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Enhancing productivity and profitability of rainfed rice production areas through adoption of improved rice ratooning technology

Gajete, T. D. [1,*], Legaspi, T. D. [2], Abesamis, E. P. [3], Marquez, N. N. [4], Cabute, Z. C. [5], Padilla, J. N. [1] and Aquino, F. B. [1]

[1]Research Office, Central Luzon State University, Science City of Muñoz, Philippines; [2]Department of Agriculture-Local Government Unit (DA-LGU) Science City of Muñoz, Philippines; [3]DA-LGU Guimba; [4]DA-LGU Lupao; and [5]DA-LGU Talugtug, Nueva Ecija, Philippines.

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Abstract The technology was piloted in the Science City of Muñoz and in Guimba, Lupao and Talugtug, Nueva Ecija, with 84 farmer cooperators trained on the improved rice ratooning. Four farmers' field days were attended by 319 participants. Five inbred and three hybrid rice varieties were ratooned. The 47 farmers ratooned NSIC Rc-222 and 20 farmers used NSIC Rc-216, seven farmers for SL-9H, four farmers for NSIC Rc-308, three farmers for NSIC Rc-10 and one farmer each for NSIC Rc-396, SL-8H and IL-29. In Science City of Muñoz, NSIC Rc-216 produced the highest yield of ratoon rice with a mean of 950 kg/ha and 820 kg/ha in Guimba followed by 660 kg/ha in Lupao and 500 kg/ha in Talugtug. For NSIC Rc-222, the highest yield was recorded in Lupao with 517 kg/ha and in Science City of Muñoz with 438 kg/ha then in Guimba with 407 kg/ha and the lowest in Talugtug with 405 kg/ha. The highest yield of NSIC Rc-308 with a mean of 783 kg/ha was recorded in Lupao followed by 352 kg/ha in Science City of Muñoz. In Guimba, NSIC Rc-396 has a mean yield of 800 kg/ha and in Talugtug NSIC Rc-10 yielded 435 kg/ha. Hybrid rice SL-8H and SL-9H of Science City of Muñoz which were ratooned for the first time produced a mean yield of 230 kg/ha and 238 kg/ha respectively. In Lupao, IL-29 yielded 632 kg/ha. In all the pilot sites, the NSIC Rc-216 with an average yield of 950 kg/ha obtained a gross income of Php 16,910.00 at a price of Php 17.80 per kg. The total expenses in ratooning was Php 8,112.00/ha. The value cost ratio was 1.92. The breakeven yield of 494.97 kg/ha is an implication that rice ratooning is profitable.

Keywords: food security, rice suficiency, rainfed, rice ratooning, productivity, profitability

Introduction

The Department of Agriculture Regional Field Office III (DA-RFO3) Research, Development and Extension (RDE) agenda is focused on attaining rice sufficiency with emphasis on stress environments specifically on rain fed areas to become productive and profitable. To increase food

[*] **Coressponding Author:** Froilan B. Aquino; **Email:**frinzphilipgajete@yahoo.com

production for the rapidly expanding population, intensive and sustainable crop production technologies are deemed necessary.

Rice ratooning is one of the potential and attractive alternative technology in rain fed areas of Central Luzon. It has an economic advantage as an alternate double cropping in monsoon areas to increase rice production.

In traditional rice ratooning, during the main crop, all the cultural management practices namely; land preparation, seedling production, water management, fertilizer application, weed control and crop protection are followed. During harvesting, the usual cutting height is 50-70 cm. In some areas of Cagayan Valley, the rice stubbles are laid down by passing a hand tractor with a paddy wheel or carabao drawn log or metal. This allows harvesting of ratoon rice in 80-90 days. For fertilizer application, one (1) bag urea per hectare are applied at two weeks after harvesting. This is the usual rate recommended earlier by some researchers but there were only few takers and were not sustained. In some cases, the ratoon rice was left unattended without the removal of weeds and spraying of insecticides, fungicides and without fertilizers and usually yield 10 cavans per hectare.

