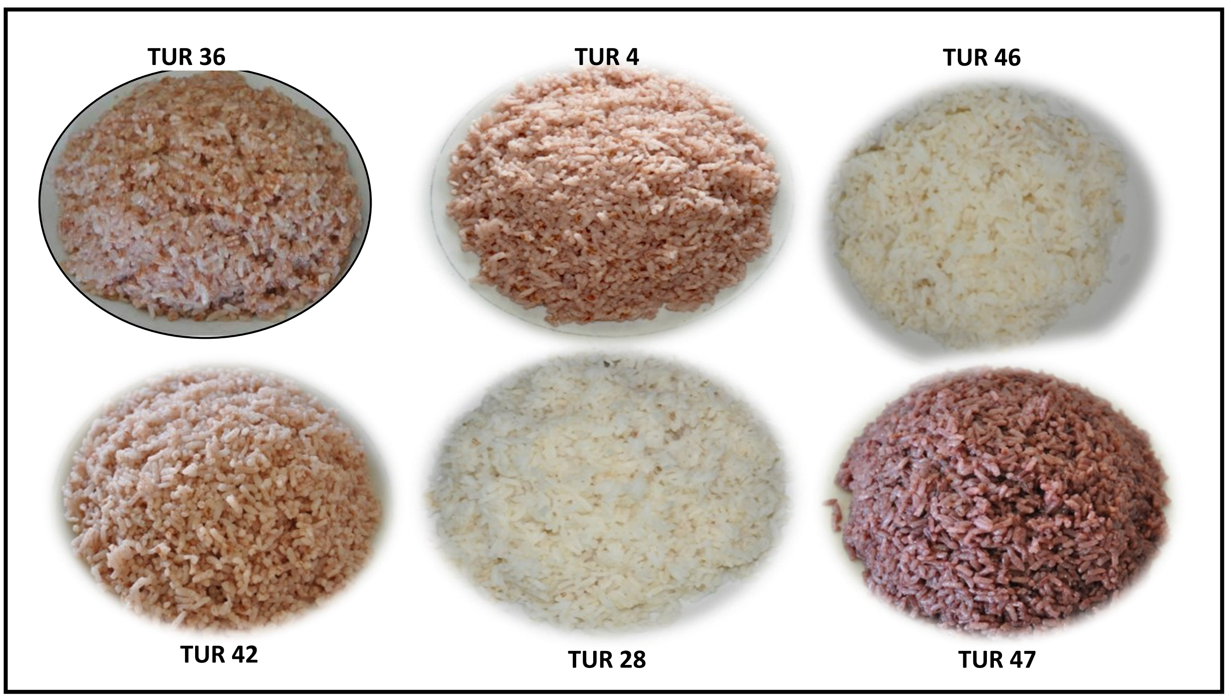

Fig. 4. Cooked grains of some of the high-yielding Traditional Upland Rice (TUR) entries (Antonio *et al*, 2011).

Table 6. Average yield of 18 farmers' varieties of upland rice recorded on-farm in Bucarot, Adams, Ilocos Norte, 2010 WS

VARIETY	GRAIN YIELD ($t\ ha^{-1}$)
At-atay (Bu1)	0.62
Samsam (Bu 2)	2.87
Sinad-an (Bu3)	2.25
Dangrat/Idangrat (Bu4)	2.25
Inu nudan (Bu 5)	3.18
Agonoy (Bu6)	2.50
Dangrat/Idangrat (Bu7)	1.25
Inu nudan (Bu8)	2.50
Pusa Pusa/U-uwak/Osa osa (Bu 9)	1.56
Dagguk (Bu10)	1.12
Twao (Bu 11)	1.25
Limon/Orto (Bu12)	4.75
Wenan, Duprak (Bu13)	1.37
Azucena (Bu14)	3.75
Sinayawan (Bu15)	3.87
Ginaang (Bu16)	0.62
Baruyan (Bu17)	3.12
Duy duyan (Bu18)	0.75

approximately 10% to 15% of the leaf area. This was noticed when the plants were in their booting stage. Sheath blight was also observed in six entries (TUR12, 13, 21, 28, 29 and 39) but the damage was slight. Dead heart caused by stem-borer was observed in entries TUR13, 19 and 47 only. These observations, however, did not significantly affect the yield of the entries since the occurrence is negligible. On the other hand, friendly species of spiders, damselflies and coccinelids were also present in the experimental area.

CONCLUSIONS AND RECOMMENDATIONS

Traditional upland rice varities which used to be cultivated in high elevation agro-ecosystems are also adaptable to low elevation upland as manifested by their good agronomic performance. Most of the entries surpassed the reported yields of traditional as well as modern rice varieties grown in swidden farms in the high elevation upland and rainfed lowland, respectively.

Farmer's variety (Isek) TUR 5, 17, 30, 36, 50, 1, 18, 4, 30, 3, TUR 46 (Wagwag), TUR 15 (Maluit), TUR 28 (Pamplona), TUR 39 (Azucena), TUR 41 (Tallingo), TUR 42 (Maluit) TUR 47 (Limon) are recommended for cultivation in lower elevation uplands, as seen in their consistent high yields of 3.34 to 4.67 $t\ ha^{-1}$.

Seed purification and multiplication is recommended on the identified promising entries for re-introduction and commercial production in areas from which the genetic materials were collected. Submission of these entries for multi-location testing is also recommended, subject to compliance with farmers' rights *i.e.* intellectual property concerns for the farmers from whom the materials were collected.

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