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# Agro-economic performance of intercropping hybrid maize with potato at farmers field

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**Abstract:** The experiment was carried out at farmers field in Farming Systems Research and Development (FSRD) site, Pushpapara, Pabna covering two *rabi* cropping seasons during the year 2005-06 and 2006-07 to evaluate the effect of potato intercropping on maize yield, appropriate time of intercropping maize with potato and the economic performance of the maize + potato intercropping systems. Three different intercropping combinations along with sole cropping of maize and potato were employed in the investigation following randomized complete block design. The results revealed that the highest yield of potato and maize was attained in sole cropping of component crops but maize yield from sole and intercropping was statistically similar except maize sowing at 35 days after planting (DAP) of potato. Maize equivalent yield was statistically similar in case of sole potato and intercrop except same day planting and sowing of component crops. In intercrop combination, 133.22% maize equivalent yield increased and land equivalent ratio (LER) leads 46% yield advantage over sole maize with maize sowing at 35 DAP of potato. Maximum economic return in terms of gross margin and benefit cost ratio (BCR) was also achieved with maize sowing at 35 DAP of potato. The overall results indicated that among the intercrop combinations maize sowing at 35 DAP of potato was found suitable for total productivity and economic return of the systems.

## Introduction

Maize is the third important cereal crop in Bangladesh. The area coverage under maize was 165 thousand acres (BBS, 2005) and rapidly expanding in a new area. In the past several years short period of winter season adversely affected wheat crop resulted declining yield at farmers field.

Climatic change along with lower wheat yield enhances the farmers to grow alternate crops in *rabi* season. Due to develop some potential hybrid maize and its availability in this region, farmers tend to shift their cultivation with maize crop in *rabi* season. In addition to that, favourable agro-climatic conditions have made this crop suitable for greater adoption in winter season in Pabna region as well as in the country. Moreover, its diversified uses as poultry feed, fodder, fuel and bakery industry have created greater access to grow in the cropping pattern. Now the huge area is covered by maize and maize based cropping pattern has been developed in this region. But maize is quite long duration crop and general practice at farmers level is to grow sole maize with intensive management. Being row and spaced crop, some short duration vegetables may have access to grow with maize as intercrop for extra quick cash generation without hampering maize yield. Farmers of this region already being practiced in small scale with short duration potato to get quick return. Growing of short duration vegetables specially potato as intercrop with maize in between row may offer considerable yield advantage over sole cropping due to efficient utilization of growth resources. Higher total productivity per unit area in intercropping is achieved over sole cropping (Boras *et al*., 2006). Intercropping practice lead to more monetary return and better utilization of land and inputs (Quayyum *et al*., 1985). However, to get maximum benefit from intercropping, time and plant population should be optimized. Regarding this views, an experiment was undertaken with the objectives to evaluate the effect of potato intercropping on maize yield, to find out appropriate intercropping time of potato with maize and to asses the economic performance of intercropping potato with long duration maize.

## Materials and Methods

The experiment was conducted at farmers' field of FSRD site, Pushpapara Pabna during the winter season of 2005-2006 and 2006-07 in medium high land under irrigated condition. The experimental site was in Gopalpur soil series belongs to the agro ecological zone- High Ganges River Flood Plain Soils (AEZ-11). The soil of the experimental area was silty loam with low organic matter content (2.06%) and slightly alkaline ($p^H$ 8.10) in nature. The experiment was laid out in randomized complete block (RCB) design with four dispersed replications. The unit plot size was 10 m x 8 m. Five different treatments were employed in the study viz. $T_1$= Same day sowing & planting of maize and potato, $T_2$ = Maize sowing at 20 DAP (days after planting) of potato, $T_3$ = Maize sowing at 35 DAP of potato, $T_4$ = Sole maize and $T_5$ = Sole potato. The land of the experimental plot was prepared with a power tiller by ploughing and cross ploughing followed by laddering and the soil was brought into good tilth. Fertilizers were applied @ 550-280-280-187-17-12-Kg Urea-TSP-MP-Gypsum-$ZnSo_4$-Boric Acid $ha^{-1}$ for both the sole maize and intercrop combinations. One third of urea and full amount of other fertilizers were applied at final land preparation. Remaining urea was applied in two splits at 8-10 leaves stage and tasseling stage (14-16 leaves) of maize. Under intercropping situation no additional fertilizer was applied for potato and potato was grown in those treatments with the basal fertilizer applied for maize. In the case of sole potato, fertilizers were applied @ 250-150-250-120-10-10-Kg Urea-TSP-MP-Gypsum-$ZnSo_4$-Boric Acid $ha^{-1}$. Half of urea and full amount of other fertilizers were applied at final land preparation and the remaining half urea was top dressed at 30-35 DAP of potato tuber and then earthing up was done. Spacing of maize was maintained 75 cm x 25 cm under both sole and intercrop combination. Potato tuber was planted in single row between maize row maintaining 20 cm spacing from tuber to tuber under intercrop combination. In the case of sole potato, 60 cm X 25 cm spacing was maintained. Potato tuber (var. Diamont) under sole and intercropping were planted on November 28-30 during the consecutive years. Maize seeds (BARI hybrid maize 3) under intercropping

