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PERFORMANCE EVALUATION OF INBRED LOWLAND RICE VARIETIES UNDER VARYING NUTRIENT MANAGEMENT IN IRRIGATED LOWLAND ECOSYSTEM

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Abstract: **Variety plays a significant role in rice production. However, these varieties depend on right nutrient management suited in the farm so that essential nutrients are applied to crops when they are needed, thus achieve high and profitable yields. Hence, this study was conducted to evaluate the performance of inbred lowland rice varieties under varying nutrient management options in irrigated lowland ecosystem in Luna, Apayao from August to November, 2015.Strip – plot design was used wherein inbred varieties and nutrient management options were the variables.**

No significant differences were observed on plant vigor, plant height at 60 DAT, total tillers, productive tiller, seed size, and grain yield as to nutrient management. However, significant differences were observed on days to heading, days to maturity, plant height at 30 DAT and maturity, total tiller, percentage productive and unproductive tillers. Insignificant differences were also observed on plant vigor, grain yield, percentage productive and unproductive tillers as to nutrient management while significant differences were noted to the days to heading, days to maturity, plant height at 30 DAT and maturity, length of panicles percentage filled grains and unfilled grains, seed size and harvest index as to varieties.

Interaction effects were also noted both on filled and unfilled grains.

In terms of economic benefits, NSIC 226 under MOET+LCC produced the highest yield of 5.27 tha^{1}, highest gross income, net income and highest RAVC among the inbred lowland rice varieties tested.

NSIC Rc 226 applied with MOET+LCC is highly recommended for high yield and profit as reflected in the production analysis.

Keywords: **inbred low land rice varieties, nutrient management, irrigated lowland ecosystem.**

1. INTRODUCTION

Rice(*Oryza sativa*) is a very important crop in the Philippines because it accounts for thirty-five percent (35%) of the average calorie intake of the population. Also, rice industry has the highest labor absorption (11.5 million farmers) among the sub-sectors of Philippine Agriculture.[1] The country's rice production is mainly attributed to irrigated areas. From 2000-2010, 73% or 314,115 MT OF THE Production increase came from irrigated areas; 27% or 113, 815 MT came from non-irrigated areas. These offset the decrease in production in rain fed upland area, which is declining by around 8000 tons per year since 2000 [2]

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Like other provinces in Cordillera, Apayao's main source of livelihood is agriculture.[3] The primary strength of the province lies on its vast track agricultural land and its natural resources. The economic mainstay of about 70% of the total populace or household of the province devoted to farming and other agricultural activities.[4]

Fertilizer is vital for rice production where nearly all rice farmers use fertilizers but most farmers do not use the best nutrient management practices in rice production.[5] However, the increasing price of fertilizers presents a particular challenge to rice producers. In the Philippines, the sharp increase in prices has made the farmers to be creative, resourceful, and adaptive in their practices associated with nutrient management.[6]

Site-specific nutrient management (SSNM) is a major component of a soil and crop management system. It is knowledge of the required nutrients for all stages of growth and understanding, the soil's ability to supply those needed nutrients are critical to profitable crop production. SSNM is applying those concepts to areas within a field that are known to require different management from the field average. [7]

But in spite of the fact that nutrient management has been studied for a long time and adopted all over the country, current production data from the Bureau of Agricultural Statistics show that there is only low to medium (average of 3.68 t/ha) productivity in Philippine lowland rice areas [8]

Therefore, SSNM, a fertilizer application scheme taking into account site and season variations in both attainable rice yield with fertilization and the indigenous nutrient-supplying capacity of soil, has been developed for rice in Asia from research begun in the mid-1990s. SSNM promotes the optimal use of existing indigenous nutrients from soil, plant residues, manure, and irrigation water combined with the timely application of fertilizers at appropriate rates to match crop needs during the cropping season. The underlying premise of SSNM is that indigenous and applied nutrients will be used more effectively by the crop when they are applied when and as needed. As a result, wider farmer adoption of SSNM will increase land productivity, yield, and profitability of farmers, and decrease fertilizer-related pollution in the environment.[9]

Objectives of the study

The study aimed to evaluate the performance of inbred lowland rice varieties under different nutrient management options.

Specifically;

1. Compare the growth and yield performance of the different inbred lowland rice varieties under irrigated lowland ecosystem;
2. Determine whether the cultivars respond differently to nutrient management options;
3. Identify the best nutrient management options that can be used in irrigated lowland ecosystem; and
4. Determine the production economics of the different inbred lowland rice varieties grown under different nutrient management options.

2. CONCEPTUAL FRAMEWORK

Varieties differ in their genetic makeup therefore vary in yield potential. Fertilizer is the most expensive input in rice farming yet its use is often inefficient. The inefficient use of fertilizer can result from the application of nutrients in amounts and at times not well matched to the requirement of the crop. This can lower profit for farmers and excess application of fertilizers can have detrimental effects on the environment.[10]

On the other hand, nutrient management requires right combination of fertilizer sources, rates and timing of application for the field – specific condition.

The independent variables, variety, and nutrient management affect the dependent variables crop growth, yield, and production economics are presented in figure 1.

