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# COMPARATIVE STUDY OF DRUM SEEDING WITH OTHER PLANTING METHODS IN AUS RICE

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## ABSTRACT

An experiment was conducted at the Agronomy field laboratory, Hajee Mohammad Danesh Science and Technology University, Dinajpur during the period from March 2007 to July 2007 to study the comparative study of drum seeding with other planting methods in aus rice. The highest panicle length (29.00 cm) was found in single thick row using drum seeder. The shortest panicle length (24.50 cm) was found in broadcasting method. The highest number of filled grains per panicle (134.40) was observed in single thin row using drum seeder. The lowest number of filled grains per panicle (100.00) was found in broadcasting. The highest number of unfilled grains per panicle (34.50) was found in broadcasting. The lowest number of unfilled grains per panicle (22.40) was found in double row using drum seeder. The highest number of total spikelets per panicle (164.80) was found in single thin row using dram seeder. The lowest (134.50) was found in broadcasting. The highest grain yield (4.20 t/ha) was observed in double rows using drum seeder. The lowest grain yield (3.32 t/ha) was observed in broadcasting method similar to that of (3.60 t/ha) conventional transplanting method. The present findings suggested that direct wet seeded rice cultivation by using drum seeder increase grain yield, saved input cost compared to conventional transplanting and also save time around 10 days for harvesting BR-26. From the experiment, it revealed that among five treatments, double rows (thin + thick) using drum seeder was the best one for getting higher grain production of BR-26.

***Kew words**: Aus rice drum seeding, planting methods,*

## INTRODUCTION

Rice (*Oryza sativa, L.)* is the principle food of the people of Bangladesh and it is the world's second important food grain. It is grown worldwide on 150 million hectares (ha) with the total production of about 563 million tons of unmilled rough rice (FAO, 1999). Nearly half of the total population of the world use rice as their staple food and it is main source of calories for about 40% of the world population (Hoffman, 1991). Bangladesh is not only a rice growing country but also a rice-consuming people. It is the forth-largest country in the world with respect to rice area and production (IRRI, 2000). The net cultivable area at present is about 8.4 Mha (Million hectare) while the net area sown is 7.99 Mha (Ministry of Agriculture, 2001). Yet, rice is the backbone to Bangladesh's economy and agriculture, accounting to nearly 18% of national Gross Domestic Product (GDP) and providing about 70% of an average citizen's total calorie intake. The rice sector alone is the most important provider of rural employment. Aus rice is grown on about 12.44 lac ha of which, HYV Aus rice covers about 4.67 lac ha and local 7.77 lac ha (BBS, 2004). But the yield is very low compared to other rice producing countries of the world. For achieving higher yield per unit area, introduction of improved technology is important. A drum seeder is a simple implement by which direct wet seeded rice can be sown. This is a comparatively new implement in Bangladesh. The seeder is popular in Vietnam. Presently few farmers are using this implement in Bangladesh. From literature, it is known that by using drum seeder for rice cultivation grain yield can be increased and can also save time and labour. Direct seeding eliminates the need for seed bed preparation, seedling uprooting and transplanting and the associated cost and energy. In addition, direct seeding rice matures about 10 days earlier and gives about 10-15% higher yield than conventional transplanted rice (BRRI, 2004). Southeast Asian countries are now trying to

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shift to direct wet seed method of grain rice (Moody and Cordova, 1985; Erguiza *et al.*, 1990; Pandey *et al.*, 2002). But still, the practice of direct wet seeded rice is very little in Bangladesh although research results have clearly shown the superiority of direct seeded rice to conventional transplanting (Hussain *et al.* 2002).

Keeping this view in mind an experiment was conducted with the following objectives.

(i) To assess the performance of drum seeder with other methods related to sowing and planting in aus rice (BR-26).

(ii) To evaluate the performance of drum seeder using in aus rice production.