However, in improved rice ratooning technology, rice ratoon matures in 60-70 days and produce yield of 4.5 tons using hybrid and 3.8 tons for inbred rice varieties when cut at 30 cm above the ground and fertilized with 120-30-30 kg/ha NPK for hybrids and 90-30-30 kg/ha NPK for inbred respectively (Junejo, 2011).

Ratooning can be practiced as an alternative to double cropping in areas with a limited available soil moisture after the main crop. When given appropriate nutrition and protection, the mother crop will develop new shoots (ratoon) with characteristics almost equal to its original form and ratoon rice yield in this management will increase significantly. This improved rice ratooning technology must be tested using a medium input in production to increase the local production of rice and to help sustain rice sufficiency in the country.

The project was aimed to determine the productivity and profitability in adopting the improved rice ratooning technology in rainfed areas in Nueva Ecija. The specific objectives were to conduct awareness seminar on improved rice ratooning technology for farmer participants in four (4) municipalities of Nueva Ecija, to pilot test the improved rice ratooning technology in four city/municipalities in Nueva Ecija with 20 farmer participants per city/municipality with an area ranging from 0.25 to 0.50 hectare per farmer, to gather yield data in each farmers' field for determining the profitability of adopting the improved technology under rainfed condition, to conduct farmers field day prior to harvesting to show the improved rice ratooning technology to interested adopters, and to increase of ratoon rice yield from 500 kilograms to 2,000 kilograms per hectare.

Materials and Methods

Project Management and Selection of Areas as Pilot Site

The pilot project was implemented in four municipalities of Nueva Ecija with approximately 20 km radius from CLSU. The selection of sites on rainfed areas was coordinated with the Department of Agriculture-Local Government Unit (DA-LGU) of each selected city/municipality. Meetings were held in the identified barangays followed by appraisal of the areas and discussion of the role of farmers and the role of implementing agencies. Regular monitoring of the field activities of farmers in each pilot sites to ensure that the target outputs are met.

Selection of Cooperators

The farmers were selected based on the following criteria:

a. Willing to adopt the technology and do record keeping.
b. Has planted hybrid rice varieties and inbred varieties (NSIC Rc-216, NSIC Rc-160) and other good ratooning varieties as main crop.
c. Willing to pay their traveling expenses to and from seminars, training and field day.
d. Willing and capable to cooperate with the implementing agencies (DA-RFO3 and CLSU).
e. Willing to protect his farm from stray animals.
f. Willing to share information about improved rice ratooning technology to other farmers.
g. With good credit standing and of good moral character.
h. Field is near the service road.
i. He owns the land.

A. Training, Applied Communication and Extension

a. Held farmers on-site training on the recommended package of improved rice ratooning technology including project orientation and implementation strategies.
b. Introduced improved rice ratooning technology for possible farmer adopters.
c. Held farmers field day for each barangay covered by the project.
d. Established tie-ups with concerned government / private agencies.
e. Production of Information, Education& Communication (IEC) materials.

B. Input Assistance and Marketing

All farmer cooperators were given free farm inputs (fertilizers and pesticides) as incentives in participating on the project. Quantity of inputs were based on the variety and size of the area used for ratooning. The Central Luzon State University-Research, Extension and Training (CLSU-RET) assisted in the marketing of the ratoon rice produced by the cooperator farmer.

Results

Project Implementation

Selected Barangays in Four Municipalities of Nueva Ecija

Table 1. Agricultural land area of each barangay of the four selected pilot sites in Nueva Ecija

Pilot Sites (City/Municipality and Barangay)	Agricultural Farm (Ha)		Total Agricultural Farm (Ha)
	Irrigated	Rainfed	
SC Muñoz			
Mapangpang	100.00	75.00	175.00
Guimba			
Guiset	138.15	133.40	271.55
Lupao			
San Roque	85.00	230.00	315.00
Salvacion	113.00	302.00	415.00
Talugtug			
Alula	108.00	230.00	338.00
Sampaloc	52.00	244.00	296.00
Sto. Domingo	80.00	319.00	399.00

Source: Office of the municipal agriculturist.