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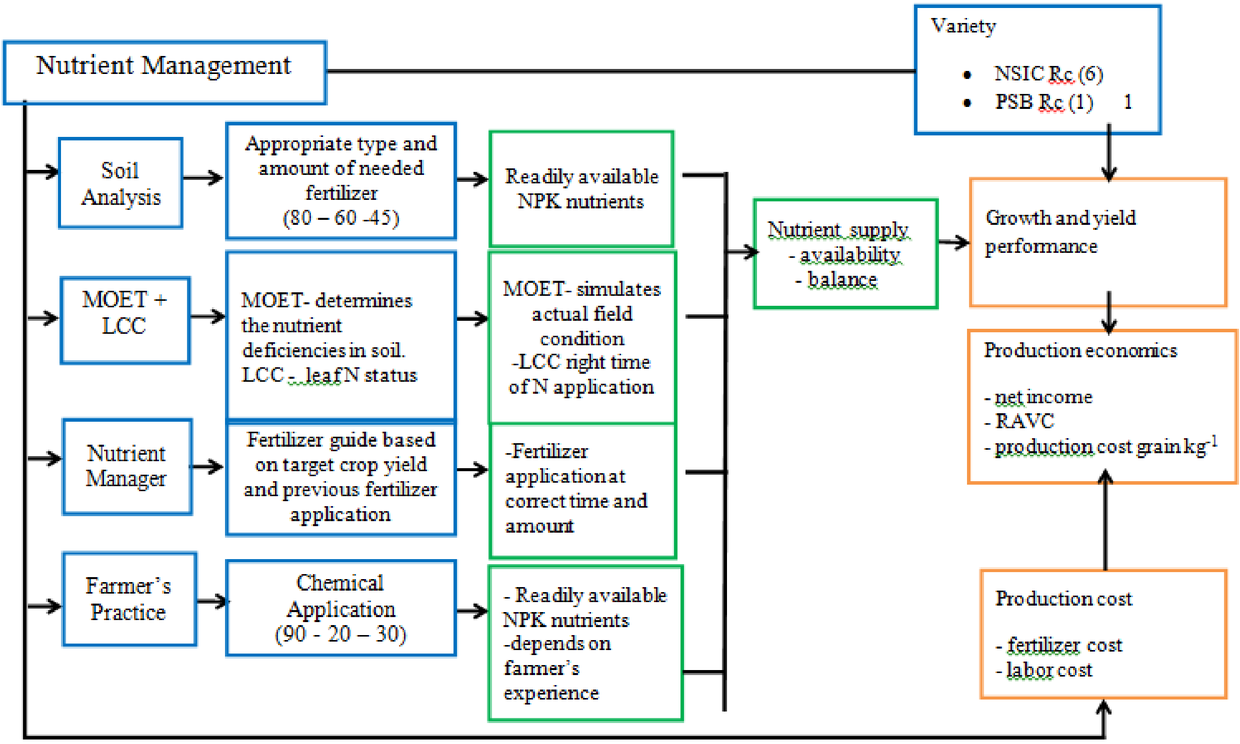

Figure 1. Conceptual Paradigm of the Study.

The study was conducted during the 2015 wet season (WS) cropping from July to November in a lowland rice field of Luna, Apayao. (Fig.2). the municipality of Luna is geographically situated in the northern part of the province of Apayao. It is bounded by the Apayao river in the east, the Malunog River in the south, by the Cagayan provincial boundary in the north and by the municipality of Calanasan in the west. Luna is under type 111 climate which is characterized by unpronounced rain period with dry season lasting for one to three months and with a rainfall more or less evenly distributed throughout the year. The study site is accessible to the barangay road and near the irrigation canal of the National Irrigation Administration thus water was not a production limiting factor.

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Figure 2. Map of the Philippines, Showing the Locale of the Study.

During the study period, maximum temperature ranged from 20.60 ^{O}C to 34. 90 ^{0}C and the minimum temperature ranged from 19.60 ^{0}C to 30.25 ^{0}C (Fig.4).The maximum temperature of 34. 90 ^{0}C occurred on July 21, when the plants were at vegetative stage and lowest temperature of 19.0 ^{0}C occurred on September 25 when the plants were at early reproductive stage.

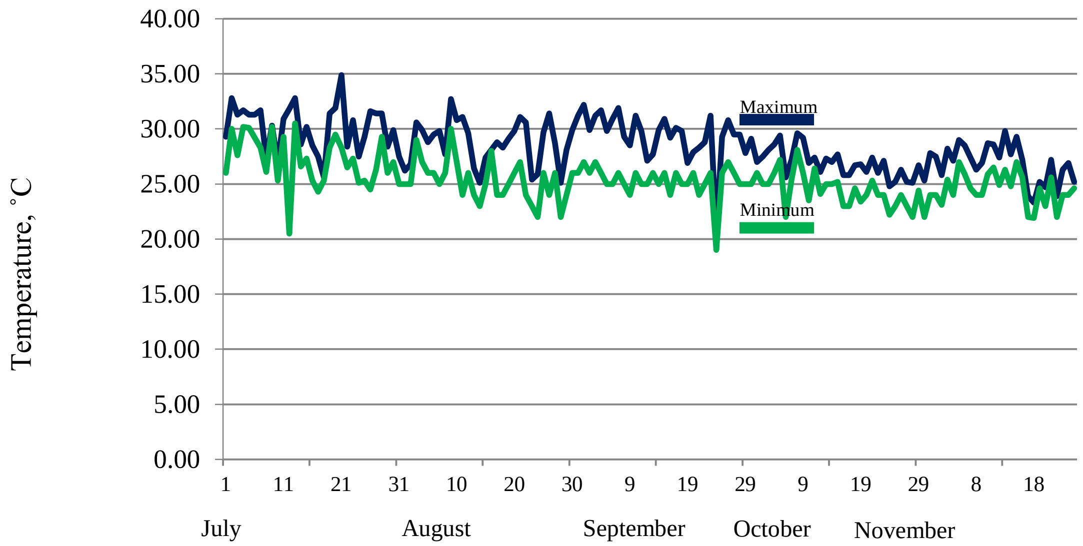

Figure 3. Maximum and minimum temperature during the study period, July to November 2015.

3. RESEARCH DESIGN

The study involved a field experiment covering a land area of 952 m^2.The experiment was laid out in a strip-plot design with three replication. The unit plot size was 2m x 3m spaced 0.5m apart and 1.0m between blocks.