## MATERIALS AND METHODS

An experiment was conducted at the Agronomy Field Laboratory, Department of Agronomy, Hajee Mohammad Danesh Science and Technology University, Dinajpur during the period from March 2007 to July 2007 to study the performance of drum seeding with other planting methods in Aus rice. The site is located between 25.13° N latitude and 88.23° E longitude and at an elevation of 37.5m above the mean sea level. The land belongs to the Old Himalayan Piedmont plain Agro-ecological Zone (AEZ-1) (UNDP and FAO, 1988). The field is a medium high land having sandy loam soil with $P^H$ 5.65. The top soil (0-15 cm depth). Test revealed that the soil contained 0.08% total nitrogen, 1.31% organic matter, 16.85 ppm available phosphorus, 0.22 me/100g available potassium, 48.81ppm available sulphur and 0.63 ppm magnesium. BR-26 was used as the test crop for the experiment. It was released by NSB for cultivation as aus crop in Bangladesh. Five treatments (single factor) was applied in a Randomized Complete Block design (RCBD) with four replications. The treatments were as follows:

i. $T_1$ single thin row, seed to seed spacing 3cm using drum seeder (Seed rate 22 kg/ha or 22g/plot)

ii. $T_2$ single thick row, seed to seed spacing 1cm using drum seeder (Seed rate 37 kg/ha or 37g/plot)

iii. $T_3$ Double rows (thin + thick) using drum seeder (Seed rate 59 kg/ha or 59 g/plot).

iv. $T_4$ Broadcasting method using manual (Seed rate 80kg/ha or 80g/plot)

v. $T_5$ (control) Conventional transplanting method, row to row distance 20 cm, (Seed rate 50kg/ha or 50g/plot).

Figure 1. Dram seeder was used for BR-26 cultivation

During final land preparation NPK were applied in the form of urea, triple super phosphate, muriate of potash and sulphur. The rates of fertilizer used were 135-100-70, 60 kg of NPKS ha $^{-1}$, respectively. One half quantity of N and the whole quantity of P, K and S were applied as basal dose. The other one half quantity of N was top dressed in two equal splits on 21 and 40 days after sowing (DAS). Row to row distance using drum seeder was 20 cm maintained for each treatment except broadcasting as mentioned above. The used seeds had 84% germination capacity. Seeds were sown on 25 March, 2007 and on 20th April, 2007 rice seedling, (BRRI rice 26) were transplanted in unit plots at the rate of 2-3 seeding/hills. Plant spacing was maintained as per treatment. The first and second and third weeding, simultaneous thinning, top dressing of N fertilizer and hoeing of land (to mix up fertilizer with soil) were done at 15 and 25 DAS (days after sowing). The third weeding was done at 40 DAS. Before harvest, 10 plants from each plot were selected at random and taken off from the plot to record individual plant characters. Then all the plants of each plot were counted per $m^2$. Growth parameters, such as total dry matter production (TDM), were monitored on 60, 80and 100 DAS by taking five samples randomly from each plot. Crop growth rate (CGR), Crop growth rate (CGR), Relative growth rate (RGR)were taken in the final harvesting. Five hills were selected randomly from each unit plot and uprooted before harvesting for recording of necessary data (studying morphological attributes). For yield attributes, 1 $m^2$ size of three samples from each plot was selected randomly. These samples were taken and marked with respective tag levels. The harvested crops were threshed and grains were cleaned and dried to moisture content of 14%. Weight of grains was recorded plot wise. The grain yield $m^{-2}$ was coverted to hectare$^{-1}$. Collection of Data at harvest: Plant height, Total number of tillers $m^{-2}$, Number of effective tillers $m^{-2}$, Number of non-bearing tillers $m^{-2}$, Panicle length, Number of total grains per panicle, Number of filled grains per panicle, Number of unfilled grains per panicle, Weight of 1000-grains and Grain yield (t/ha). Data were analysed statistically using the analysis of variance technique and mean differences were adjusted by the Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) test, as and when necessary (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

### Morphological characters of rice

#### *Plant height*

Plant height was significantly affected by direct wet seeded rice cultivation, broadcasting and conventional transplanting (Table 1). At 25 DAS, significantly the tallest plant (33.62 cm) was observed in single thin row using drum seeder followed by single thick row using drum seeder (29.82 cm) and also double row using drum seeder (29.82 cm). The shortest plant height (25.10 cm) was found in conventional transplanting method which was followed by broadcasting method (28.50 cm). At 50 DAS, the tallest plant (51.00 cm) was observed in single thin row using drum seeder ($T_1$) which was significantly different than other treatments. The shortest plant height (47.80 cm) was found in conventional transplanting method. At 75 DAS, the tallest plant height was observed in single thick row using drum seeder (73.00 cm) and the shortest plant height (64.20 cm) was found in conventional transplanting method and broadcasting method (64.50 cm). At 100 DAS the tallest plant was found (108.46 cm) in single thin row using drum seeder and the shortest plant height (98.20 cm) was found in conventional transplanting method. Lower plant height with increasing plant population per unit area in direct wet seeded rice may be attributed to the inter seedling competition for light, moisture and nutrients. Another cause may be shortening of plants in direct wet seeded rice might be due to shortage of time for proper vegetative growth and development. Similar results were also reported by Mollah *et al.* (1992).