treatment were sown on November 28-30, December 19-21 and January 04-06 during the years as per treatment specification. Maize seeds under sole cropping were planted on November 28-30 during the conducting years. Two irrigations were provided after top dressing of urea in the initiated year. The crop received three times rain at the early stage and hence only one irrigation was applied at the late vegetative stage of maize in the succeeding year. Earthing up and other intercultural operations were done when required. Potato crop in the succeeding year was severely infested with late blight disease and Ridomil gold was applied for its remedies. Other plant protection measures were taken when required. Potato crop was harvested on February 11-13 and the maize was harvested at 4 - 6 ($T_1$ and $T_4$), 21-23 ($T_2$), and 29-31 ($T_3$) May, 2007, respectively during the consecutive years.

Yield contributing characters of potato and maize were measured from ten randomly selected plants of the sampling area of each treatment avoiding border plants for one meter from the border line. Grain and straw yields of maize and tuber yield of potato were measured from 5 m long X 3 m wide sampling area at the centre of each plot. Grain and tuber yield of maize and potato was then calculated per hectare basis maintaining standard moisture content. Straws of maize (harvested at ground level) were dried in the sun properly and their weight was taken from same sampling area of each plot and expressed as t $ha^{-1}$. Treatments were compared in terms of land equivalent ratio using the formula developed by Willey (1979). Collected data were statistically analyzed by using MSTAT soft ware packages and mean differences for each character were compared by Least Significant Difference (LSD) test (Gomez and Gomez, 1984).

## Results and Discussion

The number of potato tubers $plant^{-1}$ did not respond significantly due to intercrop combinations and sole cropping during the study period (Table 1). Wight $tuber^{-1}$ showed significant variation under intercropping and sole cropping situations. The maximum weight $tuber^{-1}$ was attained in sole cropping of potato ($T_5$) and it was statistically similar to the treatments where maize seeds were sown at 35 and 20 days after planting of potato tuber ($T_3$ & $T_2$), respectively. The increased tuber weight in sole potato probably due to prevailing of favourable growth promoting factors like nutrient uptake, solar interception and photosynthesis which accelerated better initial growth and development of potato crop at the absence of maize.

**Table1: Yield contributing characters of potato under sole and intercropping situations (Pooled over 2 years)**

| Treatments | Tuber $plant^{-1}$ (no.) | Weight $tuber^{-1}$ (g) |
|---|---|---|
| $T_1$ | 5 | 41.94 |
| $T_2$ | 5 | 43.03 |
| $T_3$ | 6 | 45.25 |
| $T_5$ | 6 | 58.30 |
| $LSD_{0.05}$ | ns | 16..08 |

The minimum weight $tuber^{-1}$ was recorded in the same day planting and sowing of potato and maize ($T_1$), respectively. Continuous competition for growth regulating factors between the component crops from the initial growth stages might be attributed to lower tuber weight.

Days required for tasseling and maturity of maize showed some variation due to sole and intercropping over two years studies (Fig. 1). In the case of same day planting and sowing of both component crops ($T_1$) and sole crop of maize ($T_4$), days required for initiation of tasseling was similar but with the delayed sowing of maize under intercropping situation days to tasseling of maize was gradually reduced i.e. delayed sowing enhanced earlier tasseling. The similar observation was made on days to maturity. Cob length of maize exerted significant variation under sole and intercrop combinations. In the case of sole cropping, the maximum length of cob was observed which was statistically identical to same day planting and sowing of potato and maize ($T_1$) and 20 days late sowing of maize ($T_2$). The lowest cob length was recorded in treatment where maize seeds were sown at 35 days after planting of potato ($T_3$). The result indicated that after planting of potato, delayed sowing of maize slightly reduced the cob length. The number of grains $cob^{-1}$ and the weight of 100 grain were not significantly affected by sole and intercropping treatments.