Variables of the Study

The variables of the study were inbred varieties and nutrient management. Variety as assigned as the vertical factor while nutrient management was assigned as the horizontal factor. Following were the details of the experimental variables;

Nutrient Management (vertical factor)

T_1–Soil Analysis

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T_2– MOET + LCC

T_3–Nutrient Manager

T_4–Farmer's Practice

B. Varieties (horizontal factor)

V_1 - NSIC 216

V_2 - NSIC 222

V_3 - NSIC 224

V_4 - NSIC 226

V_5- NSIC 238

V_6-NSIC240

V_7- PSB Rc 82 (check variety)

Procedures of the Nutrient Management

Used in the Study

The different nutrient management options were conducted before the start of the study as basis for the application of fertilizer to the different treatment plants.

Soil Analysis

Composite soil samples were collected randomly from the experimental area, air dried for one week, finely pulverized then placed in properly labeled plastic bags. These samples were analyzed at the Regional Soils Laboratory in Tuguegarao City, Cagayan for organic matter, soil pH, Nitrogen (N), phosphorous (P), and potassium (K) content.

Table 1. Analysis of soil sample from the experimental site (.52ha)

	NUTRIENT REQUIREMENT		
CROP VARIETY/AGE	**NITROGEN**	**PHOSPHOROUS**	**POTASSIUM**
Hybrid Rice - wet	100	60	65
Hybrid Rice - dry	120	60	45
Inbred Rice - wet	80	60	45
Inbred Rice - dry	100	60	45

Source: Regional Soils Laboratory, Tuguegarao City

Fertilizer Recommendation

Inbred Rice **<u>80 – 60 – 45</u>**

Basal Application. 3.2 bags/ha 14-14 -14, 2.2 bags/ha 16-20- 0, 1.7 bags/ha

0-18-0 and 10 bags/ha organic fertilizer

Topdress 1.7 bags/ha 46-0-0

0.75 bags/ha 0-0-60 at panicle initiation

Minus One Element Technique and Leaf

Color Chart (MOET + LCC)

This was procured from PhilRice Batac, Ilocos Norte before the conduct of the study. Collection of soil samples (35 kgs) was conducted, pulverized and properly mixed. Four kg of wet soil were placed into each black plastic pot mixed with the fertilizer formulations separately with the soil in each pot. These were labeled with the corresponding formulations applied in each pot as Complete, -N, -P, -k, -Zn, -S, and - Cu. Six (6) pre- germinated seeds were sown in each pot while the soil was kept wet but without standing water until the plants are well established. When the plants need water, they were supplied using irrigation water from the field. After 10 days, only the two best growing plants per pot were retained ensuring that the pots are watered and leave with atleast 2cm deep standing water up to 45 DAT. Starting on the 14th DAT, observation was done to the growth of the rice plants. At 30 DAT, nutrient deficiencies were already apparent, thus amendment measures were made.

The result of the observations made was as follows: Complete has 53 tillers, Nitrogen (N) 12, Phosphorus (P) 11, Potassium (K) 47, Zinc (Zn) 65, Sulfur (S) 10, Copper (Cu) 46 plants respectively. With this, recommendation was made based on the elements which do not meet atleast 80% of the plants in the pot compared with complete fertilizer. Hence, elements lacking were N, P and S.

Table 2. Recommendation Per Hectare (For target yields of 5 tons for dry season and 4 tons for wet season).

Deficiency	10 days after transplanting (DAT) for 21 – day old seedlings	TIMING OF FERTILIZER APPLICATION			
		Mid- tillering Stage		Panicle Initiation Stage	
		Dry season	Wet season	Dry season	Wet season
	14 DAT for dapog Seedlings or 20 DAT for direct Seeded				
N,P and S	*2 bags of ammophos And 0.5 bag ammonium sulfate*	*2.5bagsurea*	*1.5 bags urea*		

Source: Minus One Element Technique Kit

LCC was used at 14 DAT, 10 healthy plants were randomly selected in the field where plant distribution was uniform. With the use of LCC, compare the topmost, fully expanded and healthy leaf each of the 10 plants by placing the middle part on top of the LCC's color strips for comparison making sure that the leaf will not detach. Readings were taken at the same time of the day (8 – 10am) by same person from the first up to the last reading. If six or more of the 10 leaves have readings below the critical value of four (4), apply 23 kg N/ha; 1 bags of urea (46 – 0-0) or 2 bags of ammonium sulfate (21 -0-0 – 25S) per hectare during wet season.

The study has 6 readings from 14 DAT to 19 DAT where it was on the 3rd and 5th week reading where the plants lack nitrogen as indicated on the reading so application of 30g/plot urea was made.

Nutrient Manager

With the use of this web- based decision tool, fertilizer guidelines to the rice variety and growing conditions was quickly generated after answering the required few key questions.

Table 3. Recommended rate per hectare based on nutrient manager.

GROWTH STAGE	DAT	CURRENT YIELD (60 sacks at 50 kg/sack 3/ha-1 (14% MC)
Early	0 -10	14 – 14 – 14: 1 3/4 bags
Active tillering	20 -24	Urea: 27 kg
Panicle initiation	27 - 31	Urea: 1 bag

Source: Nutrient Manager for Rice Philippines version 2.

Farmers' Practice

This refers to the current rate of farmers experienced in fertilization of the farm.

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Table 4. Rate of application for farmers' practice in hectare basis

METHOD AND TIME OF APPLICATION	RATE (ha^{-1}) (bags)	FERTILIZER MATERIAL
7 DAT	1.43	Complete fertilizer
	1.52	Urea
Topdress at 21 DAT	1.43	Complete fertilizer
	1.52	Urea
	3.33	Muriate of potash

Cultural Management Practices

Seedling Production

Seeds were procured at PhilRice Batac and at the Department of Agriculture Northern Cagayan Experiment Station, Abulug, Cagayan. Two kilograms seeds per variety were soaked for 24 hours and sown in separate seedbed by variety to avoid mixture. The seedbed was constructed using 1m x 1m for 100 grams seeds. Carbonized rice hull was applied as basal at the rate of 1kg per m2 to facilitate pulling of seedlings and control Golden Apple Snail and bird infestation.