#### *Number of tillers per meter square*

Number of tillers per square meter was significantly influenced by direct wet seeded rice cultivation, broadcasting and conventional transplanting (Table 1). At 75 DAS, the highest number of total tillers (465) was observed in double row using drum seeder and the lowest number of total tillers per meter square (270) was found in conventional transplanting. Similar trend was found at 50 DAS. At 100 DAS, the maximum number of total tillers per meter square (353.00) was found in double rows using drum seeder followed by single thick rows (324.00) using drum seeder. The minimum number (222.00) of total tillers per meter square was found in conventional transplanting method which was close to broadcasting method (266.00). Similar results were found by Ali (2005) and BRRI (2003, 2005a, 2005b).

Table 1. Effect of direct wet seeded rice and conventional transplanting on plant height and number of total tillers $m^{-2}$

| Treatment | Plant height (cm) | | | | Number of tillers $m^{-2}$ | | |
|---|---|---|---|---|---|---|---|
| | 25 DAS | 50 DAS | 75DAS | 100 DAS | 50 DAS | 75 DAS | 100 DAS |
| $T_1$ | 33.62 a | 51.00 a | 73..00 a | 108.46 a | 316.00 c | 322.00 c | 289.00 c |
| $T_2$ | 29.82 b | 49.20 b | 70.85 a | 106.04 a | 399.00 b | 401.00 b | 324.00 b |
| $T_3$ | 29.82 b | 49.00 b | 67.34 b | 105.84 a | 465.00 a | 465.00 a | 353.00a |
| $T_4$ | 28.50 c | 50.50 b | 64.50 c | 101.12 b | 298.00 c | 298.00 c | 266.00 e |
| $T_5$ | 25.10 d | 47.80 c | 64.20 c | 98.20 c | 270.00 c | 270.00 c | 222.00 d |
| Level of significant | ** | ** | ** | ** | ** | ** | ** |
| LSD | 1.462 | 1.757 | 2.124 | 3.898 | 8.439 | 46.39 | 12.89 |
| CV% | 3.33 | 2.52 | 2.31 | 3.37 | 1.68 | 9.18 | 3.39 |

The figure(s) in a column having common letter(s) do not differ significantly and those having different letters differ significantly as per DMRT.

** Significant at 1% level
NS= Not significant

**Growth characters of rice**

***Total dry matter*** *(TDM)*

The total dry matter production was significantly affected by direct wet seeded rice cultivation, broadcasting and conventional transplanting (Table 2). At 60 DAS, significantly the highest total dry matter (390.360 $gm^{-2}$) was observed in double rows using drum seeder and the lowest TDM production (201.600 $gm^{-2}$) was found in conventional transplanting followed by broadcasting method (250.50 $gm^{-2}$). The highest TDM (800.440 $gm^{-2}$) at 80 DAS was found in double rows using drum seeder and the lowest (410.60 $gm^{-2}$) was found in conventional transplanting close to broadcasting method (450.32 $gm^{-2}$). At 100 DAS, significantly the highest total dry matter (1215.00 $gm^{-2}$) was observed in double rows using drum seeder followed by (1099 $gm^{-2}$) single thick row. The lowest TDM production (763.00 $gm^{-2}$) was found in conventional transplanting. This result is in conformity with the view of Vergara *et al.* (1964) who calculated that faster the growth the higher the TDM production.

Table 2. Effect of direct seeded BR-26 and conventional transplanting on total dry matter production at different DAS

| Treatment | Total dry matter production ($gm^{-2}$) | | |
|---|---|---|---|
| | 60DAS | 80 DAS | 100 DAS |
| $T_1$ | 228.380 b | 598.990 c | 1000.58 b |
| $T_2$ | 283.100 b | 689.86 b | 1099.70 ab |
| $T_3$ | 390.360 a | 800.440 a | 1215.00 a |
| $T_4$ | 250.50 d | 450.32 d | 763.00 c |
| $T_5$ | 201.600 d | 410.60 d | 720.32 c |
| Level of significant | ** | ** | ** |
| LSD | 19.49 | 48.72 | 168.80 |
| CV% | 5.13 | 5.66 | 12.01 |

The figure(s) in a column having common letter(s) do not differ significantly and those having letters differ significantly as per DMRT.