**Table-2 Yield contributing characters of maize under sole and intercropping situations (pooled over 2 years**)

| Treatments | Cob length (cm) | No. of grain $cob^{-1}$ | 100 grain wt. (g) |
|---|---|---|---|
| $T_1$ | 18.77 | 520 | 33.14 |
| $T_2$ | 18.37 | 516 | 32.11 |
| $T_3$ | 17.23 | 494 | 31.64 |
| $T_4$ | 19.00 | 562 | 33.89 |
| CV% | 5.32 | 9.21 | 4.81 |
| $LSD_{0.05}$ | 0.81 | ns | ns |

**Potato yield:** Tuber yield of potato was significantly responded due to different treatments (Table 3). It was observed that tuber yield obtained from different intercrop combinations was significantly lower than sole cropping. Under intercrop situation potato tuber yield was reduced by 38.47-54.18% compared to sole potato (Fig. 2). This result is supported by the findings of Prakash *et al*. (2004). However, the highest tuber yield was obtained from sole potato followed by intercrop treatment where maize was sown at 35 DAP of potato. The lowest tuber yield was attained in same day planting and sowing of both component crops ($T_1$). Due to competition between component crops for sharing of nutrients and other growth regulating factors at the initial stage, plant growth was to some extent affected in $T_1$ treatment. In addition to that, being a temperature responsive crop, maize growth was progressively increased with the gradual rising of temperature which created partial shading on potato and made more competition for nutrition, light and other growth regulators at the early growth stages. However, the cumulative effect of these factors might be retarded potato yield in $T_1$. In the case of other

intercrop treatments, potato plants at the early stage got some added benefits for their better initial growth because of the absence of maize which probably contributed to higher yield in $T_2$ and $T_3$ combinations, respectively.

**Maize yield:** From two years experimentation, the result revealed that the grain yield of maize obtained from sole cropping and intercrop combinations was statistically similar except maize sowing at 35 DAP of potato ($T_3$). Better yield response under sole maize and intercrop combinations except $T_3$ treatment might be due to ensure of early optimum growth and development of maize plants. But in the case of maize sowing at 35 DAP of potato ($T_3$), initial plant growth faced more competition with active growing stage of potato for nutrition and other growth factors resulted lower yield. Yield reduction of maize under intercrop combinations compared to sole cropping was less pronounced than potato. However, maize yield under intercropping was reduced by 3.80-13.65% compared to sole maize (Fig. 3). From two years results, it indicated that all intercrop combinations enhanced total production in terms of maize equivalent yield by 2.06-2.34 times higher over sole maize. Prakash *et al*. (2004) also investigated the similar findings. The highest maize equivalent yield was achieved with sole potato and it was statistically similar to $T_3$ and $T_2$ treatments where maize was sown at 35 and 20 DAP of potato, respectively. The results indicated that among the intercrop combinations, delayed sowing of maize after potato planting encouraged higher maize equivalent yield probably due to higher potato production. The maximum equivalent yield increased 133.22% by maize sown at 35 DAP of potato and it was followed by 20 DAP of potato (116.22%) and same day planting (106.48%), respectively, over sole maize (Fig. 4). Chand *et al*. (2001) also investigated that intercropping potato with maize resulted in yield improvements.

Assessment of biological efficiency of intercropping using Land Equivalent Ratio revealed that yield advantages increased due to intercropping during the study years (Table 3). The result is also in agreement with the findings of Boras *et al*., 2006 who investigated that LER increased due to intercropping against single crop. The maximum land equivalent ratio was observed in maize sowing at 35 DAP of potato indicating a 46% yield advantage over sole maize and it was followed by maize sowing at 20 DAP of potato. Similar observations were also reported by Ebwongu *et al*. (2001). The lowest LER was estimated in same day planting and sowing of potato. The result indicated that LER slightly increased with increasing potato production under intercrop combinations.

**Economic analysis:** Regarding economic return, the highest gross margin and benefit cost ratio was obtained from maize sowing at 35 DAP of potato and the lowest return was achieved with sole potato. The economic result indicated that under intercrop combinations gross margin and benefit cost ratio was increasing in trend with the delayed sowing of maize i.e. increasing potato production. Though the maximum gross return was recorded in sole potato, the involvement of maximum total variable cost probably reduced the benefit cost ratio. However, the highest economic return in intercropping (in terms of gross margin) was 139.39 % higher over sole maize with maize sowing at 35 DAP of potato followed by maize sowing at 20 DAP of potato and same day sowing and planting of both the crops (Fig. 5).