Land Preparation

The soil in the experimental area was puddled thoroughly. Prior to transplanting a 15 cm water depth was maintained to keep the soil soft and ensure faster weed decomposition. Leveling was done to ensure even distribution of water. Dikes and ditches between treatment plots were constructed to prevent treatment contamination between and among plots.

Pulling of Seedling and Transplanting

The seedlings were pulled 21 days after sowing. Transplanting was done immediately with two seedlings per hill at a distance of 20 cm x 20 cm following straight row planting.

Irrigation

Rice requires adequate water to grow and develop at its maximum potential yield. A water depth of 3-5 cm was maintained up to maximum flowering. From time to time, the bunds were repaired to avoid seepage. The treatment plants were drained two weeks before harvest.

Fertilizer Application

The table shows the method, time and rate of fertilizer application based from the different nutrient management options.

Table 5. Method and time of fertilizer application and the rate and type of fertilizer materials Used.

NUTRIENT MANAGEMENT	METHOD AND TIME OF APPLICATION	RATE $PLOT^{-1}$ (g)	FERTILIZER MATERIAL
Soil analysis	basal application	96.00	Complete fertilizer
		66.00	Ammophos
		51.00	Solophos
		300.00	Vermicompost
	Top dress at maximum tillering	51.00	Urea
	Panicle initiation	22.50	Muriate of potash
MOET+LCC	10 DAT	30.00	Urea
		60.00	Ammophos
		.30	Ammonium sulfate
		15.00	Zinc sulfate
	Panicle initiation	30.00	Urea
	Booting stage	30.00	Urea
Nutrient Manager	5 DAT	100.96	Complete fertilizer
	Active tillering	5.19	Urea

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	Top dress PI	57.69	Urea
Farmer's Practice	7 DAT	42.86	Complete
		45.65	Urea
	Topdress at 21 DAT	42.86	Complete
		45.65	Urea
		10.00	Muriate of Potash

DAT – days after transplanting
PI – panicle initiation
Plot size – 6m^2

Crop Protection

Close monitoring was done to the crops. Occurrence of insect pest and diseases was observed and recorded during the experimental period. Rice blast and bacterial leaf blight occurred at flowering stage but was controlled using the chemical pesticides following the dosage of the manufacturer's recommendation. Hand weeding was employed when weeds occurred in the area.

Harvesting

Harvesting was done when 80 to 85 percent of the grains have turned golden yellow which was approximately ninety six days after transplanting. Harvested grains were dried, cleaned and weighed separately.

Data-Gathering Procedures

Plant Vigor

This was done 21 DAT using the vigor rating scale from the IRRI's Standard evaluation System (SES) for Rice [11]. A rating scale of 1 (extra vigorous) if very fast growing or plants at 5 leaf stage, have 2 or more tillers in majority of population; 3 (vigorous) if fast growing: plants at 4-5 leaf stage have 1-2 tillers in majority of population; 5 (normal)if plants at 4 leaf stage; 7 (weak) if plants are somewhat stunted: 3-4 leaves: thin population or no tiller formation; 9 (very weak) if the plants have stunted growth or yellowing of leaves to 10 randomly selected sample hills per plot.

Table 6. The rating scale for the plant vigor.

SCALE	LIMITS	DESCRIPTION
1	1.00 – 2.59	Extra vigorous
3	2.60 – 4.19	Vigorous
5	4.20 – 5.79	Normal
7	5.80 – 7.39	Weak
9	7.40 – 9.00	Very weak

Growth Performance

Plant Height. Plant height was recorded from 10 randomly selected sample plants per plot.It was measured from the ground level up to the tip of the longest leaf at 30, 60 DAT and at maturity or before harvest.

Growth Duration. The number of days to heading was recorded when 50 percent of the plant population in each treatment plot has fully exerted panicles while the number of days to maturity was recorded when 80 to 85 percent of the grains in the panicle were fully matured or have turned yellow. Counting the days started from the day of sowing.

Yield Performance

Tiller count. Total number of tillers was counted from the 10 sample plants. Productive tillers were taken by counting all panicle – bearing tillers while percentage while tillers with panicles bearing five seeds or less were considered as unproductive tillers.

Panicle length. The length of the panicle was determined by measuring the linear distance from the base of the node of the panicle to its tip using 10 randomly selected panicles per plot.

Filled and unfilled grains. The 10 sample panicles were threshed after measuring their length. The grains were sorted and counted into filled and unfilled grains. The value was expressed in percentage as follows.

% filled grains = $\frac{\text{total number of filled grains}}{\text{Total number of grains}} x\ 100$

% unfilled grains= $\frac{\text{total number of unfilled spikelets}}{\text{Total number of spikelets}} x\ 100$

Seed size (based on 1000 seeds). After harvesting, the weight of 1000 seeds in grams was determined by taking sample seeds from each experimental plot. Before measuring, the moisture content (MC) of the seeds was measured to 14%.

Grain yield per hectare. The grain yield per hectare was taken and computed from the data on yield per plot using the formula:

Yield per hectare (kg/ha) = $\frac{\text{10000m2/ha x yield/harvested area (m2)}}{\text{1000kg/ton x harvested area (m2)}} x \frac{100-MC}{86}$

Harvest index. HI refers to the fraction of economically useful products of plant in relation to its total biomass produced. This was taken and computed using the formula:

HI = $\frac{Ey}{By + Ey}$

Where:

HI – Harvest index

Ey – Economic yield

By – Biological yield

Production analysis

The cost of production during the conduct of the study were promptly recorded. Inputs and outputs were based on the current market price. Gross income and net income (per hectare, per day and per peso) invested were calculated using the formula:

Gross income = Yield (kg/ha)(price/kilo)

Net income = Gross income – total expenses

Return above variable cost (RAVC) = Net income (Php)/ total expenses (PhP)

Production Cost kg $^{-1}$ grains = cost of production/ yield

Data Analysis

Primary data, which were gathered from the experiment, were used as the main basis of the analysis and recommendation. The data gathered were summarized and analyzed statistically using the Analysis of Variance (ANOVA) for Strip- Plot design. Comparison of treatment mean was done with the use of Least Significant difference (LSD) test. The statistical analysis was done using R – CropStat program.

