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# Evaluation of production potential and economics of Garlic-Maize-T. Aman rice based cropping system in Kurigram

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***ABSTRACT***

*The study was conducted to determine the yield and economic return of two cropping patterns viz. introduced cropping pattern (Garlic-Maize-T. Aman rice) and farmers' traditional pattern (Fallow-Boro-T. Aman rice) through incorporation of HYV crops with standard management practices for crop production. The experiment was laid out in randomized complete block design with six dispersed replications in farmers' fields in Ulipur, Kurigram during two consecutive years 2012-13 and 2013-14. Two years mean data showed that the standard management practices for the patterns provided significantly high yield. The gross return (Tk. 435176/ha) and net return (Tk. 195237/ha) of new pattern were respectively 26.06 % and 231 % higher than that of farmers' pattern with 140% extra cost. The high marginal benefit cost ratio, land use efficiency and production efficiency indicated the superiority of the introduced pattern to the farmers' traditional practices.*

***Key Words:*** *Cropping pattern, Agronomic practices, Land use efficiency, Production potential and Marginal Benefit-Cost Ratio (MBCR)*

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## I. Introduction

About 63805 hectares area of Kurigram district (AEZ-3) is under char land which covers about 19.4% of the total cultivated area of the district (BBS, 2012). The productivity of char land is very poor. The productivity can be increased by inclusion of high value crops in the existing cropping system. Fallow-Boro-T. Aman rice cropping pattern is commonly practiced in the stable char lands and the farmers their in are totally depend on underground water for Boro crops. As a result cost of production surpasses the profit. On the other hand, Rabi Maize with less number (2-3) of irrigation ensures higher production. Day by day the area for Boro cultivation is on increasing trend and the water table is going down for the excess use of underground water. For increasing productivity of char land, development of alternate cropping pattern is urgently needed. In this context, not only the modern production technology and complementary inputs are essential but also the diversification of crops throughout the country is foremost. Further, spices cultivation in northern part is very low due to use of low



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yielding cultivar. Per annum a huge fund is needed for importing spices from abroad. So, development of spice based cropping pattern may avail of large cash return. One of the major patterns is Potato-Maize-T. Aman rice in the light soilis considered to be more profitable as compared to other existing cropping patterns (Kabir & Islam, 2012). Overall productivity in addition as profit of the farmers can be multiplied significantly by introducing trendy varieties and improved management practices (Khan et al., 2005, Khan et al., 2006; Nazrul et al., 2013). A study was, therefore, undertaken with the objective to evaluate the agro-economic feasibility of a introduced cropping pattern (Garlic-Maize-T. Aman), ICP over the traditional cropping pattern (Fallow-Boro-T. Aman rice), TCP.

## II. Materials and Methods

The study was conducted at Multi Location Testing (MLT) site of Bangladesh Agricultural Research Institute (BARI) at Ulipur, Kurigram during 2012-14. It belongs to the Testa Meander Floodplain Agro-ecological Zone of Bangladesh (AEZ-3). The experimental site is dominant with tropical monsoon climate with irregular rainfall. The most of the rainfall was received during the months of May to September. The annual rainfall in 2012-13 and 2013-14 were 862 mm and 512mm respectively (Figure 01). Mean annual minimum and maximum temperature was 23.47/32.46$^{o}$C and 20.55/29.95$^{o}$C, respectively. The soil was sandy loam in texture with medium organic matter content (1.83%) and soil pH ranged from 5.7 to 5.8. The statuses of N, K, P, S, Zn and B are shown in Table 01. The introduced cropping pattern (ICP) was tested and compared against the farmers' pattern (FCP) with six dispersed replications under irrigated condition. Two plots each of 660m$^2$ for both patterns were selected for each replication. In the ICP pattern, BARI Rasun-1, NK-40 and BRRI dhan 49 were introduced against the FCP, Fallow-BRRI dhan 28/BR11. The standard agronomic practices and cultural operations for crop production and farmers' practices are presented in Table 02. All field operations and management practices of both improved and farmers' patterns were closely monitored and data were recorded on agronomic performance like field duration, land use efficiency, production efficiency and rice equivalent yield of the cropping patterns.

