*Int.J.Curr.Microbiol.App.Sci* (2020) *9*(8): 1788-1810

EXCELLENT PUBLISHERS

*International Journal of Current Microbiology and Applied Sciences*
***ISSN: 2319-7706*** **Volume 9 Number 8 (2020)**
Journal homepage: http://www.ijcmas.com

**Original Research Article** https://doi.org/10.20546/ijcmas.2020.908.207

# Economics of Rice and Pea

**Ao. Arenjungla[1*], Lowrence Kithan[2] and L. Tongpang Longkumer[3]**

[1]*School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus, India*
[2]*AICRP on Pigeonpea,* [3]*Department of Agronomy, SASRD, Nagaland University, Medziphema Campus, India*

**Corresponding author*

**Keywords**

Liming, INM, Rice-Pea, Economics, System productivity, Rice equivalent yield and Yield

**Article Info**

***Accepted:***
15 July 2020
***Available Online:***
10 August 2020

**A B S T R A C T**

A field experiment to ascertain the "Economics of rice and pea" was conducted during the *kharif* and *rabi* seasons of 2016-17 and 2017-18 in the experimental farm of Agronomy at School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus. The experiment was laid out in FRBD with two levels of lime *viz.* $L_0$ - without lime, $L_1$ - Lime @ 2 q $ha^{-1}$ and four levels of integrated nutrient management *viz.* $N_1$ - RDF, $N_2$ - RDF (75%) + FYM @ 6 t $ha^{-1}$, $N_3$ - RDF (75%) + Poultry manure @ 1 t $ha^{-1}$ and $N_4$ - RDF (75%) + *Azospirillum* + PSB and replicated thrice. The analysis of the results with regard to economics from the various data revealed that $L_1$ - Lime @ 2 q $ha^{-1}$ and $N_2$ - RDF (75%) + FYM @ 6 t $ha^{-1}$ was the best among all the different treatments combination. With regard to gross return $ha^{-1}$, net return $ha^{-1}$ and benefit-cost ratio the highest was recorded by treatment combination (i.e. $T_8$) of lime @ 2 q $ha^{-1}$ + RDF (75%) + FYM @ 6 t $ha^{-1}$ in rice-pea during the two consecutive years with (Rs 141221.5 and Rs 146962), (Rs 79281.5 and Rs 85022) and (1.28 and 1.37). With regard to rice yield (3537.90 kg $ha^{-1}$, 3653.83 kg $ha^{-1}$ ), System productivity (11377.31 kg $ha^{-1}$, 11752.29 kg $ha^{-1}$) and rice equivalent yield (7839.41 kg $ha^{-1}$, 8098.46 kg $ha^{-1}$ ) the best and highest results was shown by $L_1$ - Lime @ 2 q $ha^{-1}$ and $N_2$ - RDF (75%) + FYM @ 6 t $ha^{-1}$ and its treatment combinations (i.e. $T_8$) with 3832.67 kg $ha^{-1}$, 12400.28 kg $ha^{-1}$ and 8567.61 kg $ha^{-1}$ in both the years. Thus with treatment combinations of $L_1$ - Lime @ 2 q $ha^{-1}$ and $N_2$ - RDF (75%) + FYM @ 6 t $ha^{-1}$ a higher productivity and profitability of upland rice-pea cropping system can be achieved which can be recommended.

## Introduction

Rice (*Oryza sativa* L.) is the staple food for more than 50 % of the world's population (Verma *et al.,* 2015). Global food demand is increasing rapidly and so more in developing nations where crop lands and resources hardly contribute to an efficient crop production needed to meet such an urgent demand for food. With the burgeoning increase of population, demand for food is on high. It has been estimated that rice demand in 2025 will be 765 mt in the world (Malo *et al.*, 2018). The food demands of a growing human population and need for an eco-friendly strategy for sustainable agricultural development require significant attention while addressing the issues of enhancing crop productivity and soil quality.

India is ranked second following china with 100 million metric tons of rice consumption in the same period (Shahbande, 2019). In the global context, India stands first in area with 43.7 m ha, second in production with 106.29 mt and an average productivity of 2.43 t $ha^{-1}$ (Anonymous, 2018). In Nagaland, rice being the most important of the people, it is grown throughout the entire state and covers an area of 214450 hectares with a production of 5,35040 tonnes out of which upland rainfed occupies an area of 91,040 hectares with a production of 1,81,080 tonnes (Anonymous, 2019).

Pea (*Pisum sativum* L.) is an important rabi pulse crop in Nagaland. Its cultivation is being especially encouraged so as to include them in human nutrition as our continued emphasis on both food and nutritional security for our own people. So its importance and potentiality to be adopted as an economical crop in rice based sequential cropping has been well marked. Peas are sensitive to soil acidity and liming is the only option for increasing yield in such soil conditions (Gupta *et al.*, 2000).

About 11.7 million ha of land in India is left fallow after rice (*Oryza sativa* L.) harvest (Gumma *et al.*, 2016). The rice fallow areas is mostly concentrated in eastern India (around 80%) covering the states of Assam, Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Chhattisgarh, Odisha, West Bengal and North Eastern Hill states (Singh *et al.*, 2016).

The cropping intensity of North Eastern Region (NER) of India is low (134%) mainly due to non-utilization of fallow lands after harvesting of rainy season rice (*Oryza sativa* L.). Pea (*Pisum sativum* L.) is one of the most potential leguminous field crops for crop diversification and enhancing productivity of rice based cropping systems in NER. Thus, introduction of pea in rice fallows with appropriate production technologies may increase cropping intensity, improve soil health, and productivity in fragile NER of the country.

## Materials and Methods

The present research entitled "Economics of rice and pea" was carried out in the experimental research farm of Agronomy at School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus during *Kharif* and *Rabi* seasons of 2016-2017 and 2017-2018. The experimental farm is located in the foot hill of Nagaland at an altitude of 310 metres above mean sea level with the geographical location at $25^{o}45^{'}43''$N latitude and $95^{o}53'04''$ E longtitude. The climatic condition of the experimental site is sub-tropical with high humidity and moderate temperature, having medium to high rainfall. The mean temperature ranges from $21^{o}$-$32^{o}$C during summer and rarely goes below $8^{o}$C in winter due to high atmospheric humidity. The annual rainfall ranges from 2500 mm, spread over six months i.e., from April-September, while the remaining period from October to march is virtually dry. In general, the soil type of the experimental site was categorized sandy loam in texture and well drained. The experimental design that was conducted in the experiment field was Randomized Block Design (RBD) with three replications and it has factorial concept. The whole experimental field was divided into three equal blocks, with each block subdivided into 10 equal sized plots, in total consisting of 30 plots. Placement of each treatment was done in randomized manner. The different treatment combinations are Control $T_1$ ($L_0N_0$) No lime + RDF (120: 60: 60 NPK kg $ha^{-1}$), $T_2$ ($L_0N_1$) No lime + RDF

(120: 60: 60 NPK kg ha$^{-1}$), $T_3$ ($L_0N_2$) No lime+ RDF (75%) + FYM @ 6 t ha$^{-1}$), $T_4$ ($L_0N_3$) No lime+ RDF (75%) + poultry manure @ 1 t ha$^{-1}$, $T_5$ ($L_0N_4$) No lime+ RDF (75%) + *Azospirillum* + PSB, $T_6$ ($L_1N_0$) Lime @ 2 q ha$^{-1}$, $T_7$ ($L_1N_1$) Lime @ 2 q ha$^{-1}$+ RDF (120: 60: 60 NPK kg ha$^{-1}$, $T_8$ ($L_1N_2$) Lime@ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$, $T_9$ ($L_1N_3$) Lime @ 2 q ha$^{-1}$ + RDF (75%) + Poultry manure @ 1 t ha$^{-1}$, $T_{10}$ ($L_1N_4$) Lime @ 2 q ha$^{-1}$ + RDF (75%) + *Azospirillum* + PSB.

The rice variety used was Longkumtsuk which is a local cultivar and grown during kharif season. It matures in 155-160 days and yield 40q ha$^{-1}$. The colour of the grain is pale yellow. Seeds were obtained from Yisemyong (Mokokchung district). Spacing used for rice was 20x10 cm$^2$. Every cultural operations was carried out based on calendar of agronomic management practices.

## Results and Discussion (Table 1–11)

### On economics of rice

### Number of panicles m$^{-2}$

The data revealed that there was significant variation on number of panicles m$^{-2}$ due to lime application during both years of experiment. The results during 2016, 2017 and the pooled showed the highest number of panicles m$^{-2}$ with 224.67, 232.33 and 228.50 being recorded with the treatment $L_1$ (Lime @ 2 q ha$^{-1}$) as compared to treatment $L_0$ (without lime). Significant increase in number of panicles m$^{-2}$ was probably due to liming of acid soil. Slattery and Conventry (1993) and Moody *et al.,* (1995) has suggested liming as the most efficient practice to attain and maintain a suitable pH for the growth of panicle of crops.

An inquisition of the data during 2016, 2017 and the pooled showed significant variation on number of panicles m$^{-2}$ with 229.00, 238.00 and 233.50 due to variation in INM levels at $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$) which was statistically at par with $N_4$ (RDF (75%) + Azospirillim + PSB) and $N_3$ (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$), while $N_0$ (Control) and $N_1$ (RDF) recorded the lowest number of panicles m$^{-2}$. Increase in panicles m$^{-2}$ through FYM was supported by Mirza *et al.,* (2005), Barik *et al.,* (2006) and Revathi *et al.,* (2014).

There was no significant variation between lime and INM levels on number of panicles m$^{-2}$ during both the years of experimentation.

### Length of panicle (cm)

A critical analysis of the results revealed that different liming rates had non-significant effect on panicle length during both the years of experiment.

Variations on length of panicle due to INM levels were found to be significant during both the years of experiment. The longest panicle was recorded with 26.63 cm and 27.18 cm during 2016 and 2017 with the treatment $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$). Treatment $N_4$ (RDF (75%) + Azospirillim + PSB) and $N_3$ (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) were found to be at par, while the shortest panicle (23.67 cm) was recorded with treatment $N_0$ (Control). Similarly pooled result also recorded the longest panicle length with $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$). Arif *et al.,* (2014) reported that increase in panicle length in response to balanced use of organic and inorganic fertilizers might be due to more availability of macro as well as micronutrients.

The treatment interaction of lime and INM levels on length of panicle was found insignificant during both the years.