4. RESULTS AND DISCUSSION

Agronomic Characteristics

Plant Vigor

Table 7 shows the vigor rating of the inbred lowland rice varieties at 21 DAT as affected by nutrient management. Both variety and nutrient management did not affect plant vigor. Results revealed that means of the nutrient management used ranges from 3.22 to 4.17 or vigorous.

As to varieties, all the inbred lowland rice varieties got a mean range of 3.63 to 4.23 or normal.

No significant interaction effect was observed between nutrient management options and rice varieties on the plant vigor.

Days to heading and days to maturity

Nutrient management and varieties showed significant effects on the number of days to heading and maturity (Table 7). In general, the number of days to heading and to maturity was significantly higher in plants under soil analysis based nutrient management.

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Among varieties in terms on days to heading and to maturity, NSIC Rc 222 and NSIC Rc 226 were the first to reached heading time and maturity.

The result confirms that the varieties were mid maturing for they matured in 115 - 120 days (Rice production, 1993).

However, no significant interaction effect between new released inbred rice varieties and nutrient management options was observed on the days to heading and to maturity.

Table 7. Plant vigor, days to heading and days to maturity of inbred lowland rice varieties under varying nutrient management in irrigated lowland ecosystem,

REATMENT	PLANT VIGOR	DAYS TO HEADING	DAYS TO MATURITY
Nutrient Management (A)	ns	*	**
Soil Analysis	4.17	65 [b]	95[c]
MOET + LCC	3.92	66 [ab]	96 [b]
Nutrient Manager	3.71	67 [a]	97[a]
Farmers Practice	3.22	66 [ab]	97[a]
Variety (B)	ns	**	**
NSIC Rc 216	3.80	66 [ab]	96 [ab]
NSIC Rc 222	4.23	64 [b]	94 [b]
NSIC Rc 224	4.19	67 [ab]	97 [ab]
NSIC Rc 226	3.70	64 [b]	95[b]
NSIC Rc 238	3.98	66 [ab]	96[ab]
NSIC Rc 240	3.76	69 [a]	99[a]
PSB Rc 82	3.63	66 [ab]	96[ab]
A X B	ns	Ns	ns
CVa (%)	19.90	1.84	1.08
CVb (%)	2.98	3.00	2.39
CVc (%)	9.45	1.57	0.93

CV – Coefficient of variation
** - significant at 1% level
* - significant at 5% level
ns - not significant
DAT – Days after transplanting
Within each group in a column means marked with a common letter do not differ using LSD.

Table 8. Plant vigor rating.

SCALE	LIMITS	DESCRIPTION
1	1.00 – 2.59	Extra vigorous
3	2.60 – 4.19	Vigorous
5	4.20 – 5.79	Normal
7	5.80 – 7.39	Weak
9	7.40 – 9.00	Very weak

Plant Height

Significant differences were observed on plant height at 30 DAT, and at maturity but no significant differences were observed at 60 DAT. Plants under nutrient manager were taller at 30 DAT while MOET+LCC recommendation at 60 DAT and at maturity. Plants applied based on farmers practice were also noted as the shortest in all observations.

Varieties were also differed significantly in all observations. Tallest variety was observed in NSIC Rc 224 in 30 and 60 DAT but not at maturity where NSIC Rc 238 and NSIC Rc 240 were noted to be the tallest. Varieties tested belonged to semi – dwarf for their height were less than 110 cm [13].

However no significant interaction effect between nutrient management options and inbred lowland rice varieties on the plant height in all observation.

Table 9. Plant height of the plants during 30 DAP, 60 DAT and at maturity in cm of inbred lowland rice varieties under varying nutrient management in irrigated lowland ecosystem.

TREATMENT	OBSERVATION PERIOD		
	30 DAT	**60 DAT**	**MATURITY**
Nutrient Management (A)	*	Ns	**
Soil Analysis	69.00[b]	84.00	104.00[bc]
MOET + LCC	69.00[ab]	87.00	107.00[a]
Nutrient Manager	72.00 [a]	82.00	105.00[b]
Farmers Practice	67.03[b]	80.56	102.00[c]
Variety (B)	**	**	**
NSIC Rc 216	70.00[ab]	83.00 [b]	97.00[b]
NSIC Rc 222	68.00 [cd]	84.00 [b]	98.00[b]
NSIC Rc 224	72.00 [a]	89.00 [a]	107.00 [a]
NSIC Rc 226	67.00 [d]	87.00 [a]	107.00 [a]
NSIC Rc 238	69.00 [bcd]	79.00 [cd]	108.00 [a]
NSIC Rc 240	70.00 [bc]	82.00 [bc]	108.00 [a]
PSB Rc 82	68.00 [bcd]	79.00 [d]	106.00 [a]
A X B	Ns	ns	ns
CVa (%)	5.10	2.23	2.76
CVb (%)	1.99	2.35	2.43
CVc (%)	2.81	2.96	2.35

CV – Coefficient of variation
** - significant at 1% level
*- significant at 5% level
ns - not significant
DAT – Days after transplanting

Within each group in a column means marked with a common letter do not differ using LSD.