Land use efficiency was worked-out by taking total duration of crops in an individual cropping pattern divided by 365 days (Tomer and Tiwari, 1990). It was calculated by the following formula:

$$\text{Land Use Efficiency (\%)} = \frac{(d_1+d_2+d_3)}{365} \times 100$$

Where, $d_1$, $d_2$ and $d_3$ represent the duration of 1st, 2nd and 3rd crop of the pattern

Production efficiency value in terms of kg ha$^{-1}$ day$^{-1}$ was calculated by total main product in a cropping pattern divided by total duration of crops in that pattern (Tomar and Tiwari, 1990).

$$\text{Production Efficiency} = \frac{Y_1+Y_2+Y_3}{d_1+d_2+d_3}$$

Where, $Y_1$= Yield of 1st crop and $d_1$= Duration of 1st crop of the pattern
$Y_2$= Yield of 2nd crop and $d_2$= Duration of 2nd crop of the pattern
$Y_3$= Yield of 3rd crop and $d_3$= Duration of 3rd crop of the pattern

**Table 01. Soil nutrient status of the experimental area during 2012-14 parameters**

| | OM (%) | pH | Total N (%) | K(meq/100 g of soil) | P | S | Zn | B |
|---|---|---|---|---|---|---|---|---|
| | | | | | (µg/g soil) | | | |
| Range | 1.72-1.94 | 5.7-5.8 | 0.09-0.10 | 0.10-0.17 | 7.07-10.88 | 7.20-9.17 | 1.06-1.13 | 0.22-0.29 |
| Average | 1.83 | 5.75 | 0.01 | 0.14 | 8.98 | 8.19 | 1.1 | 0.26 |
| Critical limit | - | - | 0.12 | 0.12 | 10.00 | 10.00 | 0.6 | 0.2 |
| Interpretation | Medium | Slightly alkaline | Very low | Medium low | Medium low | Very low | Medium | Low |



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**Rice Equivalent Yield (REY):** Yield comparision between existing cropping pattern and improved cropping pattern was done by rice equivalent yield outcome from other crop yield into rice yield by prevailing market price of individual crops (Verma and Modgal, 1983). Rice equivalent yield (REY) was computed as yield of individual crop multiplied by market price of that crop divided by market price of rice (Verma and Modgal, 1983).

$$\text{Rice Equivalent yield} = \frac{(\text{Yield of individual crop} \times \text{Market price of that crop})}{\text{Market price of Rice}}$$

The cost and return analysis i.e total gross return, total variable cost, net return and marginal benefit cost ratio of existing and improved cropping pattern was done from prevailing market price of the produces during the crop sowing and harvesting period.

Economic analysis involved collection of data on prices and quantities of inputs used and output produced. The inputs used included seed, fertilizer, labour and insecticides. The output and inputs were valued at market prices. The results were used to compute net income, benefit cost ratio and rice equivalent yield of crops. Net income was computed as the difference between management (Family labour and operator's) cost and gross margin. Marginal benefit cost ratio was computed as Total gross return divided by total variable cost of cultivation.

$$\text{Marginal Benefit Cost Ratio (BCR)} = \frac{\text{Total Gross Return}}{\text{Total(Variable)cost of cultivation}}$$

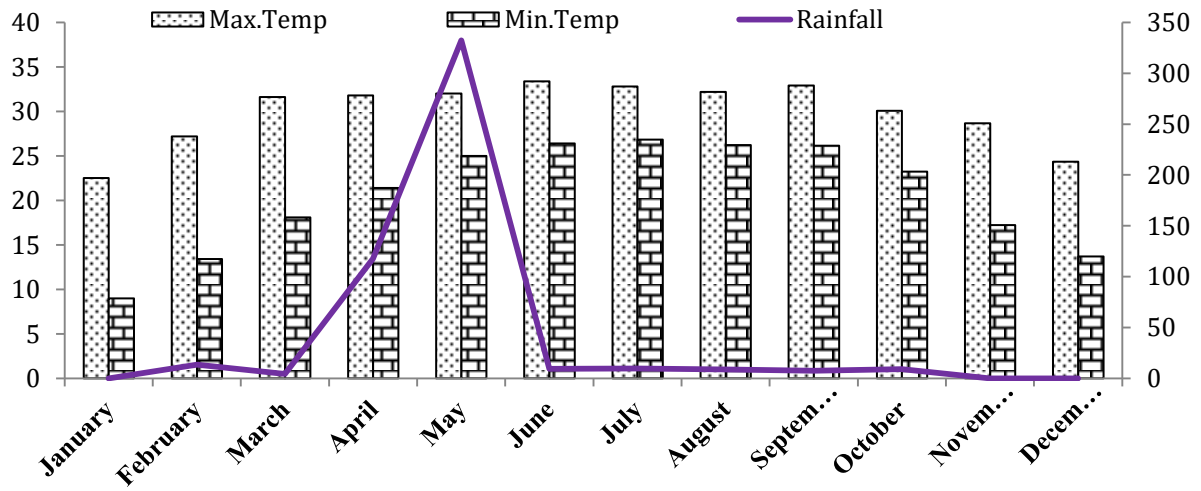


**Figure 01. Monthly average maximum temperature, minimum temperature and rainfall during the cropping period from 2012-14 in Ulipur, Kurigram.**