** Significant at 1% level
NS= Not significant

***Crop growth rate (CGR)***
The crop growth rate (CGR) was influenced by direct wet seeded rice than broadcasting and conventional transplanting (Table 3). The crop growth rate (CGR) was highest (20.504 $gm^{-2}$ $day^{-1}$) at 60 to 80 DAS with double rows using drum seeder which was statistically similar to single thick row using drum seeder (20.337 $gm^{-2}$ $day^{-1}$). The lowest (10.450 $gm^{-2}$ $day^{-1}$) was found in conventional transplanting followed by broadcasting method (12.33 $gm^{-2}$ $day^{-1}$). At 80-100 DAS, the highest CGR (20.720 $gm^{-2}$ $day^{-1}$) was observed in double rows using drum seeder which was statistically similar to the single thick row and thin row using drum seeder. The lowest CGR was found in conventional transplanting method (17.620 $gm^{-2}$ $day^{-1}$) followed by broadcasting method.

***Relative growth rate (RGR)***

Relative growth rate (RGR) was significantly different by using drum seeder. It was found highest (0.048 $gm^{-1}$ $day^{-1}$) in double rows using drum seeder and was statistically similar to single thick row using drum seeder at 60-80 DAS (Table 3). The lowest RGR (0.035 $gm^{-1}$ $day^{-1}$) in conventional transplanting and broadcasting method. At 80-100 DAS, the highest RGR (0.031 $gm^{-1}$ $day^{-1}$) was in double row ($T_3$) which was statistically similar to single thick row ($T_2$) using drum seeder. The lowest was (0.021 $gm^{-1}$ $day^{-1}$) was found in conventional method statistically similar to single thin row ($T_1$) using drum seeder and broadcasting method. Relative growth rate represent the efficiency of the crop in production of new assimilates. In case of RGR the initial high range was observed when the rapid tiller emergence had started a growing organ which is consumer of photosynthate and RGR is the best source and sink.

Table 3. Effect of direct seeded BR-26 and conventional transplanting on Crop Growth Rate (CGR) and Relative Crop Growth rate (RGR) at different DAS.

| **Treatment** | **CGR($gm^{-2}$ $day^{-1}$)** | | **RGR($gm^{-2}$ $day^{-1}$)** | |
|---|---|---|---|---|
| | **60-80DAS** | **80-100DAS** | **60-80DAS** | **80-100DAS** |
| $T_1$ | 18. 528 b | 20.082 a | 0.036 b | 0.02510 b |
| $T_2$ | 20.337 a | 20.492 a | 0.044 a | 0.03100 a |
| $T_3$ | 20.504 a | 20.720 a | 0.048 a | 0.03100 a |
| $T_4$ | 12.33 c | 17.820 b | 0.035 b | 0.02310 b |
| $T_5$ | 10.450c | 17.620 b | 0.035b | 0.021 b |
| Level of significant | ** | ** | ** | ** |
| LSD | 0.7952 | 1.462 | 0.0043 | 0.01688 |
| CV% | 3.31 | 5.38 | 6.94 | 5.30 |

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** Significant at 1% level
NS= Not significant

**Reproductive characters of rice**
***Number of effective tillers per meter square***

The effect of direct wet seeded rice cultivation, broadcasting and conventional transplanting on effective tillers was significant (Table 4). The number of effective tillers per meter square was the highest (325.00) in double row using drum seeder which was statistically similar to single thick row using drum seeder (300.0). The lower number of effective tillers per meter square (198.00) was found in conventional transplanting method followed by broadcasting method (236.00). Single thin row using dram seeder produced 265.40 number of effective tillers per meter square.

***Number of non-effective tillers per meter square***

The number of non effective tillers per meter square was significantly affected due to cellular expansion of plant in case of direct wet seeded rice cultivation, broadcasting and conventional transplanting (Table 4). The number of non-effective tillers per meter square was the highest (30.00) in conventional method followed by double row using drum seeder and the lowest (23.60) was observed in single row using drum seeder. The results indicate that tiller separation from mother crops contributed lower number of effective tillers implying a reduced intra hill competition for growth resource.