Tillers

Table 10 shows the total tillers, percentage productive and unproductive tillers. No significant difference was noted on the nutrient management options used but there exist difference on the varieties tested on total tillers. Significant difference was noted on percentage productive and unproductive tillers. However, no significant difference on total tillers while significant differences on percent productive and unproductive tillers. No interaction effect was also noted. As to result, the varieties tested were medium tillering ability which ranges from 10 – 19 tillers per plant [12].

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Table 10. Total tiller, percentage of productive and unproductive tiller of inbred lowland rice varieties under varying nutrient management in irrigate lowland ecosystem.

TREATMENT	TOTAL TILLERS	PRODUCTIVE (%)	UNPRODUCTIVE (%)
Nutrient Management (A)	ns	*	*
Soil Analysis	15.74	75.70[b]	24.30[a]
MOET + LCC	16.76	79.41[a]	20.59[b]
Nutrient Manager	16.46	74.45[b]	25.55[a]
Farmers Practice	16.25	74.74[b]	25.26[a]
Variety (B)	*	ns	ns
NSIC Rc 216	16.90[a]	72.30	27.70
NSIC Rc 222	17.87[a]	75.92	24.08
NSIC Rc 224	15.06[a]	77.52	22.48
NSIC Rc 226	15.51[a]	76.62	23.38
NSIC Rc 238	17.73[a]	75.95	24.05
NSIC Rc 240	14.40[a]	76.25	23.75
PSB Rc 82	16.64[a]	77.97	22.03
A X B	ns	ns	ns
CVa (%)	6.14	5.40	17.16
CVb (%)	15.09	9.83	31.26
CVc (%)	12.29	6.81	21.66

CV – Coefficient of variation
** - significant at 1% level
*- significant at 5% level
ns - not significant

Within each group in a column means marked with a common letter do not differ using LSD.

Panicle Length

The length of panicles were significantly affected by nutrient management (Table 11). Comparative means were observed on the nutrient management options used.

Likewise, significant differences were noted on varieties where both NSIC Rc 216 and NSIC Rc 224 producing the longest panicle length of 23.05 and 23.93 cm respectively. Other varieties did not differ from each other with panicle length varying from 21.14 to 21.51 cm.

In contrast, panicle length was not affected by variety and nutrient management.

Filled Grains

Significant results were noted on percentage filled grains as affected by different nutrient management options. Highest percentage filled grains was observed on nutrient manager while the least was noted from MOET+LCC.

Significant differences among varieties tested were also noted. NSIC Rc 216 produced the highest percentage of filled grains (73.43%) while NSIC Rc 224 produced the lowest percentage of filled grains (57.77%).

Meanwhile, significant interaction effects were observed on percentage filled grains as affected by the variety and different nutrient management used. In general, all varieties applied with fertilizers based on recommendation in soil analysis and MOET + LCC produced the most number of filled grains.

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Unfilled Grains

Significant difference was observed on nutrient management options. MOET + LCC noted the highest percentage unfilled grains while nutrient manager have the lowest percentage of unfilled grains.

Similarly, significant differences were observed on percentage unfilled grains among the varieties. NSIC Rc 224 gained the highest percentage of unfilled grains while NSIC Rc 216 gained the lowest unfilled grains.

Additionally, significant interaction effects were observed on percentage unfilled grains as affected by the variety and different nutrient management used. In general all varieties applied with fertilizers based on recommendation in nutrient manager and farmers practice produced the most number of unfilled grains

Table 11. Panicle length, percent filled and unfilled grains of inbred lowland rice varieties under varying nutrient management in irrigated lowland ecosystem.

TREATMENT	PANICLE LENGTH (cm)	FILLED (%)	UNFILLED (%)
Nutrient Management (A)	**	**	**
Soil Analysis	21.90[b]	60.17[c]	39.83[b]
MOET + LCC	22.54[a]	58.83[d]	41.17[a]
Nutrient Manager	21.45[c]	70.31[a]	29.69[d]
Farmers Practice	21.94[b]	68.36[b]	31.64[c]
Variety (B)	**	**	**
NSIC Rc 216	23.05[a]	73.43[a]	26.57[e]
NSIC Rc 222	21.51[b]	65.01[b]	34.99[d]
NSIC Rc 224	23.93[a]	57.77[e]	42.23[a]
NSIC Rc 226	21.53[b]	66.49[b]	33.51[d]
NSIC Rc 238	21.14[b]	61.43[d]	38.57[b]
NSIC Rc 240	21.20[b]	64.44[b]	36.56[c]
PSB Rc 82	21.32[b]	63.38[c]	36.62[c]
A X B	ns	**	**
CV % (a)	2.56	8.63	16.05
CV % (b)	4.11	5.03	9.11
CV % (c)	3.57	7.23	13.10

CV – Coefficient of variation
** - significant at 1% level
* - significant at 5% level
ns – not significant

Within each group in a column means marked with a common letter do not differ using LSD.

Table 12. Nutrient management x variety interaction effect on percentage filled grains of inbred lowland rice varieties under varying nutrient management in irrigated lowland ecosystem.

NUTRIENT MANAGMENT	V1	V2	V3	V4	V5	V6	V7
SA	63.93 [b]	59.25[b]	54.11 [b]	62.02 [bc]	55.70 [b]	66.65 [a]	60.54 [bc]
M+LCC	75.66 [a]	55.88 [b]	53.10 [b]	57.53 [c]	54.77 [b]	59.66 [a]	55.03 [c]
NM	77.12 [a]	72.14 [a]	70.06 [a]	68.26 [b]	67.06 [a]	65.68 [a]	71.88 [a]
FP	77.01 [a]	72.76 [a]	53.59 [b]	78.14 [a]	68.18 [a]	62.76[a]	65.09 [ab]

In a column, means marked with a common letter do not differ using LSD.

Table 13. Nutrient management x variety interaction effect on percentage unfilled grains of inbred lowland rice varieties under varying nutrient management in irrigated lowland ecosystem.