Selected Farmer Cooperators

There were 84 farmer cooperators selected in of our pilot sites with a minimum area of 0.25 to 0.50 ha each for piloting the technology. All of them were tilling rice in rainfed areas that were near or beside the service roads for convenience during field visits and they planted inbred and hybrid varieties from June to July, 2017 to take advantage of the early rain for their crop.

Orientation and Training of Farmer Cooperators

Prior to the implementation of the pilot project, orientation and training seminar was held for 42 farmer participants to inform them on the improved rice ratooning technology. The farmers were given handout of the technology and the calendar of activities.

Pilot Testing of the Rice Ratooning Technology

Rice Varieties Used by farmers in the Improved Rice Ratooning Technology

Table 2. Rice varieties used in the improved rice ratooning technology

Variety	Number of farmers that used rice varieties in four pilot sites				
	Guimba	**Lupao**	**SC Muñoz**	**Talugtug**	**Total**
NSIC Rc-216	7	5	7	1	20
NSIC Rc-222	14	11	6	16	47
NSIC Rc-308		3	1		4
NSIC Rc-396	1				1
NSIC Rc-10				3	3
SL-8H			1		1
SL-9H			7		7
IL-29		1			1
Total	**22**	**20**	**22**	**20**	**84**

Cultural Management of the Piloted Ratoon Rice

A. Main Crop

Cultural Practices:

Land Preparation= Thorough land preparation.

Seedling production=Twenty (20) days' old seedlings.

Transplanting= Distance of 20 X 20 cm.

Irrigation= Rainfed

Fertilizer Applied:

For hybrid=120-30-30 kg N-P-K/ha) applied at 15, 30 and 45 DAT with basal rate of 60-30-30 kg N-P-K/ha, 2nd application with 30-0-0 and 3rd application with 30-0-0 kg N-P-K/ha.

For inbred= 90-30-30 kg N-P-K/ha applied at 15, 30 and 45 DAT with basal rate of 30-30-30 kg N-P-K/ha, 2nd application with 30-0-0 and 3rd application with 30-0-0 kg N-P-K/ha.

Weed Control= Pre-emergence herbicide applied at 2 to 3 DAT.

Crop Protection=Recommended insecticides and fungicides were applied as the need arises.

Harvesting= The rice crop was harvested at 85% maturity and cut at a height of 30cm from the base of the plant. The height of cutting was adjusted by the reaper operator. Manual harvesting and mechanical harvesting were done.

B. Ratoon Rice

Start of ratooning: September to October

Cultural Practices:

Fertilizer Requirements:

Hybrid variety=120-30-30 kg N-P-K/ha applied in split at 1 week after harvesting of the main crop with the rate of 60-30-30 kg N-P-K/ha and with 60-0-0 kg N-P-K/ha at 2nd week after harvesting of the main crop.

Inbred variety= 90-30-30 kg N-P-K/ha applied split at 1 week after harvesting of the main crop with the rate of 45-30-30 kg N-P-K/ha and with 45-30-30 kg N-P-K/ha at 2nd week after harvesting of the main crop.

Foliar Fertilizer Sprayed

Hybrid and Inbred varieties= sprayed on the 3rd week after harvesting of the main crop and at weekly interval at a rate of 1 kilogram per hectare.

Irrigation Management= The ratoon rice depended on available soil moisture, rain and dew.

Weed Control= Manual weeding was done.

Crop Protection= Sprayed insecticide for control of rice bugs and rice black bugs.

Harvesting= The ratoon crops were harvested at 85% maturity using manual and mechanical harvester.