## Number of filled grains panicle$^{-1}$

A close scrutiny on the data revealed a significant variation on number of filled grains panicle$^{-1}$ due to lime levels during both the years of experiment. The highest number of filled grains panicle$^{-1}$ with 127.22 and 128.69 was recorded in treatment $L_1$ (Lime @ 2 q ha$^{-1}$) during 2016 and 2017 respectively. Pooled result thus obtained shows that the highest number of filled grains panicle$^{-1}$ (127.96) was recorded in treatment $L_1$ (Lime @ 2 q ha$^{-1}$) while the lowest was recorded with treatment $L_0$ (without lime). These results clearly indicate that lime application had positive effect on filled grain which ultimately produced higher yield. These observations are in consonance with the findings of Ferdous *et al.,* (2018).

The mean data on number of filled grains panicle$^{-1}$ showed a significantly variation due to application of different INM levels. The highest number of filled grains panicle$^{-1}$ with 128.22 and 129.57 during 2016 and 2017 was recorded with treatment $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$) which was statistically at par with treatment $N_4$ (RDF (75%) + Azospirillim + PSB), while treatment $N_0$ (Control) recorded the lowest number of filled grains panicle$^{-1}$ during both the years. Pooled result thus obtained depicts that the highest number of filled grains panicle$^{-1}$ with 128.90 was recorded with treatment $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$) which was statistically at par with treatment $N_4$ (RDF (75%) + Azospirillim + PSB). The reason for maximum number of filled grains panicle$^{-1}$ (%) may be due to application of FYM and inorganic fertilizers which provide K in adequate amounts. K increases the number of filled spikelets panicle$^{-1}$ (Dobermann and Fairhurst, 2000; Bahmaniar *et al.,* 2007). The findings of the present investigation was in close proximity with Singh *et al.,* (2018), who reported that all the yield attributes were higher with the substitution of FYM / green manure or wheat straw in combination with 50-75% RDF due slow release and continuous supply of nutrients in balance quantity throughout the various growth stages and enables the rice plants to assimilate sufficient photosynthetic products and thus, resulted in superior grain yield attributing characters which in turn increases the number of filled grains panicle$^{-1}$ (%).

The interaction effect between lime and INM during 2017 failed to show significant variation on the number of filled grains panicle$^{-1}$.During 2016, the highest number of filled grains panicle$^{-1}$ (133.40) was recorded with interaction $L_1N_4$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Azospirillim + PSB) which was statistically at par with $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$). Pooled result thus obtained complied with the findings of both the years giving the highest number of filled grains panicle$^{-1}$ (134.65) observed from the interaction $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$) followed by $L_1N_4$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Azospirillim + PSB). Positive responses of lime on different crop yield in acid soil were reported (Westermann, 1992; Venkatesh *et al.,* 2002; Caires *et al.,* 2005; Reddy and Subramanian, 2016). They reported that, management of soil performed better in producing more grains either alone or in combination with lime and fertilizer in acid soil and increase number of grains panicle$^{-1}$. Ferdous *et al.,* (2018) also reported similar findings that the highest number of spikelets panicle$^{-1}$ (136.1) observed from the combination of lime and fertilizer treatment.

## Test weight (g)

The variations on test weight (g) among the lime, INM levels as well as their interactions were found to be non-significant during both the years of experiment. Mondal *et al.,* (2015) reported that test weight is a very stable varietal character and does not vary much among the nutrient management practices.

## Grain yield (q ha$^{-1}$)

A perusal of the data in grain yield due to lime levels reported significant variation during both the years of experiment. During 2016 and 2017 grain yield with 35.01 q ha$^{-1}$ and 35.75 q ha$^{-1}$due to lime levels was recorded the highest with treatment $L_1$ (Lime @ 2 q ha$^{-1}$) as compared to treatment $L_0$ (without lime). Similarly pooled data recorded the same trend of findings for both the years. The grain yield benefits can be ascribed due to the increase in soil pH from application of lime along with the associated improvement in nutrients availability, reduced Fe availability and many other attributes of soil fertility (Venkatesh *et al.*, 2002; Cifu *et al.*, 2004; Costa and Rosolem, 2007; Kumar *et al.*, 2012). Reduction of grain yield in control treatment might be attributed due to significant reduction in fertile tillers running meter$^{-1}$ and filled grains panicle$^{-1}$.

The variations in grain yields due to INM levels were found to be significant. During 2016, grain yield with 35.88 q ha$^{-1}$ recorded the highest in $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$) followed by $N_3$ (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) which was statistically at par with $N_4$ (RDF (75%) + Azospirillim + PSB). The lowest recorded in $N_0$ (Control). Similar findings were recorded during 2017. Pooled data also recorded the highest grain yield of 36.54 q ha$^{-1}$ with treatment $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$) which was at par with $N_4$ (RDF (75%) + Azospirillim + PSB) and $N_3$ (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) and the lowest recorded with $N_0$ (Control). The highest grain yield in FYM and fertilizer treatment plot might be due to its profuse tillering, maximum dry matter accumulation and higher value of yield attributing characters *viz* number of panicles and number of filled grains panicles$^{-1}$. Improved yields were due to instantaneous and rapid supply of nutrients through chemical fertilizers and steady supply through mineralization of FYM for prolonged period. Similar results on rice yields were reported due to integrated application of chemical fertilizer and organic manures (Sharma *et al.*, 2016; Singh *et al.*, 2018; Tang *et al.*, 2018). Sravan and Singh (2019) also got similar result that application of recommended nutrients in integrated approach (75% RDF + 25% FYM) enhanced rice grain yield.

The treatment interaction on grain yield also produced significant variation during both years of experiment. The highest grain yield of 38.08 q ha$^{-1}$and 38.57 q ha$^{-1}$ was recorded during 2016 and 2017 which was associated with interaction $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$ followed by $L_1N_4$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Azospirillim + PSB) and $L_1N_3$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Poultry manure @ 1 t ha$^{-1}$), while the lowest was recorded with interaction $L_0N_0$ (Control). The pooled data thus obtained complied with the findings of the both years of experiment with interaction $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$) giving the highest value (38.33 q ha$^{-1}$). The interactions $L_1N_4$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Azospirillim + PSB) and $L_1N_3$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) were found to be statistically at par with each other, while the lowest grain yield (21.47 q ha$^{-1}$) recorded with interaction $L_0N_0$ (Control). The results clearly indicates that organic and inorganic based fertilizer along with lime had more influential effect on rice grain due to the higher available nutrients and optimum soil properties. Similar findings were also reported by Mitu *et al.*, (2017). The results are also in conformity with the findings of sahu *et al.*, (2018), where it was observed that the half doses of RDF combined with FYM alone or with combination of lime and zinc sulphate resulted in significant increase in grain yield as compare to control and remained at par with full doses of RDF.

## Straw yield (q ha$^{-1}$)

The variations on straw yield due to lime levels were found significant during both years of experiment. During 2016 and 2017 the highest straw yield with 69.05 q ha$^{-1}$and 70.43 q ha$^{-1}$ was recorded with treatment $L_1$ (Lime @ 2 q ha$^{-1}$) as compared to treatment $L_0$ (without lime). Pooled data of both the years showed significant variation with the highest straw yield (69.74 q ha$^{-1}$) recorded from treatment $L_1$ (Lime @ 2 q ha$^{-1}$). These results indicated that straw yields of rice increased with the application of lime. Similar results due to liming have been reported by Caires *et al.,* (2008) and Ferdous *et al.,* (2018). Murphy and Sims (2012) also reported that liming increases soil pH and reduce soil acidity which ultimately increased the straw yields.

A close scrutiny of data on straw yield due to INM levels were found significant during both the years of experiment. The highest straw yield of 72.61 q ha$^{-1}$ and 71.78 q ha$^{-1}$ was recorded with $N_3$ (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) followed by $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$), during first and second year of experiment while the lowest was recorded in $N_0$ (Control). Pooled data obtained showed a significant variation with treatment $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$) giving the highest value for straw yield of 72.19 q ha$^{-1}$ which was followed by $N_3$ (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$), while the lowest was recorded in treatment $N_0$ (Control). This is in line with the findings of Singh *et al.,* (2018), who reported that all the yield attributes were higher with the substitution of organic manures in combination with 50-75% RDF due slow release and continuous supply of nutrients in balance quantity throughout the various growth stages and enables the rice plants to assimilate sufficient photosynthetic products and thus, resulted in increased of yield attributes and finally increased straw yield.

Significant effect due to interaction of lime and INM levels was observed during both the years of experiment where the highest straw yield of 74.46 q ha$^{-1}$ and 76.25 q ha$^{-1}$ was associated with interaction $L_1N_3$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) and the lowest recorded in $L_0N_0$ (Control). Pooled data revealed similar findings with treatment interaction $L_1N_3$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) giving the highest straw yield (75.36 q ha$^{-1}$) while treatment interaction $L_0N_0$ (Control) recorded the lowest straw yield. These results is in conformity with the findings of Sahu *et al.,* (2018), who reported that application of fertilizers, manures and lime improved straw yields which might be due to favorable soil condition. Urkurkar *et al* (2010) and Alim (2012) also reported similar findings.

## Harvest index (%)

Harvest index due to lime levels could not produced significant result during both years of experiment.

The variations in harvest index due to INM levels were found to be significant during both the years of experiment. During 2016, the highest harvest index of 34.44 % was recorded with treatment $N_4$ (RDF (75%) + Azospirillim + PSB) followed by the treatment $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$). The lowest recorded in treatment $N_0$ (Control). During 2017 as well as the pooled data, the highest harvest index was recorded with treatment $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$) which was followed by $N_4$ (RDF (75%)

+ Azospirillim + PSB). Similar findings have been reported by Singh *et al.*, (2018).

The interaction effects of different treatments were found to be non-significant during 2017. During 2016, significant variation was observed with the highest value of harvest index (36.29 %) associated with the interaction $L_1N_2$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + FYM @ 6 t $ha^{-1}$) followed by interaction $L_1N_4$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + Azospirillim + PSB). The lowest was recorded in RDF and $L_0N_0$ (Control). Acharya *et al.*, (2012) also reported similar findings that combine application of NPK, FYM and lime recorded highest harvest index (47.9%) over RDF and control. High harvest index coincided with high yield and high percentages of grain filling.

## On Economics of pea

### Number of pods plant$^{-1}$

A close scrutiny of the data reveals that variation in lime had significant residual effect on the number of pods plant$^{-1}$ of pea during both the years of experimentation. The highest number of pods plant$^{-1}$ with 3.93 and 4.02 of both the years was recorded in treatment $L_1$ (Lime @ 2 q $ha^{-1}$), while the lowest recorded with treatment $L_0$ (without lime). Pooled data of both the years also showed significant variation with the highest number of pods plant$^{-1}$ (3.98) recorded in treatment $L_1$ (Lime @ 2 q $ha^{-1}$) and the lowest recorded with treatment $L_0$ (without lime). The highest number of pods plant$^{-1}$ is due to increased production of branches plant$^{-1}$ with application of lime. These results are in conformity with the findings of Meena and Prakasha (2019) who reported that growth and yield attributes of cowpea increased due to improvement of soil pH and other physic-chemical properties of soil and the better uptake of nutrients facilitated by liming.