## III. Results and Discussion

### Yield of cropping patterns

The component crops of the improved cropping pattern Garlic-Maize-T. Aman rice gave higher yield as well as by-product in both years (Table 03). The yield of ICP pattern was higher due to change of variety with improved production technologies for the component crops. Garlic yield was higher (8.69 $tha^{-1}$) in 2012-13 and mean yield was calculated 8.39 $tha^{-1}$. Average maize yield of NK-40 variety was recorded 5.98 $tha^{-1}$. In Farmers practice, average Boro rice yield of BRRI dhan28 was 4.74 $tha^{-1}$. Aman rice was present in both practice. Higher Aman rice average yield was recorded in farmers practice BR11 (4.37) and in improved practice it was BRRI dhan 49 (3.97 $tha^{-1}$). Similar results were also obtained by many researchers (Nazrul et al., 2013; Khan et al. 2006; Khan et al. 2005; Hossain and Wahhab, 1992). In both years, farmers' pattern gave lower grain yield of rice due to imbalance use of fertilizers and more population. BR 11 in farmers' practice performed better than BRRI dhan 49 in farmers' practices due to longer crop duration.



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**By-product yield of the cropping patterns**

The ICP pattern produced higher by-product yield (11.68 $tha^{-1}$) than the farmers' pattern (9.82 $tha^{-1}$). The high by-product yield of ICP pattern could be attributed to the high amount of byproduct of maize over rice.

**Field duration**

In cropping pattern individual crop duration indices field duration of te respective. Total crop duration in improved cropping pattern was longer in both years than farmers' cropping pattern due to two crop were grown in existing pattern whereas in improved three crops were grown (Table 02). As a result, production efficiency and land use efficiency were higher in improved pattern than farmers' pattern.

**Rice equivalent yield**

Rice equivalent yield result showed that the improved cropping pattern produced higher rice equivalent yield against farmers existing cropping pattern (Table 04). Inclusion of high value spice crop and improvement of management practices in the improved pattern increased the rice equivalent yield. Lower rice equivalent yield was obtained in the farmers' pattern due to variety and traditional management practices.

**Production efficiency**

Production efficiency by means of kg/ha/day was counted and maximum production efficiency (51.84) was recorded from improved cropping pattern in 2012-13 closely followed by improved pattern (49.97) in 2013-14 (Table 04). Good management practices and modern HYV varieties lead the improved cropping pattern above existing cropping pattern in regards production efficiency. The minimum production efficiency was found in farmers' pattern due to modern management practices was absent. Mean production efficiency (50.91) in terms of kg/ha/day was higher in improved pattern and lower (42.43) in farmers' pattern, which was also found by Nazrul et al. (2013), Khan et al. (2006), Khan et al. (2005); Krishna and Reddy (1997).

**Land use efficiency**

Land use efficiency depends on crop duration during a cropping season. In improved and existing cropping pattern land use efficiency was calculated which denotes effectivity of both cropping pattern. In improved cropping pattern (96.03) mean land use efficiency was recorded higher over farmers' pattern used the land for 62.74 % period of the year (Table 04). The higher land use efficiency in improved practice because this pattern occupied the field for longest duration (350 days), whereas the farmers practice occupied the field for 229 days of the year.

**Table 02. Agronomic parameters considered in Garlic/Maize-T. Aman and Fallow-Boro-T. Aman cropping pattern at Ulipur, Kurigram, during 2012 to 2014**

| Items | C1= Fallow/ Garlic<br>C2= Boro/Maize<br>C3= T. Aman | Farmers Pattern (FP) | | Improved Pattern (IP) | |
|---|---|---|---|---|---|
| | | 2012-13 | 2013-14 | 2012-13 | 2013-14 |
| Variety | C1 | Fallow | Fallow | BARI Rasun-1 | BARI Rasun-1 |
| | C2 | BRRI dhan 28 | BRRI dhan 28 | NK 40 | NK 40 |
| | C3 | BR-11 | BR-11 | BRRI dhan 49 | BRRI dhan 49 |
| Sowing/Transplanting date | C1 | - | - | Dec. 11/12 | Dec. 8-10/13 |
| | C2 | Feb. 01-07/13 | Feb. 05-08/14 | Jan.18-20/13 | Jan.17-24/14 |
| | C3 | Jul.21-24/13 | Jul.25-27/14 | July 19-21/13 | July 16-20/14 |
| Seed rate (Kg $ha^{-1}$) | C1 | - | - | 250 | 250 |
| | C2 | 40 | 40 | 20 | 20 |
| | C3 | 35 | 35 | 30 | 30 |
| | All PSB & half of N and K as basal and rest at 25 and 35DAP | All PSB & half of N and K as basal and rest at 25 and 35DAP | All PSB & half of N and K as basal and rest at 25 and 35DAP | All PSB & half of N and K as basal and rest at 25 and 35DAP | All PSB & half of N and K as basal and rest at 25 and 35DAP |
| Planting Method | C1 | - | - | Line sowing | Line sowing |
| | C2 | Line sowing | Line sowing | Line sowing | Line sowing |