Farmers Field Day

The purpose of this activity is to showcase the new practices in rice ratooning technology. On the field day, the ratoon rice is ready for harvest to show the stand of the crop for the participants to evaluate the adaptability, productivity and profitability of ratoon rice in rainfed condition. This was conducted in one city and three municipalities of Nueva Ecija and attended by the Local Government Unit of the Department of Agriculture, Municipal Agriculturist, farmer cooperators, farmers in neighboring barangay, mentors, students and some from the community. The farmers' efforts in piloting the technology was also fully recognized by the project management.

Yield Performance of Rice Ratoon using the Improved Technology

Table 3. Mean yield of ratoon inbred and hybrid rice in four pilot sites

Computed Yield (Kilograms/Hectare) of Ratoon Inbred and Hybrid Rice Varieties								
	Inbred				Hybrid			
Pilot Sites	**NSIC Rc-216**	**NSIC Rc-222**	**NSIC Rc-308**	**NSIC Rc-396**	**NSIC Rc-10**	**SL-8H**	**SL-9H**	**IL-29**
SC Muñoz	950 (n=7)	438 (n=6)	352 (n=1)	-	-	230 (n=1)	238 (n=7)	-
Guimba	820 (n=7)	407 (n=14)	-	800 (n=1)	-	-	-	-
Lupao	660 (n=5)	517 (n=11)	783 (n=3)	-	-	-	-	632 (n=1)
Talugtug	500 (n=1)	405 (n=16)	-	-	435 (n=3)	-	-	-

n =number of farmers who planted the variety

\- =no farmer cooperators who planted the variety.

Pest Management

Table 4. Pests and diseases of the ratoon rice in all pilot sites of Nueva Ecija (September to November 2017)

Pests	Number of farm sites where pest and diseases observed				
	Guimba	Lupao	SC Muñoz	Talugtug	Total
Rice Black Bug	8	2		4	14
Green Leafhopper	1				1
Rice Bug		7		3	10
Stem Borer	4		3	5	12
Rat	1				1
Tungro				2	2

Cost and Return Analysis

Table 5. Cost and return analysis of a one-hectare farm by adopting rice ratooning technology using NSIC Rc-216

ITEM	QTY	UNIT	UNIT PRICE (Php)	AMOUNT (Php)
I. SALES (GROSS INCOME)				
Production / Yield	950	Kg	17.80	16,910.00
II. EXPENSES				
a. Labor	6	MD	250.00	1,500.00
Total Labor Expenses				**1,500.00**
b. Material inputs				
1. Fertilizer				
Complete	4	Bag	980.00	3,920.00
Urea	2	Bag	879.00	1,758.00
Foliar	4	Kg	218.00	872.00
2. Chemicals				
Insecticide	2	Bottle	374.00	748.00
Total Material Expenses				**7,298.00**
III. TOTAL EXPENSES				8,798.00
IV. NET INCOME				8,112.00
V. Value cost ratio				1.92
VI. Return to Total Expenses (%)				92.20
VII. Average Cost of Production				0.52
VIII. Bre ak Even Yield (Kg)				494.27

Agro-Meteorological Information

Table 6. Agro-climatic condition during the pilot testing of rice ratooning technology in four pilot sites of Nueva Ecija from July to December 2017

MONTH	PRECIPITATION (mm)		TEMPERATURE(℃)		RELATIVE HUMIDITY (%)
	Total	Mean	Min	Max	
July	260.9	8.4	24.5	31.8	84
August	323.4	10.4	24.2	32.3	87
September	122.8	4.1	24.0	32.5	85
October	102.8	3.3	23.8	32.3	85
November	191.3	6.4	24.0	32.2	76
December	6.4	0.2	23.6	31.4	71

Source: PAG-ASA Agromet Station, Central Luzon State University, Science City of Muñoz, Nueva Ecija, 2017.