It is evident from the data that there was significant residual impact in number of pods plant$^{-1}$ due to variation in nutrient sources imposed to preceding rice crop. Treatment $N_2$ (RDF (75%) + FYM @ 6 t $ha^{-1}$) recorded significantly highest number of pods plant$^{-1}$ of 3.95 and 4.06 respectively in both years. Pooled data of both years reported significant variation with the highest number of pods plant$^{-1}$ with 4.00 reported from treatment $N_2$ (RDF (75%) + FYM @ 6 t $ha^{-1}$) and the lowest (3.31) in $N_0$ (Control). Numbers of pods plant$^{-1}$ were significantly influenced due to residual effect of fertilizers and FYM applied in preceding rice. Such effect may be owing to increased availability of nutrient in soil from native pool as well as their residual effect through mineralization and improvement of physico-chemical properties of soil and thereby improving water and nutrient holding capacity of soil. These results are in accordance with, Gawai and Pawar (2006) in sorghum-chickpea, Gudadhe (2008) in cotton-chickpea, Patil (2008) in sorghum-chickpea, Nawle (2009) in sorghum-chickpea, Saha *et al.*, (2010) in maize- mustard, Shanwad (2010) in maize-bengalgram, and Sindhi *et al.*, (2016) in maize-greengram cropping sequence.

The interaction effect of residual lime and nutrient sources failed to show any significant influence on number of pods plant$^{-1}$ during the two years of study.

### Number of seeds pod$^{-1}$

Residual effect of lime levels applied to preceding rice influenced significantly the number of seeds pod$^{-1}$ of succeeding pea at various growth stages for both the year of experimentation. Treatment $L_1$ (Lime @ 2 q $ha^{-1}$) recorded highest number of seeds pod$^{-1}$ *viz.* (4.69) and (4.77) respectively and the lowest recorded in treatment $L_0$ (without lime) of both the years. Pooled data of both the years also recorded similar trend of findings with the highest number of seeds pod$^{-1}$ (4.73) recorded from treatment $L_1$ (Lime @ 2 q ha$^{-1}$). These results are in conformity with the findings of Meena and Prakasha (2019) who reported that yield attributes of cowpea increased due to improvement of soil pH and other physic-chemical properties of soil and the better uptake of nutrients facilitated by liming.

It is clear from the data that nutrient sources had significant residual effect on the number of seeds pod$^{-1}$ during both the years of experiment. Among the nutrient sources, $N_3$ (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) recorded the highest number of seeds pod$^{-1}$ (4.74) followed by $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$). The following year as well as the pooled data of both the years recorded the similar findings with highest number of seeds pod$^{-1}$ recorded from $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$). Lowest number of seeds pod$^{-1}$ was recorded in $N_0$ (Control) followed by $N_1$ (RDF). The superiority of residual effect of integrated use of FYM and fertilizer application might be due to efficient utilization of mineralized nutrients from FYM along with atmospheric N fixed by the pea crop itself would have increased the availability of N throughout the growth period and thereby increased the assimilation of photosynthates which in turn better source and sink relationship led to better performance of cowpea. Latha *et al.*, (2019) supported the findings that yield attributes of succeeding rabi were significantly influenced by the INM which imposed to preceding rice crop.

The interaction effects of residual effect of lime and INM levels as well as the pooled data on number of seeds pod$^{-1}$ was found to be non-significant during the two years of experiment.

## Test weight (g)

A perusal of the data showed that there was no significant residual effect due to lime application on test weight during the two years of experiment.

It is clear from the data that there was no significant residual impact on test weight of succeeding pea crop by different INM levels during both years of experiment.

Variation in test weight was found to be non-significant due to interaction effects of lime and INM levels during both the years of experiment.

## Pod yield (q ha$^{-1}$)

Variation in pod yield due to lime levels had significant residual effect during both years of study. During both years of experiment, treatment $L_1$ (Lime @ 2 q ha$^{-1}$) recorded significantly highest pod yield of 13.13 q ha$^{-1}$and 13.54 q ha$^{-1}$ over treatment $L_0$ (without lime). Similar trend of findings were recorded for pooled data with the highest value of 13.33 q ha$^{-1}$ recorded from treatment $L_1$ (Lime @ 2 q ha$^{-1}$). Residual effect of lime increased the pod yield of pea over no lime amended plots might be attributed to amelioration measures of acidic soil by lime application which improve soil pH and decrease exchangeable acidity and Al activity, which in turn resulted in excellent pod filling. The results are in agreement with the findings of Mathew and Thampatti (2007) and Meena and Prakasha (2019) who reported that the better uptake of nutrients facilitated by liming increased vegetative growth and resulted in increased dry matter production and ultimately seed yield of cowpea.

Among the different INM levels, significant residual effect in pod yield observed during both the years of experiment. During both years of experiment, the highest pod yield of 13.46 q $ha^{-1}$and 14.10 q $ha^{-1}$was recorded with residue treatment $N_2$ (RDF (75%) + FYM @ 6 t $ha^{-1}$). Pooled data of both the years revealed similar findings with treatment $N_2$ (RDF (75%) + FYM @ 6 t $ha^{-1}$) giving the highest pod yield (13.78 q $ha^{-1}$). Residual treatment of $N_3$ (RDF (75%) + Poultry manure @ 1 t $ha^{-1}$) and $N_4$ (RDF (75%) + Azospirillim + PSB) were found to be statistically at par for both the years. The lowest was recorded in $N_0$ (Control) followed by $N_1$ (RDF).

The increased green pod yield might be due to addition of FYM to preceding rice resulting in improvement in soil structure which reduced the soil crusting and also serves as a source of energy for soil microflora which resulted in better root nodulation and nitrogen fixation. The result is in conformation with those reported by Gudadhe *et al.*, (2015) and Sindhi *et al.*, (2016). Latha *et al.*, (2019) also opined that application of INM to preceding rice crop, increased rabi crop yields by 25-30% when compared to inorganic alone.

The interaction effects due to lime and INM levels had significant residual impact on pod yield of succeeding pea crop during both the years of study. Application of $L_1N_2$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + FYM @ 6 t $ha^{-1}$) recorded significantly highest pod yield over all the treatments during both the years. Pooled data also showed significant variation with the highest pod yield (14.68 q $ha^{-1}$) observed from residue treatment $L_1N_2$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + FYM @ 6 t $ha^{-1}$). The results clearly indicate that the combined application of lime with FYM and chemical fertilizer significantly increased growth and yield parameters of pea, which ultimately results into higher pod yield. Lokose *et al.*, (2015) reported similar findings that residue RDF +FYM + lime recorded the maximum seed yield (0.55) which was at par with residue RDF + FYM and closely followed by RDF + lime and RDF alone.

### Stover yield (q $ha^{-1}$)

Between residual lime levels, significant difference was observed on stover yield during both the years of experiment. Residual treatment $L_1$ (Lime @ 2 q $ha^{-1}$) recorded significantly highest stover yield over residue treatment $L_0$ (without lime) i.e. (17.70 q $ha^{-1}$) and (17.94 q $ha^{-1}$) in first and second years, respectively. Similar trend of findings were recorded for pooled data with the highest value (17.82 q $ha^{-1}$) recorded from residue treatment $L_1$ (Lime @ 2 q $ha^{-1}$). Increased stover yield of pea due to residual effect of liming in both the years could be attributed to increased plant height and branches $plant^{-1}$. The results are in agreement with the findings of Sorokhaibam *et al.*, (2016).

It is indicated from the data that stover yield differed significantly due to different residual INM levels during both the years of experiment. Amongst all the treatment, application of $N_2$ (RDF (75%) + FYM @ 6 t $ha^{-1}$) to rice recorded the highest stover yield of succeeding pea *i.e.* (18.01 q $ha^{-1}$) and (17.93 q $ha^{-1}$) in first and second years, respectively. Pooled data of both the years recorded similar trend of findings with the highest stover yield (17.97 q $ha^{-1}$) recorded from treatment $N_2$ (RDF (75%) + FYM @ 6 t $ha^{-1}$).

Significantly, higher stover yield under above treatments might be due to increase in vegetative growth in terms of plant height, number of branches and dry matter accumulation. Present results are in conformity with the findings of Sindhi *et al.*, (2016). Similar results also reported earlier by Singh *et al.*, (2002) in rice-lentil, Gawai and Pawar (2006) in sorghum-chickpea, Gudadhe (2008) in cotton-chickpea.

Variation in stover yield was found to be significant due to interaction effects of residual lime and INM levels during both years of study.

The highest stover yield was associated with the interaction $L_1N_2$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + FYM @ 6 t $ha^{-1}$) followed by $L_1N_3$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + Poultry manure @ 1 t $ha^{-1}$). Pooled data of both the years recorded similar findings with the highest stover yield (18.92 q $ha^{-1}$) recorded from treatment interaction $L_1N_2$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + FYM @ 6 t $ha^{-1}$). Residual treatment interactions of $L_1N_3$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + Poultry manure @ 1 t $ha^{-1}$) and $L_1N_4$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + Azospirillim + PSB) were found to be statistically at par. Residual effect of lime, FYM and chemical fertilizer increased the stover yield of pea which might be due to the improvement in soil conditions and increased availability of nutrients through manure and lime application, and also to the addition of NPK which is important during initial root growth, nutrient uptake and therefore plant development. This is in line with the findings of Meena and Prakasha (2019).

## Economics of rice-pea production

The economics including cost of cultivation $ha^{-1}$, gross return $ha^{-1}$, net return $ha^{-1}$ and benefit cost ratio was worked out on the basis of prevailing market prices for both the years.

### Cost of cultivation (₹ $ha^{-1}$)

The data revealed that the cost of cultivation differs with the treatments. There is a common cost of cultivation (₹ 54,240) for all the control treatments where no fertilizer doses applied. In all other remaining treatments cost of cultivation $ha^{-1}$ is slightly varied because of the differences in rate of lime, organic manure, biofertilizers and chemical fertilizers applied. The maximum cost of cultivation (₹ 61,940) involved in RDF (75%) + FYM @ 6 t $ha^{-1}$) with lime @ 2 q $ha^{-1}$ during both the years of experiment. This might be due to additional cost of lime and FYM. The lowest cost of cultivation $ha^{-1}$ was incurred by $L_0N_0$ (Control) during both the years.