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| Items | C1= Fallow/ Garlic C2= Boro/Maize C3= T. Aman | Farmers Pattern (FP) | | Improved Pattern (IP) | |
|---|---|---|---|---|---|
| | | 2012-13 | 2013-14 | 2012-13 | 2013-14 |
| Spacing (cm) (Row x Hill) | C3 | Line sowing | Line sowing | Line sowing | Line sowing |
| | C1 | - | - | 20cm ×10cm | 20cm ×10cm |
| | C2 | 25 cm ×15 cm | 25 cm ×15 cm | 60 cm × 25 cm | 60 cm ×25 cm |
| | C3 | 25 cm ×15 cm | 25 cm ×15 cm | 25 cm ×15 cm | 25 cm ×15 cm |
| Seedling age (days) | C1 | - | - | 30 days | 30 days |
| | C2 | 45 days | 45 days | - | - |
| | C3 | 35 days | 35 days | 30 days | 30 days |
| Seedlings (no. hill$^{-1}$) | C1 | - | - | - | - |
| | C2 | 3 | 3 | - | - |
| | C3 | 3 | 3 | 3 | 3 |
| Fertilizer (N-P-K-S-Zn-B) dose (Kg ha$^{-1}$) | C1 | - | - | 97-52-165-20-0-31.73 | 97-52-165-20-0-31.73 |
| | C2 | 140-30-90-10-0-0 | 140-30-90-10-0-0 | 200-45-90-30-4-1 | 200-45-90-30-4-1 |
| | C3 | 100-0-0-15-0-0 | 100-0-0-15-0-0 | 115-0-40-15-0-2 | 115-0-40-15-0-2 |
| Fertilizer application method | C1 | All PKSZn& N as basal and rest N at 25 and 45DAP | All PKSZn& N as basal and rest N at 25 and 45DAP | All PSB & half of N and K as basal and rest at 25 and 35DAP | All PSB & half of N and K as basal and rest at 25 and 35DAP |
| | C2 | All PKS basal & N in equal splits at 20 and 45DAP | All PKS basal & N in equal splits at 20 and 45DAP | All PKSZn& 1/3 N as basal and rest N at 25 and 45DAP | All PKSZn& 1/3 N as basal and rest N at 25 and 45DAP |
| | C3 | | | All PKS basal & N in equal splits at 20 and 45DAP | All PKS basal & N in equal splits at 20 and 45DAP |
| Weeding (no.) | C1 | - | - | 2 | 2 |
| | C2 | 1 | 1 | 2 | 2 |
| | C3 | 1 | 1 | 1 | 1 |
| Weeding time AT (after top dress) | C1 | | | 1 | 1 |
| | C2 | 1 | 1 | 1 | 1 |
| | C3 | 1 | 1 | 1 | 1 |
| Irrigation/Rainfed | C1 | | | 2 | 2 |
| | C2 | 15 | 15 | 2 | 2 |
| | C3 | 2 | 2 | 2 | 3 |
| Insect-pest control | C1 | | | Chemical | Chemical |
| | C2 | Chemical | Chemical | IPM | IPM |
| | C3 | Chemical | Chemical | IPM | IPM |
| Harvest time (date) | C1 | - | - | Mar.20/13 | 20-22 Mar, 2014 |
| | C2 | May 20-25/13 | May 23-26/14 | 13-15 June, 2013 | 17-19 June, 2014 |
| | C3 | Nov 22-24/13 | Nov 25-28/14 | Nov.6-8/13 | 1-4 Nov, 2014 |
| Field duration (days) | C1 | | | 98 | 100 |
| | C2 | 107 | 107 | 144 | 147 |
| | C3 | 120 | 124 | 108 | 104 |