Discussion

Selected Barangays in Four Pilot Sites

The Science City of Muñoz (SC Muñoz), Guimba, Lupao and Talugtug were identified as the pilot sites of the rainfed rice ratooning project in Nueva Ecija. The municipal agriculturists of each town provided the master list of all farmers and their land holdings. In SC Muñoz, Brgy. Mapangpang was selected with a total agricultural area of 175 hectares with 75 ha. rainfed. In Guimba, Brgy. Guiset was also selected with 133.40 ha of rainfed fields and with a total agricultural area of 271.55 ha. In Lupao, two barangays were chosen, Salvacion I with a total agricultural area of 415 and 302 ha of rainfed land and San Roque with 230 ha of rainfed areas and a total agricultural land of 315 ha (Table 1).

In Talugtug, three barangays were chosen; Alula, Sto. Domingo and Sampaloc. Alula has a total cultivated area of 338 ha with 230 ha rainfed fields, followed by Sto. Domingo with total area of 399 ha and 319 ha rainfed. Sampaloc, with total area of 296 ha and 244 ha of unirrigated farms. All the chosen barangays had more than 10 hectares of rainfed agricultural land as required and the number of farmer cooperators were also met.

The four municipalities were selected on the basis that they are covered at the 20 km radius from Central Luzon State University (CLSU) Science City of Muñoz, Nueva Ecija. The SC Muñoz is 5 km away from the university with barangays that have rainfed farms. Since it is near to this agricultural university, people are expected to be receptive to new innovations and technologies. Towns of Guimba, Lupao and Talugtug are still with wide unirrigated rice farms which also under the 20 km radius but some barangays are approximately farther than 20 km radius, however, only those barangays near CLSU and covered by 20 km radius were chosen. The

nearness to CLSU is preferred for ease in monitoring and implementation of the technology tested.

Selected Farmer Cooperators

Although there were criteria in selection of farmer cooperators during the conduct of the study, it was observed that most of them are not good in record keeping. By that, the technicians were tired in monitoring and implementing the technology. Some failed to correctly follow instructions in fertilizer application. Since the sites were near, the technicians were able to solve the problem.

Orientation and Training of Farmer Cooperators

The one-day orientation and training seminar was held in each municipalities and was attended by the chosen farmers. The resource person to this activity is the project leader and assisted by the municipal agriculturist and agricultural technicians in each municipality, barangay officials in the chosen pilot sites and the research assistant. Snack and lunch were served which was came from the project fund. There were questions and answers comes from the actual experience of the farmers and those questions were explained and answered by the speaker to satisfy their doubts. The interaction of the participants was appreciated and shared their honest experiences in rice ratooning. At the end of the training, all of the farmer participants were contented and happy.

Rice Varieties Used by Farmers in the Improved Rice Ratooning Technology

The most preferred variety by farmer cooperators for ratooning is NSIC RC-216 (Table 2) because it matures in 112 days with yield potential of 6.0 to 9.7 tons/ha (www. pinoyrice.com/rice varieties). The high yield performance of NSIC Rc-216 in the main crop in farmers' field coupled with its profuse tillering is an evident that it can produce high yield if ratooned. Seven (7) farmers planted NSIC Rc-216 in SC Muñoz, seven (7) in Guimba, five (5) in Lupao and one (1) in Talugtug. The NSIC Rc-222 in which matures in 114 days with potential yield of 6.1 to 10.0 tons/ha (www.pinoyrice.com/rice-varieties) were ratooned by 16 farmer cooperators in Talugtug, 14 in Guimba, 11 in Lupao and six (6) in SC Muñoz with a total of 47 farmers. The number of farmers that used NSIC Rc-222 for ratooning is higher than NSIC Rc-216, because NSIC Rc-222 is high yielding in the main crop than that of NSIC Rc-216. Most farmers preffered NSIC Rc-222 as main crop, however, the ratooning characters of NSIC Rc-222 is inferior to NSIC Rc-216 specifically in rainfed areas. NSIC Rc-308