### Gross return (₹ $ha^{-1}$)

The results indicated that the maximum gross return of (₹ 1,41221.5) and (₹ 1,46962) was recorded during 2016-17 and 2017-18, respectively with treatment application of RDF (75%) + FYM @ 6 t $ha^{-1}$) with lime @ 2 q $ha^{-1}$ while the lowest return of (₹ 70,274.5) and (₹ 68,673) was recorded for $L_0N_0$ (Control) during both the years of experiment. The highest gross return is obviously due to high yield (Singh *et al.*, (2011).

In support of the above findings, Ganapathi *et al.*, (2019) reported similar results that the treatment which received RDF + FYM + 50 % lime requirement through granulated lime based on 45% Ca saturation recorded higher gross returns (₹ 69,945.75) over other treatments. Lakshmi *et al.*, (2013) also reported that the gross return were more in INM treatments than 100 % RDF and control plots.

### Net return (₹ $ha^{-1}$)

A perusal of data indicated that the maximum net return of (₹ 79,281.5) and (₹ 85,022) was recorded during 2016-17 and 2017-18, respectively with treatment application of RDF (75%) + FYM @ 6 t $ha^{-1}$) with lime @ 2 q $ha^{-1}$ while the least net return of (₹ 16,034.5) and (₹ 14,433) was recorded in $L_0N_0$ (Control) during both the years of experiment. The maximum net income is due to higher gross income. Ganapathi *et al.*, (2019) also reported that the treatment which received RDF + FYM + 50 % lime requirement through granulated lime based on 45% Ca saturation recorded higher net returns (Rs 33,292.73) over other treatments. Manpreet and Dixit (2017) also reported that fertilizer and lime application gave the highest economic returns as compared with the sole or separate application. The high economic return could be realized if lime is applied in acidic soil was also reported by Kumar (2015).

## Benefit cost ratio

An inquisition of data revealed that application of treatment $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$) attained significantly higher benefit cost ratio (1.28) during 2016-17. Similar trend of findings was recorded for 2017-18 where higher benefit cost ratio (1.37) recorded in $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$) and the lowest was recorded in $L_0N_0$ (Control).

The maximum benefit cost ratio is owing to higher grain yield and inturn higher gross and net returns.

## Rice equivalent yield of pea (kg ha$^{-1}$)

Among the lime levels, the highest rice equivalent yield (7735.16 kg ha$^{-1}$) and (7943.65 kg ha$^{-1}$) was recorded from treatment $L_1$ (Lime @ 2 q ha$^{-1}$) during 2016-17 and 2017-18 respectively. Pooled data of both the years showed significant variation with improved rice equivalent yield (7839.41 kg ha$^{-1}$) recorded from treatment $L_1$ (Lime @ 2 q ha-$^{1}$) over treatment $L_0$ (without lime).

The improvement in lime treated plots may be due to increased in grain yield of rice as well as pod yield of pea. Sorokhaibam *et al.*, (2016) also reported similar findings that since liming treatment had resulted increase in grain yield of rice as well as seed yield of lathyrus, hence, REY was also increased.

Among the INM levels, the highest rice equivalent yield (7927.82 kg ha$^{-1}$) and (8269.09 kg ha$^{-1}$) was recorded from treatment application of RDF (75%) + FYM @ 6 t ha$^{-1}$) with lime @ 2 q ha$^{-1}$ during 2016-17 and 2017-18 respectively followed by $N_3$ (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) and $N_4$ (RDF (75%) + Azospirillim + PSB).

**Table.1** Economics on yield attributes of rice

| Treatments | Number of panicles m$^{-2}$ | | | Number of filled grains panicle$^{-1}$ | | | Test weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled |
| **Lime** | | | | | | | | | |
| **$L_0$** | 199.35 | 202.00 | 200.67 | 112.05 | 114.61 | 113.33 | 29.81 | 30.63 | 30.22 |
| **$L_1$** | 224.67 | 232.33 | 228.50 | 127.22 | 128.69 | 127.96 | 31.74 | 32.26 | 32.00 |
| **SEm±** | **3.91** | **4.86** | **3.12** | **1.10** | **1.01** | **0.75** | **0.66** | **0.74** | **0.50** |
| **CD (P= 0.05)** | **11.61** | **14.45** | **8.95** | **3.26** | **3.00** | **2.14** | **NS** | **NS** | **NS** |
| **INM** | | | | | | | | | |
| **$N_0$** | 162.17 | 164.17 | 163.17 | 92.43 | 95.17 | 93.80 | 28.89 | 29.21 | 29.05 |
| **$N_1$** | 217.03 | 218.33 | 217.68 | 123.00 | 126.08 | 124.54 | 30.70 | 31.26 | 30.98 |
| **$N_2$** | 229.00 | 238.00 | 233.50 | 128.22 | 129.57 | 128.90 | 31.55 | 32.61 | 32.08 |
| **$N_3$** | 223.33 | 229.17 | 226.25 | 126.83 | 128.92 | 127.88 | 31.81 | 31.85 | 31.83 |
| **$N_4$** | 228.50 | 236.17 | 232.33 | 127.70 | 128.50 | 128.10 | 30.93 | 32.28 | 31.60 |
| **SEm±** | **6.18** | **7.69** | **4.93** | **1.73** | **1.60** | **1.18** | **1.05** | **1.17** | **0.79** |
| **CD (P= 0.05)** | **18.36** | **22.84** | **14.15** | **5.15** | **4.75** | **3.38** | **NS** | **NS** | **NS** |

**Table.2** Interaction effect on economics of rice on yield

| Treatments | Number of panicles $m^{-2}$ | | | Number of filled grains $panicle^{-1}$ | | | Test weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled |
| **Lime x INM** | | | | | | | | | |
| $L_0N_0$ | 134.00 | 129.67 | 131.83 | 79.46 | 83.55 | 81.51 | 28.20 | 28.47 | 28.33 |
| $L_0N_1$ | 206.40 | 201.67 | 204.03 | 114.22 | 119.67 | 116.94 | 30.02 | 30.29 | 30.16 |
| $L_0N_2$ | 218.00 | 227.67 | 222.83 | 123.11 | 123.18 | 123.15 | 30.62 | 31.98 | 31.30 |
| $L_0N_3$ | 217.00 | 221.33 | 219.17 | 121.44 | 124.30 | 122.87 | 30.76 | 30.86 | 30.81 |
| $L_0N_4$ | 221.33 | 229.67 | 225.50 | 122.00 | 122.34 | 122.17 | 29.46 | 31.53 | 30.50 |
| $L_1N_0$ | 190.33 | 198.67 | 194.50 | 105.39 | 106.80 | 106.09 | 29.58 | 29.94 | 29.76 |
| $L_1N_1$ | 227.67 | 235.00 | 231.33 | 131.78 | 132.49 | 132.13 | 31.38 | 32.23 | 31.80 |
| $L_1N_2$ | 240.00 | 248.33 | 244.17 | 133.33 | 135.97 | 134.65 | 32.48 | 33.24 | 32.86 |
| $L_1N_3$ | 229.67 | 237.00 | 233.33 | 132.22 | 133.54 | 132.88 | 32.86 | 32.85 | 32.85 |
| $L_1N_4$ | 235.67 | 242.67 | 239.17 | 133.40 | 134.66 | 134.03 | 32.39 | 33.02 | 32.71 |
| **SEm±** | **8.74** | **10.87** | **6.97** | **2.45** | **2.26** | **1.67** | **1.48** | **1.66** | **1.11** |
| **CD (P= 0.05)** | **NS** | **NS** | **NS** | **7.28** | **NS** | **4.78** | **NS** | **NS** | **NS** |

**Table.3** Economics of rice on yield

| Treatments | Grain yield (q $ha^{-1}$) | | | Straw yield (q $ha^{-1}$) | | | Harvest index (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled |
| **Lime** | | | | | | | | | |
| $L_0$ | 30.94 | 31.33 | 31.14 | 64.60 | 64.94 | 64.77 | 32.36 | 32.43 | 32.40 |
| $L_1$ | 35.01 | 35.75 | 35.38 | 69.05 | 70.43 | 69.74 | 33.66 | 33.70 | 33.68 |
| **SEm±** | **0.24** | **0.34** | **0.21** | **1.11** | **1.32** | **0.86** | **0.44** | **0.52** | **0.34** |
| **CD (P= 0.05)** | **0.71** | **1.02** | **0.60** | **3.29** | **3.91** | **2.46** | **NS** | **NS** | **0.98** |
| **INM** | | | | | | | | | |
| $N_0$ | 25.80 | 26.25 | 26.03 | 57.61 | 58.89 | 58.25 | 30.89 | 30.79 | 30.84 |
| $N_1$ | 33.82 | 33.90 | 33.86 | 67.14 | 67.69 | 67.42 | 33.64 | 33.39 | 33.51 |
| $N_2$ | 35.88 | 37.20 | 36.54 | 70.62 | 69.68 | 70.15 | 33.74 | 34.86 | 34.30 |
| $N_3$ | 34.69 | 35.14 | 34.92 | 72.61 | 71.78 | 72.19 | 32.34 | 32.92 | 32.63 |
| $N_4$ | 34.68 | 35.22 | 34.95 | 66.15 | 70.38 | 68.27 | 34.44 | 33.37 | 33.90 |
| **SEm±** | **0.38** | **0.54** | **0.33** | **1.75** | **2.08** | **1.36** | **0.70** | **0.83** | **0.54** |
| **CD (P= 0.05)** | **1.13** | **1.61** | **0.95** | **5.20** | **6.18** | **3.90** | **2.07** | **2.46** | **1.55** |

**Table.4** Interaction effect on economics of rice on yield

| Treatments | Grain yield (q $ha^{-1}$) | | | Straw yield (q $ha^{-1}$) | | | Harvest index (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled |
| **Lime x INM** | | | | | | | | | |
| $L_0N_0$ | 21.89 | 21.04 | 21.47 | 52.20 | 51.62 | 51.91 | 29.72 | 29.27 | 29.50 |
| $L_0N_1$ | 32.15 | 31.28 | 31.71 | 60.55 | 63.10 | 61.83 | 34.72 | 33.20 | 33.96 |
| $L_0N_2$ | 33.67 | 35.83 | 34.75 | 74.34 | 70.90 | 72.62 | 31.20 | 33.62 | 32.41 |
| $L_0N_3$ | 33.34 | 33.83 | 33.59 | 70.75 | 67.30 | 69.03 | 32.05 | 33.47 | 32.76 |
| $L_0N_4$ | 33.65 | 34.67 | 34.16 | 65.17 | 71.80 | 68.48 | 34.12 | 32.58 | 33.35 |
| $L_1N_0$ | 29.71 | 31.45 | 30.58 | 63.01 | 66.17 | 64.59 | 32.06 | 32.31 | 32.19 |
| $L_1N_1$ | 35.49 | 36.52 | 36.01 | 73.73 | 72.29 | 73.01 | 32.56 | 33.57 | 33.06 |
| $L_1N_2$ | 38.08 | 38.57 | 38.33 | 66.90 | 68.46 | 67.68 | 36.29 | 36.09 | 36.19 |
| $L_1N_3$ | 36.04 | 36.45 | 36.24 | 74.46 | 76.25 | 75.36 | 32.63 | 32.37 | 32.50 |
| $L_1N_4$ | 35.70 | 35.77 | 35.74 | 67.13 | 68.96 | 68.05 | 34.75 | 34.16 | 34.45 |
| **SEm±** | **0.54** | **0.76** | **0.47** | **2.47** | **2.94** | **1.92** | **0.98** | **1.17** | **0.76** |
| **CD (P= 0.05)** | **1.60** | **2.27** | **1.34** | **7.35** | **8.74** | **5.51** | **2.92** | **NS** | **NS** |