***Panicle length***

The panicle length of rice significantly affected by direct drum seeded rice, broadcasting and conventional transplanting (Table 4). It was observed that highest panicle length (29.00 cm) was found in single row using drum seeder followed by single thick row and double row using drum seeder. The shortest panicle length (25.40 cm) was found in broadcasting method followed by conventional transplanting. Similar result was also reported by Ali (2005).

***Number of filled grains per panicle***

Number of filled grains per panicle was significantly influenced by direct wet seeded rice, broadcasting and conventional transplanting method (Table 4). The highest number of filled grains per panicle (134.40) was observed in single row using drum seeder. The lowest number of filled grains per panicle (100.00) was found in broadcasting method followed by conventional transplanting. This result indicates that higher the effective tillers higher the number of filled grains per panicle implying inter tiller competition for growth resources.

***Number of unfilled grains per panicle***

Among the undesirable trails, the number of unfilled grains per panicle is the most significant one and plays vital role in yield reduction (Table 4). The number of unfilled grains per panicle was significantly influenced by direct drum seeded rice cultivation. The highest number of unfilled grains per panicle (34.50) was found in broadcasting method followed by conventional transplanting method and also single thin row using drum seeder. The lowest number of unfilled grains per panicle (22.24) was found in double row using drum seeder similar to single thick row.

***Number of total spikelets per panicle***

Number of total spikelets per panicle was significantly affected at 1% level by direct wet seeded rice cultivation, broadcasting and conventional transplanting. Significantly the highest number of total spikelets per panicle (164.80) was found in single thin row which was similar to single thick row and double row using dram seeder. The lowest (134.50) was found in broadcasting method (Table 4).

***Thousand grains weight***

Weight of 1000-grains was not significantly affected by direct drum seeded rice cultivation, broadcasting and conventional transplanting (Table 4). However, numerically the maximum weight (17.00 g) of 1000-grains was found in double rows using drum seeder which was statistically similar to other treatment. The lowest weight of 1000-grains (16.20 g) was recorded in broadcasting method.

***Grain yield (t/ha)***

Grain yield was significantly influenced by direct wet seeded rice cultivation, broadcasting and conventional transplanting at 5% level (Table 4). The highest grain yield (4.20 t/ha) was observed

Table 4. Effect of treatments on yield and yield contributing characters of Aus rice

| Treatments | No. of effective tillers $m^{-2}$ | No of non effective tillers $m^{-2}$ | Panicle length(cm) | No. of unfilled grain $panical^{-1}$ | No of filled grain $panical^{-1}$ | No of total spikelets $panical^{-1}$ | Thousand grain weight (g) | Grain yield (t/ha) |
|---|---|---|---|---|---|---|---|---|
| $T_1$ | 265.40b | 23.60c | 29.00a | 30.40a | 134.40a | 164.80a | 16.85a | 3.68ab |
| $T_2$ | 300.00a | 24.00b | 28.98a | 24.80bc | 130.40a | 155.20a | 16.90a | 4.11a |
| $T_3$ | 325.00a | 28.00a | 28.98a | 22.24c | 133.80a | 150.24a | 17.00 a | 4.20a |
| $T_4$ | 236.00bc | 30.00a | 25.40b | 34.50 a | 100.00d | 134.50bc | 16.20a | 3.32 c |
| $T_5$ | 198.00c | 24.60b | 28.57a | 30.50a | 115.00c | 145.50b | 16.40a | 3.60b |
| Level of significant | ** | ** | * | ** | ** | ** | NS | * |
| LSD | 25.62 | 1.757 | 3.25 | 4.24 | 6.792 | 17.05 | 1.289 | 0.53 |
| CV% | 4.09 | 7.77 | 7.29 | 8.91 | 5.02 | 9.28 | 4.30 | 6.87 |

The figure(s) in a column having common letter(s) do not differ significantly and those having different letters differ significantly as per DMRT.
* Significant at 5% level
** Significant at 1% level
NS= Not significant

in double rows using drum seeder which was statistically identical to single thick row using drum seeder (4.11 t/ha). The lowest grain yield (3.32 t/ha) was observed in broadcasting method similar to that of (3.60 t/ha) conventional transplanting ($T_5$). From the above result we found that direct wet seeded treatment generally out yielded the transplanted rice significantly. The direct seeded treatments produced highest grain yield of about (4.20 t/ha) in double row using drum seeder treatment which was about 20.46% higher than that of the transplanted crops (Table-4.4). However, the increase in direct seeded rice over transplanting ranged from 6 to 35%. This result is consistent with the findings of Ali (2005), Bari (2004) and BRRI (2003; 2005a; 2005b). They observed that there was a compensatory effect of higher number of tillers with the lower number of grains panicle$^{-1}$ resulting higher number of grains m$^{-2}$.