which mature in 111 days with potential yield of 5.8 to 10.9 tons/ha were ratooned by three (3) farmer cooperators in Lupao and one (1) in SC Muñoz. NSIC Rc-396 which mature in 114 days with a potential yield of 5.1 to 10.3 tons/ and was used for ratooning by one (1) farmer cooperator in Guimba. The NSIC Rc-10 with potential yield of 4.8-7.5 tons/ha and matures in 106 days was used in Talugtug by three (3) farmer cooperators. Hybrid rice SL-8H, with a potential yield of 7.0-14.0 tons/ha, SL-9H with 9.0-12.0 tons/ha (www.sl-agritech.com) and IL-29 (newly produced rice variety, according to farmer cooperators of Lupao) were also planted and ratooned. One (1) farmer cooperator in SC Muñoz used SL-8H and seven (7) farmer used SL-9H. Also one (1) farmer cooperator ratooned IL-29 in Lupao.

The varieties used in the technology were NSIC Rc-216, 222, 396, 308, 10, IL-29, SL-8H and SL-9H. These varieties were already planted upon project implementation. NSIC Rc-216 observed the most outstanding variety used in the technology. Due to the establishments of the existing varieties, the management considered these varieties for ratooning instead of NSIC Rc-160 and NSIC Rc130 which were have potentials in ratooning but were not present in the pilot sites. Raising a good ratoon crop mainly depends on the variety used in the main crop (Hasan *et al.*, 2013). According to Poehlman (1976), the varietal ability, plant type and responsiveness to nitrogen are the most considered plant characters for the success of the ratoon. As suggested by Anonymous (1992), long duration rice varieties are recommended for ratooning under rainfed transplanted condition.

Nutrient Management

The recommended 120-30-30 N-P-K/ha for hybrid ratoon and 90-30-30 N-P-K/ha for inbred ratoon (Junejo, 2011) were used in the pilot testing with complete (14-14-14) fertilizer and urea (46-0-0) as source. The applications were done twice; the first application was 60-30-30 N-P-K/ha for hybrid and 45-30-30 N-P-K/ha for inbred and it was broadcasted one week after harvesting of the main crop. The second application of 60-0-0 N-P-K/ha for hybrid and 45-0-0 N-P-K/ha for inbred were broadcasted on the second week after harvest of the main crop. Then, foliar fertilizer was sprayed weekly until the sixth week of ratooning to ensure sufficient supply of nutrients for the growth and development of the ratoon rice. Based on the research of Bond and Bollich (2006) and (Setty *et al.*, 1993), by increasing nitrogen fertilizer rate will significantly increase the ratoon rice yield and delayed its maturity of 1 day. Nitrogen has been observed to improve tillering and increase grain yield of the ratoon crop. However, responses of ratoon to nitrogen rate were not constant. Fertilized plots produced better ratoon yields than unfertilized plots (Reddy and Pawar, 1959).

For Nitrogen, 90 pounds of N applied on a dry soil just after the main crop is harvested and immediately followed by a shallow flood is the best management strategy in almost every study across all varieties and hybrids. (Harrell, 2009). Seventy-five percent of the recommended amount of N for the main crop should be applied immediately after harvest of main crop to achieve good ratoon yields (Flinchum and Evatt, 1972), whether second and third fertilizer applications are recommended (Parago, 1963). Post-harvest N application to main crop consistently increase ratoon crop yield. Besides, amount of applied N in the main crop affects the ratoon crops (Quddus, 1981).

Fertilizer applied to the ratoon crop were placed close to the stubble rows for better nutrient uptake and growth (Plucknet *et al.*, 1978). Complete fertilizer was needed not only for the main crop but also for the ratoon crop as stated by Szokolay (1956). Applying P and K to the ratoon crop did not significantly affect ratoon grain yield as explained by Chatterjee et al. (1982). However, applying P to the main crop produced a highly significant increase in ratoon yield (Flinchum and Evatt, 1972).