## **Table.5** Economics of pea on yield

| Treatments | Number of pods plant$^{-1}$ | | | Number of seeds pod$^{-1}$ | | | Test weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2016-17 | 2017-18 | Pooled | 2016-17 | 2017-18 | Pooled | 2016-17 | 2017-18 | Pooled |
| **Lime** | | | | | | | | | |
| $L_0$ | 3.49 | 3.53 | 3.51 | 4.12 | 4.17 | 4.14 | 40.32 | 39.86 | 40.09 |
| $L_1$ | 3.93 | 4.02 | 3.98 | 4.69 | 4.77 | 4.73 | 40.78 | 41.08 | 40.93 |
| **SEm±** | **0.07** | **0.08** | **0.05** | **0.08** | **0.07** | **0.05** | **0.48** | **13.50** | **6.76** |
| **CD (P= 0.05)** | **0.21** | **0.24** | **0.16** | **0.23** | **0.21** | **0.15** | **NS** | **NS** | **NS** |
| **INM** | | | | | | | | | |
| $N_0$ | 3.34 | 3.29 | 3.31 | 3.94 | 3.95 | 3.94 | 39.20 | 38.66 | 38.93 |
| $N_1$ | 3.67 | 3.78 | 3.72 | 4.39 | 4.45 | 4.42 | 40.69 | 40.24 | 40.46 |
| $N_2$ | 3.95 | 4.06 | 4.00 | 4.56 | 4.85 | 4.70 | 41.01 | 41.74 | 41.37 |
| $N_3$ | 3.89 | 3.94 | 3.92 | 4.74 | 4.63 | 4.68 | 40.66 | 40.22 | 40.44 |
| $N_4$ | 3.72 | 3.83 | 3.78 | 4.40 | 4.46 | 4.43 | 41.21 | 41.48 | 41.35 |
| **SEm±** | **0.11** | **0.13** | **0.09** | **0.12** | **0.11** | **0.08** | **0.76** | **21.35** | **10.68** |
| **CD (P= 0.05)** | **0.34** | **0.38** | **0.25** | **0.37** | **0.33** | **0.24** | **NS** | **NS** | **NS** |

## **Table.6** Interaction effect on economics of pea on yield

| Treatments | Number of pods plant$^{-1}$ | | | Number of seeds pod$^{-1}$ | | | Test weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2016-17 | 2017-18 | Pooled | 2016-17 | 2017-18 | Pooled | 2016-17 | 2017-18 | Pooled |
| **Lime x INM** | | | | | | | | | |
| $L_0N_0$ | 2.89 | 2.78 | 2.84 | 3.32 | 3.33 | 3.33 | 38.48 | 37.79 | 38.14 |
| $L_0N_1$ | 3.44 | 3.56 | 3.50 | 4.22 | 4.28 | 4.25 | 40.04 | 39.11 | 39.58 |
| $L_0N_2$ | 3.78 | 3.89 | 3.84 | 4.28 | 4.67 | 4.47 | 40.38 | 41.14 | 40.76 |
| $L_0N_3$ | 3.78 | 3.78 | 3.78 | 4.67 | 4.33 | 4.50 | 41.36 | 40.10 | 40.73 |
| $L_0N_4$ | 3.56 | 3.67 | 3.61 | 4.11 | 4.22 | 4.17 | 41.35 | 41.14 | 41.24 |
| $L_1N_0$ | 3.78 | 3.79 | 3.79 | 4.55 | 4.56 | 4.56 | 39.92 | 39.53 | 39.73 |
| $L_1N_1$ | 3.89 | 4.00 | 3.95 | 4.56 | 4.61 | 4.59 | 41.33 | 41.37 | 41.35 |
| $L_1N_2$ | 4.11 | 4.22 | 4.17 | 4.83 | 5.04 | 4.94 | 41.65 | 42.33 | 41.99 |
| $L_1N_3$ | 4.00 | 4.11 | 4.05 | 4.81 | 4.92 | 4.86 | 39.95 | 40.33 | 40.14 |
| $L_1N_4$ | 3.89 | 4.00 | 3.95 | 4.70 | 4.71 | 4.70 | 41.07 | 41.83 | 41.45 |
| **SEm±** | **0.16** | **0.18** | **0.12** | **0.17** | **0.16** | **0.12** | **1.07** | **30.19** | **15.10** |
| **CD (P= 0.05)** | **NS** | **NS** | **NS** | **NS** | **NS** | **0.34** | **NS** | **NS** | **NS** |

## **Table.7** Effect on economics of pea on yield

| Treatments | Pod yield (q ha$^{-1}$) | | | Stover yield (qha$^{-1}$) | | |
|---|---|---|---|---|---|---|
| | 2016-17 | 2017-18 | Pooled | 2016-17 | 2017-18 | Pooled |
| **Lime** | | | | | | |
| $L_0$ | 10.97 | 11.25 | 11.11 | 14.57 | 14.60 | 14.58 |
| $L_1$ | 13.13 | 13.54 | 13.33 | 17.70 | 17.94 | 17.82 |
| **SEm±** | **0.19** | **0.23** | **0.15** | **0.40** | **0.37** | **0.26** |
| **CD (P= 0.05)** | **0.58** | **0.69** | **0.43** | **1.20** | **0.95** | **0.74** |
| **INM** | | | | | | |
| $N_0$ | 8.52 | 8.43 | 8.47 | 12.32 | 12.74 | 12.53 |
| $N_1$ | 12.21 | 12.52 | 12.36 | 16.15 | 16.58 | 16.37 |
| $N_2$ | 13.46 | 14.10 | 13.78 | 18.01 | 17.93 | 17.97 |
| $N_3$ | 12.89 | 13.40 | 13.15 | 17.46 | 17.53 | 17.49 |
| $N_4$ | 13.18 | 13.53 | 13.35 | 16.73 | 16.57 | 16.65 |
| **SEm±** | **0.31** | **0.37** | **0.24** | **0.64** | **0.50** | **0.41** |
| **CD (P= 0.05)** | **0.91** | **1.09** | **0.69** | **1.90** | **1.50** | **1.17** |

**Table.8** Interaction effect on economics of pea on yield

| Treatments | Pod yield (q ha$^{-1}$) | | | Stover yield (q ha$^{-1}$) | | |
|---|---|---|---|---|---|---|
| | 2016-17 | 2017-18 | Pooled | 2016-17 | 2017-18 | Pooled |
| **Lime x INM** | | | | | | |
| $L_0N_0$ | 6.30 | 6.24 | 6.27 | 8.54 | 8.33 | 8.44 |
| $L_0N_1$ | 11.03 | 11.09 | 11.06 | 15.08 | 15.97 | 15.53 |
| $L_0N_2$ | 12.72 | 13.04 | 12.88 | 17.32 | 16.72 | 17.02 |
| $L_0N_3$ | 12.00 | 12.17 | 12.08 | 16.39 | 16.67 | 16.53 |
| $L_0N_4$ | 12.83 | 13.70 | 13.27 | 15.50 | 15.28 | 15.39 |
| $L_1N_0$ | 10.75 | 10.61 | 10.68 | 16.11 | 17.14 | 16.62 |
| $L_1N_1$ | 13.39 | 13.94 | 13.67 | 17.22 | 17.19 | 17.21 |
| $L_1N_2$ | 14.19 | 15.16 | 14.68 | 18.69 | 19.14 | 18.92 |
| $L_1N_3$ | 13.78 | 14.64 | 14.21 | 18.53 | 18.39 | 18.46 |
| $L_1N_4$ | 13.53 | 13.36 | 13.44 | 17.96 | 17.86 | 17.91 |
| **SEm±** | **0.44** | **0.52** | **0.34** | **0.90** | **0.84** | **0.58** |
| **CD (P= 0.05)** | **1.29** | **1.55** | **0.97** | **2.68** | **2.12** | **1.65** |

**Table.9** Economics of rice-pea production

| Interactions | Cost of cultivation (₹ ha$^{-1}$) | Gross income (₹ ha$^{-1}$) | | Net income (₹ ha$^{-1}$) | | Benefit cost ratio | |
|---|---|---|---|---|---|---|---|
| | | 2016-17 | 2017-18 | 2016-17 | 2017-18 | 2016-17 | 2017-18 |
| $T_1$ ($L_0N_0$) | 54240 | 70274.5 | 68673 | 16034.5 | 14433 | 0.30 | 0.27 |
| $T_2$ ($L_0N_1$) | 57840 | 112212.5 | 111308 | 54372.5 | 53468 | 0.94 | 0.92 |
| $T_3$ ($L_0N_2$) | 59940 | 125188.5 | 129131.5 | 65248.5 | 69191.5 | 1.09 | 1.15 |
| $T_4$ ($L_0N_3$) | 57840 | 118724 | 120550.5 | 60884 | 62710.5 | 1.05 | 1.08 |
| $T_5$ ($L_0N_4$) | 56980 | 122974.5 | 127946.5 | 65994.5 | 70966.5 | 1.16 | 1.25 |
| $T_6$ ($L_1N_0$) | 56240 | 106906.5 | 108928.5 | 50666.5 | 52688.5 | 0.90 | 0.94 |
| $T_7$ ($L_1N_1$) | 59840 | 129388.5 | 134054 | 69548.5 | 74214 | 1.16 | 1.24 |
| $T_8$ ($L_1N_2$) | 61940 | 141221.5 | 146962 | 79281.5 | 85022 | 1.28 | 1.37 |
| $T_9$ ($L_1N_3$) | 59840 | 134394 | 139528.5 | 74554 | 79688.5 | 1.25 | 1.33 |
| $T_{10}$ ($L_1N_4$) | 58980 | 130994 | 130059.5 | 72014 | 71079.5 | 1.22 | 1.21 |