In the light of the findings it may be concluded that in intercropping system maize sowing at 35 days after planting of potato tuber is promising for boosting up total production and economic return.

**Table 3. Yield of different components under sole and intercrop combination (pooled over 2 years)**

| Treatments | Tuber yield (t ha$^{-1}$) | Maize yield (t ha$^{-1}$) | Maize equivalent yield (t ha$^{-1}$) | LER |
|---|---|---|---|---|
| $T_1$ | 9.04 | 8.60 | 18.46 | 1.41 |
| $T_2$ | 10.27 | 8.14 | 19.34 | 1.43 |
| $T_3$ | 12.14 | 7.72 | 20.96 | 1.46 |
| $T_4$ | - | 8.94 | 8.94 | 1.00 |
| $T_5$ | 19.73 | - | 21.52 | 1.00 |
| CV(%) | 10.42 | 7.05 | 7.26 | - |
| LSD $_{0.05}$ | 1.815 | 0.850 | 2.03 | - |

**Table 4. Cost and return analysis of sole and intercrop combination of maize and potato ( 2 years average)**

| Treatments | Gross return (Tk. ha$^{-1}$) | Total variable cost (Tk. ha$^{-1}$) | Gross margin (Tk. ha$^{-1}$) | Benefit cost ratio (BCR) |
|---|---|---|---|---|
| $T_1$ | 211535 | 48250 | 163285 | 4.38 |
| $T_2$ | 221581 | 49473 | 172108 | 4.48 |
| $T_3$ | 235556 | 49473 | 186083 | 4.76 |
| $T_4$ | 104006 | 26275 | 77731 | 3.96 |
| $T_5$ | 236720 | 63120 | 173600 | 3.75 |

$T_1$ = Same day sowing & planting, T2 = Maize sowing at 20 DAP of potato, $T_3$ = Maize sowing at 35 DAP of potato, $T_4$ = Sole maize, $T_5$ = Sole potato

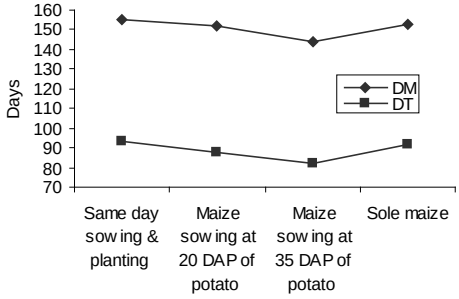


Fig. 1 Days to tassling (DT) and maturity (DM) of maize under intercropping

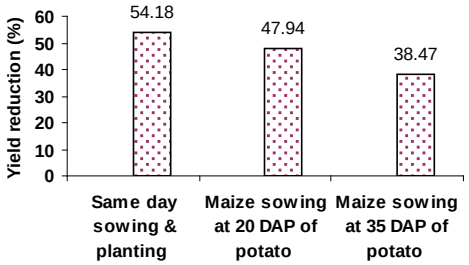


**Fig. 2 Yield reduction of potato due to intercropping over sole cropping**

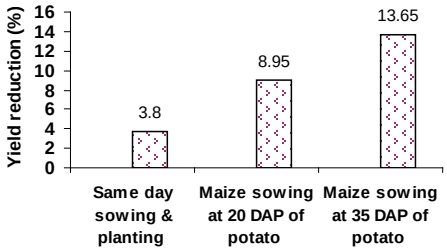


**Fig. 3 Yield reduction of maize due to intercropping over sole cropping**

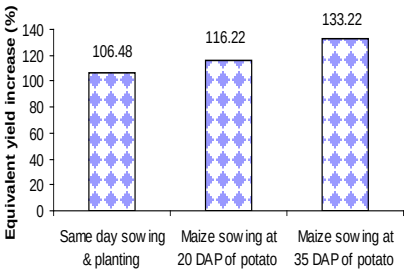


**Fig. 4 Equivalent yield increases due to intercropping over sole maize**

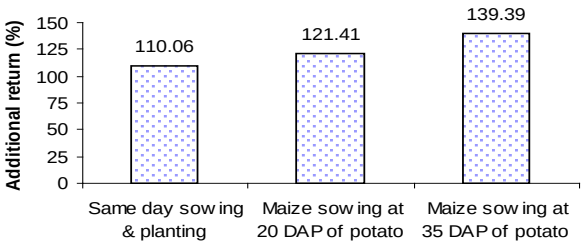


**Fig.5 Additional return (in terms of gross margin) due to intercropping over sole maize**


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