Cutting Height of Ratoon Rice

The cutting height in this study was 30 cm but according to Turner and Junes (1993), for increased rice ratoon grain yield, cutting height must be 0.5 m from soil surface and Pirdashti *et al.*, (2006) stated that most ratoon yield were produced at 15 cm cutting height. As stated by Bond et al., (2009), the cutting at appropriate height has positive effect on ratoon yield. The ratoon crop matures earlier. It has been reported that days to maturity of the ratoon crops are 65% less than the main crop. Ratoon crops require 50-60% less labor, less water inputs, water use efficiency is high and crop used 60% less water than the main crop.

According to Jones, (1993), when main crop plants were harvested at a cutting height of 0.1, 0.2, 0.3, 0.4 and 0.5 m above the soil surface found out that the highest ratoon yield were obtained at a cutting heights of 0.2 and 0.3 m. Increasing cutting heights had little effect on ratoon panicle number per meter squared, but significantly decreased filled grains, number per panicle, which yield to decreased ratoon yields at the highest two cutting heights. Jones (1993) results show that proper main crop harvest cutting height can increase ratoon yields but selecting a cultivar with inherent ratooning ability is also essential to successful ratooning.

Irrigation Management of Ratoon Rice

Since the rice ratooning technology was piloted in rainfed areas, the crop depends on the remaining moisture in the soil after the main crop. Also, the fogs early in the morning sustained the growth of the emerging shoots and panicles of ratoon rice wherein fogs make the environment humid and

is of great help to ratoon plants. This agrees with the study of Bartok, Jr. (2014) that in controlled environment for vegetable production, fog and mist reduced the air temperature and increased the humidity within the plant canopy.

Yield Performance of Rice Ratoon Using the Improved Technology

Table 3 shows the yield of ratoon rice in four pilot sites of Nueva Ecija. In SC Muñoz, variety NSIC Rc-216 produced a ratoon rice with the highest mean yield of 950 kg/ha, followed by Guimba with 820 kg/ha, 660 kg/ha in Lupao and 500 kg/ha in Talugtug respectively. The highest yield of NSIC Rc-222 was recorded in Lupao with 517 kg/ha second in SC Muñoz with 438 kg/ha then in Guimba with 407 kg/ha and the least is 405 kg/ha in Talugtug. The highest average yield of NSIC Rc-308 is recorded in Lupao with a mean of 783 kg/ha and 352 kg/ha in SC Muñoz. NSIC Rc-308 was not planted in Guimba and Talugtug. The NSIC Rc-396 was planted only in Guimba has a mean yield of 800 kg/ha and NSIC Rc-10 planted in Talugtug yielded 435 kg/ha. Hybrid rice SL-8H and SL-9H of SC Muñoz produced a mean yield of 230 kg/ha and 238 kg/ha respectively. Only in SC Muñoz where these hybrid rice varieties were ratooned for the first time. In Lupao, IL-29 yielded a 632 kg/ha.

Each variety piloted failed to reach the target yield of 2,000 kg/ha. Some possible reasons are: the national average for the main crop's yield of 2017 either irrigated or rainfed is low so it follows with the ratoon rice. This could be due to existing environmental condition in the country at present. The outbreak of rice black bug on the main crop also affected the ratoon rice. Due to insufficient water, the soil failed to sustain the growth and development of the ratoon rice and this favored the breeding of rice black bugs. As stated by Arida and Truong (2013), when not properly controlled, 10 adult rice black bugs per hill can cause losses of up to 35 percent. However, of all the varieties ratooned by the farmers, NSIC Rc-216 showed better performance over the rest of the varieties that were regularly planted. Farmer cooperators observed that, under this condition (no management), the variety is able to produce ratoon without additional application of fertilizers for ratoon growth and development and without spraying of pesticides for protection against pests. Although, farmers' yield in ratoon rice at this 2017's main crop is low, they are inspired of the initial promising result of NSIC Rc-216 and plan to use the variety in the next ratooning instead of other varieties.

For the hybrid rice varieties, their performance in ratooning failed to show convincing results. Before the harvesting of the hybrid varieties of the main crop, frequent rain occurred and harvesting is difficult, so harvesting was done after the rain stops. As a result, the harvesting was delayed and the right time of harvesting of the main crop for ratooning was not met.