**Table.10** Interaction effect on economics of rice-pea

| Treatments | Rice equivalent yield of pea (kg ha$^{-1}$) | | | Rice yield (kg ha$^{-1}$) | | | System productivity (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2016-17 | 2017-18 | Pooled | 2016 | 2017 | Pooled | 2016-17 | 2017-18 | Pooled |
| **Lime** | | | | | | | | | |
| $L_0$ | 6634.22 | 6760.88 | 6697.55 | 3094.00 | 3133.13 | 3113.57 | 9728.22 | 9894.01 | 9811.11 |
| $L_1$ | 7735.16 | 7943.65 | 7839.41 | 3500.53 | 3575.27 | 3537.90 | 11235.69 | 11518.92 | 11377.31 |
| **SEm±** | **59.66** | **79.94** | **49.87** | **24.06** | **34.19** | **20.90** | **65.80** | **97.42** | **58.78** |
| **CD (P= 0.05)** | **177.25** | **237.51** | **143.04** | **71.47** | **101.57** | **59.95** | **195.51** | **289.44** | **168.59** |
| **INM** | | | | | | | | | |
| $N_0$ | 5329.63 | 5342.58 | 5336.10 | 2580.17 | 2624.83 | 2602.50 | 7909.80 | 7967.41 | 7938.60 |
| $N_1$ | 7320.34 | 7426.76 | 7373.55 | 3382.17 | 3389.67 | 3385.92 | 10702.51 | 10816.43 | 10759.47 |
| $N_2$ | 7927.82 | 8269.09 | 8098.46 | 3587.50 | 3720.17 | 3653.83 | 11515.33 | 11989.26 | 11752.29 |
| $N_3$ | 7626.36 | 7837.28 | 7731.82 | 3468.83 | 3514.17 | 3491.50 | 11095.20 | 11351.45 | 11223.32 |
| $N_4$ | 7719.28 | 7885.61 | 7802.44 | 3467.67 | 3522.17 | 3494.92 | 11186.95 | 11407.78 | 11297.36 |
| **SEm±** | **94.33** | **126.39** | **78.86** | **38.04** | **54.05** | **33.05** | **104.04** | **154.03** | **92.94** |
| **CD (P= 0.05)** | **280.26** | **375.54** | **226.17** | **113.01** | **160.60** | **94.78** | **309.12** | **457.64** | **266.56** |

**Table.11** Interaction effect on economics of rice-pea

| Treatments | Rice equivalent yield of pea (kg ha$^{-1}$) | | | Grain yield (kg ha$^{-1}$) | | | System productivity (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2016-17 | 2017-18 | Pooled | 2016 | 2017 | Pooled | 2016-17 | 2017-18 | Pooled |
| **Lime x INM** | | | | | | | | | |
| **$L_0N_0$** | 4220.52 | 4117.24 | 4168.88 | 2189.33 | 2104.33 | 2146.83 | 6409.85 | 6221.57 | 6315.71 |
| **$L_0N_1$** | 6771.99 | 6704.01 | 6738.00 | 3215.00 | 3127.67 | 3171.33 | 9986.99 | 9831.68 | 9909.33 |
| **$L_0N_2$** | 7468.82 | 7789.78 | 7629.30 | 3366.67 | 3583.33 | 3475.00 | 10835.49 | 11373.12 | 11104.30 |
| **$L_0N_3$** | 7204.97 | 7308.06 | 7256.52 | 3334.00 | 3383.33 | 3358.67 | 10538.97 | 10691.40 | 10615.19 |
| **$L_0N_4$** | 7504.78 | 7885.28 | 7695.03 | 3365.00 | 3467.00 | 3416.00 | 10869.79 | 11352.28 | 11111.03 |
| **$L_1N_0$** | 6438.74 | 6567.91 | 6503.33 | 2971.00 | 3145.33 | 3058.17 | 9409.74 | 9713.25 | 9561.49 |
| **$L_1N_1$** | 7868.69 | 8149.52 | 8009.10 | 3549.33 | 3651.67 | 3600.50 | 11418.02 | 11801.18 | 11609.60 |
| **$L_1N_2$** | 8386.83 | 8748.40 | 8567.61 | 3808.33 | 3857.00 | 3832.67 | 12195.16 | 12605.40 | 12400.28 |
| **$L_1N_3$** | 8047.75 | 8366.51 | 8207.13 | 3603.67 | 3645.00 | 3624.33 | 11651.42 | 12011.51 | 11831.46 |
| **$L_1N_4$** | 7933.77 | 7885.94 | 7909.85 | 3570.33 | 3577.33 | 3573.83 | 11504.11 | 11463.27 | 11483.69 |
| **SEm±** | **133.40** | **178.75** | **111.52** | **53.79** | **76.44** | **46.74** | **147.14** | **217.83** | **131.43** |
| **CD (P= 0.05)** | **396.35** | **531.09** | **319.85** | **159.82** | **227.12** | **134.05** | **437.17** | **647.21** | **376.97** |

The least was observed in $N_1$ (RDF) and $N_0$ (Control). Pooled data of both the years also followed the similar trend of findings with the highest rice equivalent yield (8098.46 kg ha$^{-1}$) recorded from treatment application of RDF (75%) + FYM @ 6 t ha$^{-1}$) with lime @ 2 q ha$^{-1}$. Acharya and Mondal (2010) reported similar results from a study on rice-cabbage-greengram cropping system where higher rice equivalent yield (REY) of 32.33 t ha$^{-1}$ was recorded under 75% RDF + 25% N through FYM to all the crops than RDF alone which produced REY of 26.80 t ha$^{-1}$.

Interaction effects between lime and INM levels were found to be significant during both the years of experimentation. During 2016-17 and 2017-18, the highest rice equivalent yield was obtained with treatment interactions $L_1N_1$ (Lime @ 2 q ha$^{-1}$ + RDF).

The treatment interactions $L_1N_3$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) and $L_1N_4$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + Azospirillim + PSB) were found to be statistically at par with each other. Pooled data of both the years also recorded similar findings with the highest rice equivalent yield (8567.61 kg ha$^{-1}$) recorded from treatment application of RDF (75%) + FYM @ 6 t ha$^{-1}$) with lime @ 2 q ha$^{-1}$.

Results are in conformity with the findings of Verma *et al.,* (2019) who reported highest maize equivalent yield with the combination of Lime + NPK (7843 kg ha$^{-1}$) over RDF and control.

## System productivity

System productivity of the cropping system was influenced significantly under different levels of lime. Among the lime levels, the highest system productivity (11235.69 kg ha$^{-1}$) and (11518.92 kg ha$^{-1}$) was recorded from treatment $L_1$ (Lime @ 2 q ha$^{-1}$) during 2016 and 2017 respectively. Pooled data of both the years showed significant variation with higher system productivity (11377.31 kg ha$^{-1}$) recorded from treatment $L_1$ (Lime @ 2 q ha$^{-1}$) over treatment $L_0$ (without lime). The use of lime in rice increased the productivity of rice and also enhanced productivity of succeeding pea thereby improved system productivity. In support of the above findings, Sorokhaibam *et al.,* (2016) also reported that application of lime @ 500 kg $CaCO_3$ $ha^{-1}$ before planting rice continuously for two cropping seasons had residual effect on seed and stover yields of succeeding rapeseed resulting in improvement of system productivity in terms of rice equivalent yield (REY) over no liming.

System productivity of the cropping system was influenced significantly under different levels of INM. Among the INM levels, the highest system productivity (11515.33 kg $ha^{-1}$) and (11989.26 kg $ha^{-1}$) was recorded from treatment application of $N_2$ (RDF (75%) + FYM @ 6 t $ha^{-1}$) with lime @ 2 q $ha^{-1}$) during 2016 and 2017 respectively. The treatments $N_3$ (RDF (75%) + Poultry manure @ 1 t $ha^{-1}$) and $N_4$ (RDF (75%) + Azospirillim + PSB) were found to be statistically at par. Pooled data also recorded significant variation with the highest system productivity (11752.29 kg $ha^{-1}$) recorded from treatment $N_2$ (RDF (75%) + FYM @ 6 t $ha^{-1}$) with lime @ 2q $ha^{-1}$) and the lowest in $N_O$ (control). Acharya and Mondal (2010) reported similar results where highest productivity was recorded under 75% RDF + 25% N through FYM than RDF alone which produced REY of 26.80 t $ha^{-1}$ on rice-cabbage-greengram cropping system.

The interaction effect between lime and INM levels were found to be significant during both the years of experiment. The highest system productivity recorded from $L_1N_2$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + FYM @ 6 t $ha^{-1}$) during both the years. The interaction treatments between interactions $L_1N_3$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + Poultry manure @ 1 t $ha^{-1}$) and $L_1N_4$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + Azospirillim + PSB) were found to be statistically at par for both the years. Pooled data of both the years also recorded significant variation with the highest system productivity (12400.28 kg $ha^{-1}$) recorded from treatment $L_1N_2$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + FYM @ 6 t $ha^{-1}$) and the lowest in $N_O$ (Control). Singh *et al.,* (2011) revealed that system productivity was increased by 2 to 4 times under INM treatments over the existing farmers' practices rice-pea cropping system.

Higher system productivity (9412 kg $ha^{-1}$) was obtained with combined application of 5 t FYM + 250 kg lime + 20 kg S+ 1 kg B $ha^{-1}$ along with 50% RDF than obtained with 100% RDF only (6832 kg $ha^{-1}$). Swain *et al.,* (2019) also reported that integrated use of 75% RDN and 25 % N through FYM along with 0.2 LR lime and biofertilizer consortium recorded the highest system yield of 9.18 t SEY $ha^{-1}$, being16 and 32 % more than RDF through inorganic sources and organic practice, respectively.

## Yield and yield attributing characters of rice

The result of the findings indicated that Lime @ 2 q $ha^{-1}$ ($L_1$) recorded significantly higher yield on number of panicles $m^{-2}$, number of filled grains $panicle^{-1}$, grain yield and straw yield as compared to plots without lime ($L_0$). The different nutrient doses had significant influence on yield attributes. The highest values on number of panicles $m^{-2}$, length of panicle, number of filled grains $panicle^{-1}$, grain yield and harvest index were recorded with $N_2$ (RDF (75%) + FYM @ 6 t $ha^{-1}$). While for straw yield, the highest value was recorded with $N_3$ (RDF (75%) + poultry manure @ 1 t $ha^{-1}$).

Yield and yield attributing characters such as number of filled grains $panicle^{-1}$, grain yield and straw yield recorded significantly highest number in $L_1N_2$ (Lime @ 2 q $ha^{-1}$ + RDF (75%) + FYM @ 6 t $ha^{-1}$) proving its superiority over other treatments.