NUTRIENT MANAGMENT	V1	V2	V3	V4	V5	V6	V7
SA	36.07 a	40.75 a	45.89 a	37.98 ab	44.30 a	34.35 a	40.73 ab
M+LCC	24.34 b	44.12 a	46.69a	42.47 a	45.23 a	40.34 a	44.97 a
NM	22.88 b	27.86 b	29.94b	31.74 b	32.94 b	34.32 a	28.12 c
FP	22.90 b	27.24 b	46.4 a	21.86 c	31.82 b	37.24 a	33.91bc

In a column, means marked with a common letter do not differ using LSD

Seed Size (g/1000)

Result shows no significant differences on the weight of 1000 seeds obtained from each of the inbred lowland rice varieties. Results revealed comparable means among treatments.

On the other hand, significant effect was noted on the different varieties as to seed weight. NSIC Rc 226 noted as heaviest weight. This was due to its attribute of long and intermediate grains.

Meanwhile, there was no interaction effects between varieties and nutrient management used on seed size.

Harvest Index (%)

Harvest index (HI) is the ratio of the economic yield (filled grains) and total above biomass of the plant (straw and grains) on fresh weight basis. It measures how efficient is the crop in partitioning the amount of photosynthesis going to the grains. Result shows no significant variation on the harvest index among nutrient management options. This means that fertilization based on recommendation on the different nutrient management did significantly affect the harvest index ranging from 33.75 to 36.21.

On the other hand, varieties show significant differences. Highest harvest index was observed from NSIC Rc 226 but comparable with all the varieties except NSIC Rc 240 where it had the least harvest index.

In addition, no significant interaction effects were observed between variety and fertilizer recommendation based on different nutrient management.

Grain Yield

Table 14 shows no significant difference was observed on the rice varieties as influenced by different nutrient management. But numerically MOET + LCC obtained the highest grain yield of 4.88 t ha^{-1} while farmers practice got the lowest yield of 3.84 t ha^{-1}.

Similarly, no significant differences were noted on the grain yield of seven varieties at 14% moisture content. NSIC Rc 226 numerically gave the highest yield of 5.01 t ha^{-1} , while NSIC Rc 238 obtained the lowest yield of 3.72 t ha^{-1}.The high yield may be attributed to the production of more filled grains and the low yield is partly attributed to its low tillering capacity with more unfilled grains. However results conforms to the study of DA – Philrice, 2011 that NSIC Rc224 (Tubigan 19) and NSIC Rc226 (Tubigan 20) showed better performance than the check varieties, PSB Rc82 and PSB Rc18, during the multi-location adaptation trials. Also, the results conforms with the NCT results of the different varieties as to yield.

Likewise, no interaction effects were observed between varieties and nutrient management options on the grain yield.

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Table 14. Seed size, harvest index and grain yield of inbred lowland rice varieties under varying nutrient management in irrigated lowland ecosystem.

TREATMENT	SEED SIZE (g/1000)	HARVEST INDEX (%)	GRAIN YIELD (t/ha)
Nutrient Management (A)	ns	ns	ns
Soil Analysis	29.49	34.93	3.90
MOET + LCC	29.40	33.75	4.88
Nutrient Manager	29.32	36.21	4.39
Farmers Practice	29.35	34.73	3.84
Variety (B)	**	**	ns
NSIC Rc 216	30.49[b]	34.82 [ab]	4.57
NSIC Rc 222	28.47[d]	34.75 [ab]	4.03
NSIC Rc 224	29.63[c]	36.08 [ab]	4.01
NSIC Rc 226	34.57[a]	43.00 [a]	5.01
NSIC Rc 238	27.67[e]	37.06 [ab]	3.72
NSIC Rc 240	27.54[e]	26.03 [b]	4.47
PSB Rc 82	27.36[e]	32.58 [ab]	3.93
A X B	ns	ns	ns
CVa (%)	0 .83	27.50	17.32
CVb (%)	1.02	13.21	1.78
CVc (%)	0 .76	17.77	9.35

CV – Coefficient of variance
** - significant at 1% level
*- significant at 5% level
ns - not significant

Within each group in a column means marked with a common letter do not differ using LSD.

Production Economics

Table 15 presents the summary of production economics of the inbred lowland rice varieties under nutrient management per hectare basis.

Varieties under MOET+ LCC produced the highest production in terms of tons which ranged from 4.56 to 5.27 t ha^{-1}. Lowest productions were produced from varieties under soil analysis.

As to production cost, gross income, net income and RAVC (%) MOET +LCC topped while varieties under soil analysis ranked last. NSIC Rc 226 outyielded other varieties tested. Production cost grains kg^{-1} was higher in soil analysis. Contributing to this was the higher production cost especially on fertilizer inputs.

Table 15. Production economics of inbred lowland rice varieties under varying nutrient management options in irrigated lowland ecosystem.