According to Rahman *et al.*, 2007, harvest date of the main crop has an effect on the ratoon. In this pilot testing, the farmers want to try it again. It can be tested to obtain a more convincing result.

Based on the result of this pilot testing and on farmer cooperators' observations, NSIC Rc-216 can be ratooned both in irrigated and rainfed areas. However, for NSIC Rc-222, this variety is good for ratooning only under irrigated conditions. For hybrid varieties SL-8H and SL-9H, these can be successfully grown in irrigated field when harvested at the right stage and with sufficient soil moisture during the ratooning stage. When ratooned in rainfed areas as it was done in this pilot test, these hybrid varieties barely survive because of limited soil moisture.

Pest Management

In all the pilot sites, insect pests and diseases were managed using pesticides. To minimize labor, insecticides were combined with foliar fertilizer and were sprayed on the third week until the sixth week of the ratoon plant. This was done to manage the population of green leafhoppers (as vector of tungro), rice bugs, stem borers, cutworms and rice black bugs. Of all the insect pests, rice black bugs were the most abundant in ratoon crops. The chemical pesticides failed to control the population of rice black bugs in all the pilot sites. Rice black bugs were observed in 8 farms in Guimba, two (2) farms in Lupao and four (4) farms in Talugtug while rice bugs were observed only in seven (7) farms in Lupao and three (3) farms in Talugtug. Rice black bugs were common in these rainfed areas. This coincide with the report of (Arida and Truong, 2013) that rice black bug damages were observed more frequently in dry season crops and densely planted fields. It was also reported that excessive nitrogen also favor the build-up of the pest. The ratoon crop applied with nitrogen fertilizers could possibly resulted to infestation. According to the farmers, ratoon crop is profitable even without fertilizer application and spraying of pesticides. Stem borers were observed in most sites but not in Lupao. Diseases failed to occur on the ratoon crop in all sites except in Talugtug where two (2) farms were infected with tungro virus (Table 4). Rats were encountered by one farmer cooperator in Guimba but according to him, he just talked to the rats not to damage his crop and it was so. Weeds were also present in all sites but failed to affect the ratoon crop.

Cost and Return Analysis

The average yield of ratoon rice was 950kg/ha. using NSIC Rc-216, with gross income of Php 16,910.00, and an output price of Php 17.80 per kg. The total expenses of Php 8,798.00 for payment of labor and material

inputs represents 17% and 83% of the cost of labor and material inputs that was incurred during ratooning (Table 5).

Net income, the ultimate determinant of the profitability of production was determined as difference between gross income and total expenses. The income generated was Php 8,112.00 with a value cost ratio of 1.92. This means that Php1.00 expense on ratoon rice generates a return of Php 1.92. The breakeven yield was computed at 494.97kg per hectare. These implies that rice rationing is profitable.

Agro-Meteorological Information

Climatological data from July to December 2017 is presented in Table 6. Throughout the duration of the ratoon crop, the average monthly rainfall from September to November was 4.1, 3.3 and 6.4 mm respectively. A little bit lower compared in July and August during the main crop. The low precipitation in September to November limit the soil moisture thereby it failed to increase the yield of ratoon rice in different areas regardless of sites. The highest temperature was observed in September with 32.5 ℃ and a minimum temperature of 24.0 ℃. The lowest minimum temperature was observed in December with 23.6 ℃ which is slightly lower than October with 23.8 ℃. Temperature is one factor in attaining a better yield in rice ratooning. As stated by Ichii (1982), the higher the temperature, the greater the ratoon plant height and tiller number. The grain yield at high temperature (35 ℃) and normal temperature (29 ℃) was significantly higher than yield at low temperature (20 ℃) (Samson, 1980). The highest relative humidity was recorded in August with 87% and the lowest is in December with 71%. However, in the month of September to October where ratooning period falls, the relative humidity is 85% and drop to 76% in November. This shows that the ratooning period received lower amounts of rainfall.

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