## Economics of the rice production

The data indicated that all the organic manure applied treatment combinations in conjunction with inorganic fertilizers recorded higher returns and B:C ratio compared to application of only inorganic fertilizers and absolute control. Among the integrated nutrient management, $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$) recorded the maximum gross income, net income as well as higher benefit cost ratio consecutively for two years.

## Growth and yield characters of succeeding pea

Growth and yield attributes and yield of succeeding rabi pea crop were significantly influenced by the lime levels which imposed to preceding rice crop. The plant height, number of branches plant$^{-1}$, number of pods plant$^{-1}$, number of seeds pod$^{-1}$, pod yield and stover yield recorded highest which received residual lime as compared to plots without lime. However, significant dry weight was recorded only at 30 DAS with the highest recorded from residual lime treated plots.

Growth and yield attributing character and yield of succeeding pea were significantly higher with residual nutrient levels given to preceding kharif rice. The highest plant height, number of branches plant$^{-1}$, number of pods plant$^{-1}$, number of seeds pod$^{-1}$, pod yield and stover yield was recorded from residual (RDF (75%) + FYM @ 6 t ha$^{-1}$) followed by residual (RDF (75%) + Poultry manure @ 1 t ha-1). However, significant dry weight was recorded only at 30 DAS with the highest recorded from residual (RDF (75%) + FYM @ 6 t ha$^{-1}$) treated plots.

During both years of study, the lime and INM treatments given to preceding kharif rice had significant influence on succeeding pea plant height (60 DAS and at harvest), pod yield and stover yield was recorded from residual treatment $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$). However, plant height at 30 DAS was recorded highest from residual treatment residual (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) followed by residual treatment $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$).

## Economics of the succeeding pea production

Residual effect of (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$) in preceding rice brought about significant improvement in yield of succeeding pea crop with the maximum gross return (₹ 70,966.67 and ₹ 75816.67), net return (₹ 39666.67 and ₹ 44516.67) and benefit-cost ratio of (1.27 and 1.42) during 2016-17 and 2017-18 respectively, and is recommended for higher productivity of succeeding pea, besides contributing significant effect on soil quality.

Residual effect of (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$) in preceding rice brought about significant improvement in yield of succeeding pea crop with the maximum gross return (₹ 70,966.67 and ₹ 75816.67), net return (₹ 39666.67 and ₹ 44516.67) and benefit-cost ratio of (1.27 and 1.42) during 2016-17 and 2017-18 respectively, and is recommended for higher productivity of succeeding pea, besides contributing significant effect on soil quality.

## Rice equivalent yield of pea

Significant difference was recorded due to lime and INM levels on rice equivalent yield of pea. Liming @ 2 q ha$^{-1}$ showed the highest rice equivalent yield (7839.41 kg ha$^{-1}$) as compared to plots without lime treatment. Among the nutrient sources, $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$ recorded the highest rice equivalent yield (8098.46 kg ha$^{-1}$) followed by (RDF (75%) + Poultry manure @ 1 t ha$^{-1}$) and (RDF (75%) + Azospirillum + PSB) and the least recorded in RDF and control. Significantly, highest rice equivalent yield (8567.61kg ha$^{-1}$) was recorded in combination of $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$) over all the treatments under experiment.

## System productivity of rice-pea cropping system

Significant difference was recorded due to lime and INM levels on system productivity of rice-pea cropping system. Liming @ 2 q ha$^{-1}$ improved system productivity over no lime treated plots while in case of nutrient sources, $N_2$ (RDF (75%) + FYM @ 6 t ha$^{-1}$) recorded the highest system productivity over other nutrient sources. The interaction effects between liming and INM were found to be significant on system productivity with the highest value (12400.28 kg ha$^{-1}$) recorded in combination of $L_1N_2$ (Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$) over other treatments.

In conclusion

Performance of rice was significantly influenced by combination of Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$ ($T_8$) followed by Lime @ 2 q ha$^{-1}$ + RDF (75%) + Poultry manure @ 1 t ha$^{-1}$ ($T_9$) and Lime @ 2 q ha$^{-1}$ + RDF (75%) + Azospirillum + PSB ($T_{10}$) in rice-pea crop sequence.

Performance of pea was significantly influenced by combination of residual Lime @ 2 q ha$^{-1}$ + RDF (75%) + FYM @ 6 t ha$^{-1}$ ($T_8$) followed by Lime @ 2 q ha$^{-1}$ + RDF (75%) + Poultry manure @ 1 t ha$^{-1}$ ($T_9$) and Lime @ 2 q ha$^{-1}$ + RDF (75%) + Azospirillum + PSB ($T_{10}$) in rice-pea crop sequence.

Integrated application of lime and FYM along with NPK fertilizers recorded the highest economics of rice-pea production, REY and maintained the system productivity and enhanced the sustain ability under rice-pea cropping system in acid soils.

Long-term studies on integration of inorganic and organic nutrient sources on crop productivity and economics of rice and pea production are needed for final recommendation to the farmers.

## References

Acharya D and Mandal S S. 2010. Effect of integrated nutrient management on the growth, productivity and quality of crops in rice (*Oryza sativa* L.)–cabbage (*Brassica oleracea*)-greengram (*Vigna radiata*) cropping system. *Indian Journal of Agronomy* 55 (1): 1-5.

Acharya R, Dash A K and Senapati H K. 2012. Effect of integrated nutrient management on microbial activity influencing grain yield under rice-rice cropping system in an acid soil. *Asian Journal of Microbiology, Biotechnology & Environmental Sciences Paper* 14 (3): 365-368.

Alim M A. 2012. Effect of organic and inorganic sources and doses of nitrogen fertilizer on the yield of boro rice. *Journal of Environmental Sciences & Natural Resources* 5 (1): 273- 282.

Anonymous. 2018. Agricultural Statistics at a Glance. Ministry of Agriculture & Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare Directorate of Economics and Statistics, Government of India.

Anonymous. 2019. *Statistical Handbook of Nagaland*. Directorate of Economics and Statistics, Government of Nagaland, Kohima.

Arif, M, Tasneem M, Bashir F, Yaseen G and

Iqbal R M. 2014. Effect of integrated use of organic manures and inorganic fertilizers on yield and yield components of rice. *Journal of Agricultural Research* 52 (2): 197-206.

Bahmaniar M A, Ranjbar G A, Ahmadian S H. 2007. Effects of N and K applications on agronomic characteristics of two Iranian and landrace rice (*Oryza sativa* L.) cultivars. *Pakistan Journal of Biological Sciences* 10 (6): 880-886.

Barik A K, Das Giri A K and Chattopadhyay G N.2006.Effect of organic (Vermicompost, farmyard manure) and Chemical sources of plant nutrients on productivity and soil fertility of kharif rice (*Oryza sativa* L). *Crop Research* 31 (3): 339-342.

Caires E F, Alleoni L R F, Cambri M A and Barth G. 2005. Surface application of lime amelioration sub-soil acidity and improves root growth and yield of wheat in an acid soil under no-till system. *Scientia Agricola* 63: 502–509.

Cifu M, Xiaonan L, Zhihong C, Zhhengyi H and Wanzhu M. 2004. Long-term effect of lime application on soil acidity and crop yields on a red soil in Central Zhejiang. *Plant and Soil* 265: 101–109.

Costa A and Rosolem C A. 2007. Liming in the translation to no-till under a wheat soybean rotation. *Soil and Tillage Research* 97: 207–217.

Dobermann A and Fairhust T H. 2000. Rice nutrient disorders and nutrient management. Potash & Phosphate Institute of Canada (PPIC) and International Rice Research Institute, Philippine. pp.3.

Ferdous S A, Miah M N H, Hoque M, Hossain M S and Hasan A K. 2018. Enhancing rice yield in acidic soil through liming and fertilizer management. *Journal of Bangladesh Agricultural University* 16 (3): 357–365.

Ferdous S A, Miah M N H, Hoque M, Hossain M S and Hasan A K. 2018. Enhancing rice yield in acidic soil through liming and fertilizer management. *Journal of Bangladesh Agricultural University* 16 (3): 357–365.

Ferdous S A, Miah M N H, Hoque M, Hossain M S and Hasan A K. 2018. Enhancing rice yield in acidic soil through liming and fertilizer management. *Journal of Bangladesh Agricultural University* 16 (3): 357–365.

Ganapathi, Niranjana K S, Jayaprakash S M and Harshitha S. 2019. Effect of granulated liming material on soil properties and yield of paddy in acid soil of Bramhavara. *International Journal of Current Microbiology and Applied Sciences* 8 (4): 1714-1723.

Gawai P P and Pawar V S. 2006. Integrated nutrient management in sorghum (*Sorghum bicolor*)-chickpea (*Cicer arietinum*) cropping sequence under irrigated conditions. *Indian Journal of Agronomy* 51 (1):17-20.

Gawai P P and Pawar V S. 2006. Integrated nutrient management in sorghum (*Sorghum bicolor*)-chickpea (*Cicer arietinum*) cropping sequence under irrigated conditions. *Indian Journal of Agronomy* 51 (1):17-20.

Gudadhe N N. 2008. Effect of integrated nutrient management system in cotton-chickpea cropping sequence under irrigated conditions. Ph.D. thesis submitted to M.P.K.V., Rahuri (M.S.).

Gudadhe N, Dhonde M B and Hirwe N A. 2015.Effect of integrated nutrient management on soil properties under cotton-chickpea cropping sequence in vertisols of Deccan plateau of India. *Indian Journal of Agricultural Research* 49 (3): 207-214.

Gumma, Krishna M, Prasad S, Thenkabail P S, Teluguntla P, Rao M N, Mohammed I A and Anthony M. Whitbread. 2016. Mapping rice fallow cropland areas for short-season grain legumes intensification in South Asia using MODIS 250 m time-series data. *International Journal of Digital Earth* 9 (10): 981-1003.

Gupta C R, Sengar S S, Singh J. (2000). Growth and yield of table pea (*Pisum sativum* L.) as influenced by levels of phosphorus and lime in acidic soil. *Vegetable Sciences* 27 (1): 101-102

Kumar M, Khan M H, Singh P, Ngachan S V, Rajkhowa D J, Kumar A, Devi M H. 2012. Variable lime requirement based on differences in organic matter content of iso-acidic soils. *Indian Journal of Hill Farm* 25 (1): 26-30.

Kumar R. 2015. Influence of mulching, liming and farm yard manures on production potential, economics and quality of maize (*Zea mays* L.) under rainfed condition of Eastern Himalaya. *Bangladesh Journal of Botany* 44 (3): 391-398.

Lakshmi Ch S R, Rao P C , Sreelatha T, Madhavi M, Padmaja G and Sireesha A. 2013. Effect of different vermicomposts under integrated nutrient management on soil fertility and productivity of rice. *Oryza* 50 (3): 241-248.