VARIETY/ NUTRIENT MANAGEMENT	GRAIN YIELD (tons)	PRODUCTION COST (PhP)	GROSS INCOME (PhP)	NET INCOME (PhP)	RAVC (%)	PRODUCTION COST Kg grain^{-1} (PhP)
NSIC Rc 216						
Soil Analysis	4.17	47,137.00	83,400.00	36,263.00	76.93	11.30
MOET+LCC	5.25	38,075.00	105,000.00	66,925.00	175.77	7.25
Nutrient Manager	4.81	41,119.00	96,400.00	55,281.00	134.40	8.55
Farmer's Practice	4.07	37,641.00	81,400.00	43,759.00	116.25	9.25
NSIC Rc 222						
Soil Analysis	3.70	47,007.00	74,000.00	26,993.00	57.42	12.70
MOET+LCC	4.66	37,932.00	93,200.00	55,268.00	145.70	8.14
Nutrient Manager	4.16	40,950.70	83,200.00	42,249.30	103.07	9.84
Farmer's Practice	3.61	37,524.00	72,200.00	34,676.00	92.41	10.39
NSIC Rc 224						
Soil Analysis	3.42	46,942.00	68,400.00	21,458.00	45.71	13.71
MOET+LCC	4.75	37,945.00	95,000.00	57,005.00	150.36	7.99
Nutrient Manager	3.95	40,885.00	79,000.00	38,114.00	93.22	10.35
Farmer's Practice	3.93	37,602.00	78,600.00	40,998.00	109.03	9.57
NSIC Rc 226						
Soil Analysis	4.61	47,254.00	92,500.00	45,246.00	95.75	10.25
MOET+LCC	5.27	38,088.00	105,400.00	67,312.00	176.73	7.23
Nutrient Manager	5.54	41,301.70	110,000.00	68,692.30	166.32	7.46
Farmer's Practice	4.63	37,778.80	92,600.00	54,821.20	145.11	8.16
NSIC Rc 238						
Soil Analysis	3.32	46,916.00	66,400.00	19,484.00	41.53	14.13
MOET+LCC	4.56	37,906.00	91,200.00	53,294.00	140.60	8.31
Nutrient Manager	3.97	40,898.00	79,400.00	38,502.00	94.14	10.30
Farmer's Practice	3.04	37,368.00	60,800.00	23,432.00	62.71	12.72
NSIC Rc 240						
Soil Analysis	4.32	47,176.00	86,400.00	39,224.00	83.14	10.92
MOET+LCC	4.91	37,997.00	98,200.00	60,203.00	158.44	7.74
Nutrient Manager	4.60	41,054.70	92,000.00	50,945.00	124.09	8.92
Farmer's Practice	4.05	37,628.00	81,000.00	43,372.00	115.27	9.29
PSB Rc 82						
Soil Analysis	3.80	43,533.00	76,000.00	32,467.00	74.58	11.46
MOET+LCC	4.74	37,945.00	94,800.00	56,885.00	149.84	8.00
Nutrient Manager	3.68	40,820.00	73,600.00	32,780.00	80.30	11.09
Farmer's Practice	3.51	37,443.00	70,200.00	32,757.00	87.48	10.67

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The study was conducted at Barangay Tumog, Luna Apayao on wet season from August to November, 2015 to evaluate the inbred lowland rice varieties to different nutrient management options. Specifically, it aimed to a.) compare the growth and yield performance of the different inbred lowland rice varieties under irrigated lowland ecosystem; b.) determine whether the cultivars respond differently to nutrient management options; c.) identify the best nutrient management options that can be used in irrigated lowland; and d.) determine the production economics of the different inbred lowland rice varieties applied with varying nutrient management.

The study was laid out in strip-plot design using three (3) replications. Four (4) nutrient management – soil analysis (SA), Minus One Element Technique and Leaf Color Chart (MOET+LCC), Nutrient Manager (NM) and Farmers Practice (FP) were assigned as vertical factor while seven (7) inbred rice varieties were assigned as horizontal factor. The varieties used were NSIC Rc 216, NSIC Rc 222, NSIC Rc 224, NSIC Rc 226, NSIC Rc 238, NSIC Rc 240 and PSB Rc 82 as check variety.

On plant vigor, plants under nutrient management have a mean ranging from 3.22 to 4.17 or vigorous while the inbred lowland rice varieties got a mean of 3.63 to 4.23 or normal.

Significant differences were observed on the days to heading and days to maturity both nutrient management and varieties. However, no interaction effects were observed between nutrient management and varieties on days to heading and days to maturity.

On the plant height, both nutrient management and varieties significantly differed at 30 DAT and at maturity. Plants under nutrient manager were taller at 30DAT while plants on MOET+LCC at 60 DAT and maturity.

Varieties were also differed significantly in all observations. Tallest variety was observed in NSIC Rc 224 in 30 and 60 DAT but not at maturity where NSIC Rc 240 was noted the tallest. However, all varieties tested belonged to semi – dwarf plant having a height of less than 110 cm.

No significant difference was observed on total tillers on the nutrient management options but significant effect was noted on percentage productive and unproductive tillers . On total tillers varieties showed significant effect while percentage productive and unproductive did not differ among varieties.

Significant differences were observed on the length of panicle, percentage filled and unfilled as affected by nutrient management and inbred lowland rice varieties. Likewise, there were significant interaction effects observed between nutrient management and varieties on both percentage filled and unfilled grains.

Seed size based on 1000 grains did not significantly vary in terms of nutrient management. Nevertheless, significant difference was observed among varieties tested.

Grain yield was not significantly affected by nutrient management. Numerically, however, plants applied from recommendation based on MOET + LCC obtained the highest yield. Similarly, no significant difference noted on the grain yield of seven varieties at 14% moisture content where NSIC Rc 226 numerically gave the highest yield.

In terms of economics, varieties under MOET+ LCC produced the highest production, gross income, net income and RAVC (%). However, SA has the highest production cost grain kg^{-1}. Among the varieties tested NSIC Rc 226 outweighed other varieties.

Conclusion

Based on the results of the study, inbred lowland rice varieties are suited and adapted in the locality, specifically, NSIC Rc 226 for it outweighed other varieties in terms of yield, gross income, net income and RAVC. In general varieties performed better on MOET+LCC.

Recommendations

Site-specific nutrient management provides scientific principles for optimally supplying rice with essential nutrients. It enables rice farmers to tailor nutrient management to the specific conditions of their field, and it provides a framework for nutrient best management practices.

The following recommendations are forwarded based on the conclusion and their implications.

1. To ensure at least an optimum rice yield, Soil analysis and nutrient manager can be used. However, MOET+LCC is recommended to attain maximum yield.
2. NSIC Rc 226 under MOET+LCC is highly recommended for it give the highest production, gross income, net income and RAVC.

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