**Table 03. Productivity of Garlic-Maize-T. Aman and Fallow-Boro-T. Aman cropping pattern**

| Year | Cropping pattern | Yield (tha$^{-1}$) | | | | Straw yield (tha$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Garlic | Boro | Maize | T. Aman | Garlic | Boro | Maize | T. Aman |
| 2012-13 | FP | - | 4.8 | - | 4.4 | - | 5.23 | - | 4.74 |
| | IP | 8.62 | - | 6.02 | 4.0 | - | - | 7.3 | 4.5 |
| 2013-14 | FP | - | 4.68 | - | 4.34 | - | 5.17 | - | 4.69 |
| | IP | 8.15 | - | 5.94 | 3.97 | - | - | 6.87 | 4.48 |
| Mean | FP | - | 4.74 | - | 4.37 | - | 5.20 | - | 4.62 |
| | IP | 8.39 | - | 5.98 | 3.99 | - | - | 7.09 | 4.59 |

FP= Farmers' Practice, IP= Improved Practice



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**Table 04. Rice-equivalent yield, production efficiency and land use efficiency of farmers' and improved cropping pattern**

| Year | Cropping pattern | Rice equivalent yield (t ha$^{-1}$) | Production efficiency Kg. ha$^{-1}$day$^{-1}$ | Land use efficiency (%) |
|---|---|---|---|---|
| 2012-13 | FP | 9.80 | 43.17 | 62.19 |
| | IP | 26.44 | 51.84 | 95.89 |
| 2013-14 | FP | 9.63 | 41.69 | 63.29 |
| | IP | 26.87 | 49.97 | 96.16 |
| Mean | FP | 9.72 | 42.43 | 62.74 |
| | IP | 26.66 | 50.91 | 96.03 |

Yield, cost and return of alternate pattern (Garlic-Maize-T. Aman) and existing pattern (Fallow-Boro-T. Aman rice) are shown in Table 01. Gross return and gross margin of alternate pattern were Tk. 423615 ha$^{-1}$and Tk. 181155 ha$^{-1}$whereas in existing pattern these were Tk. 151800 ha$^{-1}$and Tk. 52900 ha$^{-1}$, respectively. As a result, gross return was higher by Tk. 271815 ha$^{-1}$ and gross margin was higher by Tk. 128255 ha$^{-1}$ in alternate pattern over existing pattern (Table 02).

**Table 05. Cost benefit analysis of Garlic/Maize-T. Aman and Fallow-Boro-T. Aman rice cropping pattern**

| Year | Cropping pattern | Gross Return (Tk. ha$^{-1}$) | Total variable cost (Tk. ha$^{-1}$) | Gross margin (Tk. ha$^{-1}$) | MBCR |
|---|---|---|---|---|---|
| 2012-13 | FP | 161770 | 98900 | 62870 | 1.64 |
| | IP | 432765 | 242460 | 190305 | 1.78 |
| 2013-14 | FP | 156435 | 101410 | 55025 | 1.54 |
| | IP | 437587 | 237419 | 200168 | 1.84 |
| Mean | FP | 159102 | 100155 | 58947 | 1.59 |
| | IP | 435176 | 239939 | 195237 | 1.81 |

Price (Tk. /kg): Garlic=50, Maize=10, Boro rice=16.25 and T.Aman=16.25

### Cost benefit analysis

From cost and return data showed that the improved cropping pattern showed its superiority over farmers' pattern during two consecutive years of cropping. On an average, gross return of the improved pattern was Tk. 4,35,176 ha$^{-1}$ which was 26.06% higher than farmers' pattern of TK. 1,59,102 ha$^{-1}$ (Table 05). The production cost of the improved pattern (Tk. 2,39,939/ha) was higher than farmers' pattern (Tk. 1,00,155 ha$^{-1}$) due to labour intensive, cost of fertilizer and other inputs. The net return was substantially higher in the improved pattern (Tk. 195237 ha$^{-1}$) than farmers' pattern (Tk. 58947 ha$^{-1}$). The higher net return of the improved pattern was achieved mainly higher yield advantages of the component crops. 231% additional net return was achieved by adding 140% additional cost in the improved pattern. Higher marginal benefit cost ratio indicated the superiority of the improved pattern over the farmers' pattern.

## IV. Conclusion

Crop productivity, rice-equivalent yield, net monetary return and sustainability of the improved cropping patternpattern (Garlic-Maize-T. Aman Rice) with modern variety BARI Rasun-1 and BRRI dhan 49 along with standard cultivation technique could be suggested for medium high land of the Teesta Meander Floodplain Agro-ecological Zone (AEZ-3) of Bangladesh. Therefore, three crop based cropping pattern viz., Garlic-Maize-T. Aman Rice are suitable for the light textured soil of stable charland of kurigram. Garlic-Maize-T. Aman Rice can be recommended for the region, especially for the marginal farmers.

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