Latha M, Prasad P R, Prasad P R K, Lakshmipathy R and Srinivasarao V. 2019. Effect of integrated nitrogen management on rice and rice fallow rabi crops. *International Journal of Current Microbiology and Applied Sciences* 8 (1): 271-280.

Latha M, Prasad P R, Prasad P R K, Lakshmipathy R and Srinivasarao V. 2019. Effect of integrated nitrogen management on rice and rice fallow rabi crops. *International Journal of Current Microbiology and Applied Sciences* 8 (1): 271-280.

Lokose R Y P, Jena S N, Behera B, Behera J. 2015. Residual effects of weed and nutrient management in maize + cowpea intercropping system on yield of succeeding sesame. *International Journal of Science and Research* 6 (8): 1191-1195.

Malo M , Rath S and Dutta D. 2018. Response of Rice Cultivation to Inorganic and Bio-Fertilizers in New Alluvial Zone of West Bengal. *International Journal of Current Microbiological Applied Sciences* 7(3): 2707-2714.

Manpreet S and Dixit S P. 2017. Yield, profitability and nutrient uptake of wheat under soil test crop response based fertilizer application with different levels of lime in an acid Alfisol. *Journal of Pharmacognosy and Phytochemistry* 6 (6): 1985-1988.

Mathew J and Thampatti K C M. 2007. Response of cowpea (*Vigna unguiculata*) to phosphogypsum application. *Legume Research* 30 (4): 271 – 274.

Meena H M and Prakasha H C. 2019. Residual effect of soil test value based fertilizer application and amendments on cowpea productivity in acidic soil. *International Journal of Chemical Studies* 7 (4): 1480-1484.

Meena H M and Prakasha H C. 2019. Residual effect of soil test value based fertilizer application and amendments on cowpea productivity in acidic soil. *International Journal of Chemical Studies* 7 (4): 1480-1484.

Meena H M and Prakasha H C. 2019. Residual effect of soil test value based fertilizer application and amendments on cowpea productivity in acidic soil. *International Journal of Chemical Studies* 7 (4): 1480-1484.

Mirza B B, Zia M S, Szambathovan N and

Zauju A. 2005. Rehabilitation of soils through environmental friendly technologies: Role of sesbania and farmyard manure. *Agricultura Tropica Et Subtropica* 38 (1): 12-16.

Mitu A S, Khan M A and Rashed M R U. 2017. Effect of fertilizer manure and lime on growth and yield of Boro rice in acidic red soil. Agricultural Research & Technology 5 (5): 1-6.

Mondal S, Mallikarjun M, Ghosh M, Ghoshand D C and Timsina J. 2015. Effect of integrated nutrient management on growth and productivity of hybrid rice. *Journal of Agricultural Science and Technology* 5: 297-308.

Moody P W, Aitken R L and Dickson T. 1995. Diagnosis of maize yield response to lime in some weathered acidic soils. In Plant-soil interactions at low pH Proceedings of the 3rd International Symposium on Plant-soil interactions at low pH. pp: 537–541.

Murphy P N C and Sims J T. 2012. Effects of lime and phosphorus application on phosphorus runoff risk. *Water Air Soil Pollution* 223: 5459-5471.

Nawle S S, Pawar A D, Lambade B M and Ugale N S. 2009. Yield maximization of chick pea through INM applied to sorghum-chickpea cropping sequence under irrigated condition. *Legume Research* 32 (4): 282-285.

Patil H M, Tuwar S S and Wani A G. 2008. Integrated nutrient management in sorghum (*Sorghum bicolor*) – chickpea (*Cicer arietinum*) cropping sequence under irrigated conditions. *International Journal of Agricultural Science* 4 (1): 220-224.

Reddy C H B R and Subramanian K S 2016. Synthesis and characterization of nano-amendment for effective remediation of soil acidity. *Asian Journal of Soil Science* 11 (1): 51– 57.

Revathi P, Devi K B S, Reddy B G, Rao V P, Padmaja G and Shanker A S. 2014. Influence of planting methods and integrated nutrient management on growth, yield and economics of rice. *Journal of Rice Research* 7 (1 & 2): 62-76.

Saha R, Mishra V K, Majumdar B, Laxminarayana K, Ghosh P K. 2010. Effect of integrated nutrient management on soil Physical properties and crop productivity under a maize (*Zea mays*)–mustard (*Brassica campestris*) cropping sequence in acidic Soils of Northeast India. *Communications in Soil Science and Plant Analysis* 41: 2187–2200.

Sahu P, Chandrakar T, Paikra M and Joshi K K. 2018. Effect of organic and inorganic sources of nutrients on yield attributing characteristics and yield of direct seeded rice in *Inceptisols* of Bastar plateau zone. *International Journal of Current Microbiology and Applied Sciences* 7 (3): 3757-3761.

Sahu Y K, Kumar P, Dhruw T K and Joshi S K. 2018. Effects of integrated nutrient management on rice (*Oryza sativa* L) yield and yield attributes, nutrient uptake - A review. *Trends in Biosciences* 11 (1): 1-6.

Shanwad U K, Nagesh A K B, Hulihalli U K, Surwenshi A, Reddy M and Jalageri B R. 2010. Integrated nutrient management in maize-bengal gram cropping system in Northern Karnataka. *Research Journal of Agricultural Sciences* 1 (3): 252-254.

Sharma V K, Pandey R N, Kumar S, Chobhe K A and Chandra S. 2016. Soil test crop response based fertilizer recommendations under integrated nutrient management for higher productivity of pearl millet (*Pennisetum glaucum* L.)- wheat (*Triticum aestivum*L) under long term experiment.

*Indian Journal of Agricultural Sciences* 86: 1076–81.

Sindhi S J, Thanki J D, Mansuri R N and Desai L J. 2016. Residual effect of integrated nutrient management in rabi maize on growth and yield parameters of summer green gram under maize-green gram cropping sequence. *International Journal of Agriculture Sciences* 8 (52): 2443-2445.

Sindhi S J, Thanki J D, Mansuri R N and Desai L J. 2016. Residual effect of integrated nutrient management in rabi maize on growth and yield parameters of summer green gram under maize-green gram cropping sequence. *International Journal of Agriculture Sciences* 8 (52): 2443-2445.

Singh D K, Pandey P C, Nanda G, and Gupta S. 2018. Long-term effects of inorganic fertilizer and farmyard manure application on productivity, sustainability and profitability of rice-wheat system in Mollisols. *Archives of Agronomy and Soil Science* 65: 139-151.

Singh D K, Pandey P C, Nanda G, and Gupta S. 2018. Long-term effects of inorganic fertilizer and farmyard manure application on productivity, sustainability and profitability of rice-wheat system in Mollisols. *Archives of Agronomy and Soil Science* 65: 139-151.

Singh D K, Pandey P C, Nanda G, and Gupta S. 2018. Long-term effects of inorganic fertilizer and farmyard manure application on productivity, sustainability and profitability of rice-wheat system in Mollisols. *Archives of Agronomy and Soil Science* 65: 139-151.

Singh N P, Praharaj C S and Sandhu J S. 2016. Utilizing untapped potential of rice fallow of East and North-east India through pulse production. *Indian Journal of Genetics and Plant Breeding* 76 (4): 388-98.

Singh R N, Singh S, Prasad S S, Singh V K and Pramod P. 2011. Effect of integrated nutrient management on soil fertility, nutrient uptake and yield of rice-pea cropping system on an upland acid soil of Jharkhand. *Journal of the Indian Society of Soil Science* 59 (2): 158-163.

Singh S K, Varma S C and Singh R P. 2002. Effect of integrated nutrient management on yield, nutrient uptake and changes in soil fertility under rice (Oryza sativa)-lentil (*Lens culinaris*) cropping system. *Indian Journal of Agronomy* 46 (2): 191-197.

Slattery W J and Conventry D R. 1993. Response of wheat, triticale, barley and canola to lime on four soil types in south-eastern Victoria. *Australian Journal Soil Research* 33:609–618.

Sorokhaibam S, Singh N A and Nabachandra L. 2016. Enhancement of productivity, profitability and resource use efficiency of rice-rapeseed cropping system through liming, planting time and tillage practices in North East India. *International Journal of Bio-resource and Stress Management* 7 (3):373-381.

Sravan U S and Singh S P. 2019. Effect of integrated nutrient management on yield and quality of basmati rice varieties. *Journal of Agricultural Science* 11 (5): 93-103.

Swain B, Garnayak L M and Mangaraj S. 2019. Effect of crop combination and nutrient management on yield, nutrient uptake and economics of sweet corn based cropping system. *Journal of Crop and Weed* 15 (1): 114-120.

Tang H, Xiao X, Tang W, Li C, Wang K, Li W, Pan X. 2018. Long-term effects of NPK fertilizers and organic manures on soil organic carbon and carbon management index under a doublecropping rice system in Southern China. *Communications in Soil Science and Plant Analysis* 49: 1976-1989.

Urkurkar J S, Tiwari A, Chitale S and Bajpai R K. 2010. Influence of long term use of inorganic and organic manures on soil fertility and sustainable productivity of rice (*Oryza sativa*) and Wheat (*Triticum aestivum*) in Inceptisols. *Indian Journal of Agricultural Sci*ences 80 (3): 208-212.

Venkatesh M S, Majumdar B, Kunar K and Patiram. 2002. Effect of Phosphorus, FYM and lime on yield, P uptake by maize and forms of soil acidity in typic hapludalf of Meghalaya. *Journal of the Indian Society of Soil Science* 50 (3): 254–258.

Venkatesh M S, Majumdar B, Kunar K and Patiram. 2002. Effect of Phosphorus, FYM and lime on yield, P uptake by maize and forms of soil acidity in typic hapludalf of Meghalaya. *Journal of the Indian Society of Soil Science* 50 (3): 254–258.

Verma D K, Mohan M, Asthir B. 2015. Physicochemical and cooking characteristics of Azad Basmati. *International Food Research Journal* 22 (4): 1380-1389.

Verma S, Mahapatra P, Shahi D K, Agarwal B K and Sinha A K. 2019. Sustainable production potential of maize-wheat cropping system in Ranchi based on the permanent manurial trial (PMT). *International Journal of Chemical Studies* 6: 268-271.

Westermann D T. 1992. Lime effects on phosphorus availability in calcareous soil. *Soil Science Society of America Journal* 56 (2): 489–494.

**How to cite this article:**

Arenjungla, Ao, Lowrence Kithan and Tongpang Longkumer, L. 2020. Economics of Rice and Pea. *Int.J.Curr.Microbiol.App.Sci.* 9(08): 1788-1810.
doi: https://doi.org/10.20546/ijcmas.2020.908.207