## REFERENCS

Ali, MA. 2005. Productivity and Resource- Use Efficiency of Rice as Affected by Crop Establishment. Ph. D. Thesis, University of the Philippines, Los Banos, Philippines. pp. 1-55.

Bari SMW. 2004. Effect of method of planting on weeding on the yield and contributing character of aman rice. Thesis M.S. in Agron., Bangladesh Agric. Univ., Mymensingh. p. 38.

BBS (Bangladesh Bureau of Statistics). 2004. Statistical Yearbook of Bangladesh. Statistic Division. Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka. pp 61-63.

BRRI. 2000. Annual Report for 2000. Bangladesh Rice Res. Inst. Joydebpur, Gazipur, Bangladesh. Pub. No. pp. 88-256.

BRRI 2003. Annual Report for 1985. Bangladesh Rice Res. Inst. Joydebpur, Gazipur, Bangladesh,p.64-65Coxhead. I A 1984. The economics of wet seeding: inducements to and consequences of some recent changes in Philippines rice cultivation. M.S. Thesis. Agricultural Development Economic in the Australian National University, Australia.

BRRI. 2005a. Annual Internal Review for 2003-2004, held on 28 December, 2004 to 1 January, 2005. Bangladesh Rice Research Institute, Adaptive Research Dept. Wing, Gazipur, Bangladesh. pp. 6-9.

BRRI. 2005b. Annual Internal Review for 2004-2005, held on 28-22 December, 2005. Bangladesh Rice Research Institute, Adaptive Research Dept. Wing, Gazipur, Bangladesh. pp. 22-23.

Erguiza A, Duff B and Khan C. 1990. Choice crop establishment technique. Transplanting vs wet seeding. IRRI Research Paper, 139, International Rice Research Institute, Manila, Philippines.

Food And Agriculture, (FAO) Rome and UNDP (United Nation Development Program) 1999. Land Response Appraisal of Bangladesh for Agricultural Development. Rep. No-2. Agroecological Region of Bangladesh. pp.212-221.

Gomez, K.A. and Gomez, A.A. 1984. Duncans Multiple Range Test. Statistical procedures for Agric . Res. @nd Edn. A Wiley-Interscience Publication. John Wiley and Sons, New York.p.207-215.

Hoffman MS. 1991. The World Almanac and Book of Facts. An imprint of phoros books. A scrips Howard Company. 200 Park Avenue, New York. 10166 (in Bengali).

Hussain MM, Haque MA, Islam MA and Islam MR. 2002. Performance of direct wet seeded rice under on farm irrigated conditions in Bangladesh. Bangladesh journal of Environmental Sci. 6(2): 329-333.

IRRI (Internacional Rice Research Institute). 2000. Rice Production mannual U.P., L.B., Losbanos, Laguna, Philippines.P. 95.

Ministry of Agriculture-MOA, 2001. Handbook of Agricultural Statistics, Sector monitoring unit. Ministry of Agric. Govt. Of the Peoples Republic of Bangladesh.

Mollah MIU, Hossain SMA, Islam N and Miah MNI. 1992. Some aspects of tiller separation in transplant aman rice. Banladesh J. Agron. 4(1&2):45-49.

Moody K and Cordova VG. 1985. Water seeding rice. In: Women in Farming, International Rice Research Institute, P.O. Box-933, Manila, Philippines. P.467-478.



Pandey S, Mortimer M, Wade L, Tuong TPP, Lopez K, Hardy B. 2002. Direct seeding : Research Issues and Opportunities. In: proceedings of the International Workshop on Direct Seeding in Asian Rice Systems: Strategic Research Issues and Opportunities, 25-28 January 2000, Bagkok, Thailand, Los Banos (Philippines); International Rice Research Institute 383 p.

UNDP and FAO. 1988. Land Resources Appraisal of Bangladesh for Agricultural Development Report No. 2. Agro-ecolological Regions of Bangladesh. United Nations Development Programme and Food and Agriculture Organization. pp. 212-221.

Vergara BS, Lilis R and Tanaka A. 1964. Relationship between length of growing period and yield of rice plants under a limited nitrogen supply. Soil Sci. and Plant nucl., 10:59-65.