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Present land size with shape and effect on the operational efficiency of rice transplanter

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Land fragmentation, Plot number, Field capacity, Fuel consumption, Land improvement

ABSTRACT

Plot shape and size has great influence on the efficient operation of 4-row walking type rice transplanter. Field study was carried out in 15 villages under 15 upazila in 15 districts of two administrative divisions of Rajshahi and Rangpur to know the existing plot size, shape and length-width ratio of each plot in January-June 2017. The village in each district was selected purposively by using simple random sampling (SRS) method. The average plot number of 13 and 17 per hectare was observed in Rajshahi and Rangpur division, respectively. High degree of land fragmentation was observed in the survey areas of Rangpur division. The average plot sizes of 0.07 and 0.05 hectare were observed in Rajshahi and Rangpur division, respectively. Smaller sizes of plots (19% plots <250 m^2) were dominant in Rangpur division. The plot area <250 m^2 should be enlarged to get the maximum benefit of the transplanter operation. In both divisions, 5% of plot area was categorized as irregular shape where transplanter was inaccessible and initiated manual labor to transplant seedlings. The height of the rural road from the plot surface was observed more than two meter. Farmers faced problem to move the machine from road to the plot due to high elevation. Plots were observed very far from the rural road which created problem to the movement of the farm machinery. The machinery moved into the plots by crossing other plots, levees and irrigation canal. Grouping of scattered field plots or land consolidation is a complicated issue in Bangladesh. The present findings emphasized the urgency of land improvement works to improve the operational efficiency of the mechanical rice transplanter. However, the enlargement process is not an easy task. In the present context, entrepreneur should select the field based on the accessibility of farm machine, plot to plot movement time, plot elevation, plot size and shape. Careful selection of the plots will reduce the loss time during turning, plot to plot movement and consequently increase the daily area coverage.

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I. Introduction

Bangladesh is a land of agriculture where rice (*Oryza sativa* L.) is the major crop cultivated in 80% (11.27 mha) of the total cropped area (Kabir *et al.,* 2016).The land area is decreasing at the rate of 80,000 hectare annually due to construction of road, house and industry (BRRI, 2009).The agricultural labor force followed decreasing trend whereas it increasing in non-agricultural sector due to shifting low productivity to high productivity sector (BBS, 2015). To keep economical consistency over the shifting of manpower from agriculture to service and industry, it requires filling up the labor gap in agricultural operations by mechanical interventions (Islam *et al.,* 2016). Traditional method is incapable whereas mechanized cultivation substantially reduces the labor force than manual operation. Mechanization combats the acute labor shortage during peak planting and harvesting period. Mechanization helps to increase the cropping intensity by reducing the turnaround time and faster operation of agricultural activities. The shape of the land is a major cause that reduces the efficiency of farm machinery. Plot size, shape, farm roads and soil bearing capacity have become more crucial in determining the efficient utilization of farm machines. Islam *et al.* (2015) stated that daily area coverage of the transplanter depended on the plot to plot distance, plot size, seedlings tray supply and number of plots under transplanting activity. Fuel consumption also depended on the plot size, shape, transplanting area, movement from one field to another, plot to plot distance and distance from machinery shed to transplanting field. Field capacity of transplanter had direct influence on the fuel consumption, labor and transplanting cost. Fuel was fully utilized in easily accessible regular shape and large size plots because of high field capacity. Distance from one plot to another caused additional fuel consumption of the machine. Higher field coverage ensured full utilization of labor, minimal fuel consumption and hence reduced transplanting cost (Islam *et al.,* 2017). Taniyama (1975) stated that the operation efficiency of machines generally becomes higher in proportion to the size of field plots and the length-width (L/W) ratio of plots. The operational efficiency of rotary cultivation with 30-40 PS wheel tractor increased a little when the size of field lots exceeds 0.3 ha and remarkably decreased when the size of plot were below that level. The efficiency increased with the increase in L/W ratio. Larger plots were favorable in increasing daily area coverage than smaller plots. Smaller plots were not favorable to operate transplanter and not possessed economic feasibility. Small plots having less than 250 m^2 should be avoided for 4-row walking type transplanter (Islam *et al.,* 2017). In addition, field sizes less than 400 m^2 should be avoided to get the good performance of 6-row riding type transplanter (Islam *et al.,* 2015). Ganewatta (1974) mentioned that an average farmer owned 1.7-3.5 plots and the plot size ranged from 0.2-0.4 acres in dry zonal village of Srilanka. The ownership of plots ranged l-10 which was similar to Japan before the implementation of land improvement project. Nagata (1973) mentioned that each farmer owned 1-17 plots often located in different places of Okijima village (Kahoku project area), Japan before land consolidation and farmers owned a relatively large farm size having on an average plot size of 0.5 ha after farm land consolidation. In Japanese villages, the average family holdings consisted of some 15 or 20 farm plots in the 1940s. The average plot was only about 500 m^2 and the distance between two plots belonging to one farmer was several kilometers (Williamson, 1951). High degree of land fragmentation i.e. 3.2 plots per farm with average plot size of 0.16 ha were observed in Bangladesh (Mandal, 2014). Fragmented land is the effect of population explosion over the country and possibilities to control the land fragmentation is less due to socio-economic impact. The land is divided further as the ownership changes with the increase in population. Islam *et al.* (2015) studied the plot shape in Bogra and Natore district while transplanter was operated commercially in the farmer's field and mentioned that among the transplanting plots, 70,25 and 5% plots were uniform, irregular and mostly irregular, respectively. Ulluwishewa *et al.* (1985) emphasized the need of enlargement of plot size to reduce the turning events inorder to increase the operational efficiency of farm machine. The use of modern machinery is difficult or may be impossible in tiny plots and may require an excessive amount of manual work in the corners and along the boundaries (Karouzis, 1977; Burton, 1988). Tsuchiya (1976) stated that land improvement encouraged the introduction of modern farm machinery due to better irrigation and drainage facility and enlarging plot size by rearranging the existing paddy fields. Nagata (1973) mentioned that in Japan, one farmer had many small plots which were scattered

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before the implementation of land improvement projects. This impeded the mechanization by creating small field plots and by increasing the time that has to be taken for travelling from one plot to another. The small size and irregular shape of plots is another dominant problem associated with land fragmentation (Yates, 1960). From the above findings, the study makes an attempt to find out the present scenario of plot shape, size, uniformity and requirement of land management for better performance of the farm machine especially 4-row walking type rice transplanter. Therefore, the objective of the present study were to examine the existing plot size with shape, degree of land fragmentation and effect on the operational efficiency of rice transplanter.

II. Materials and Methods

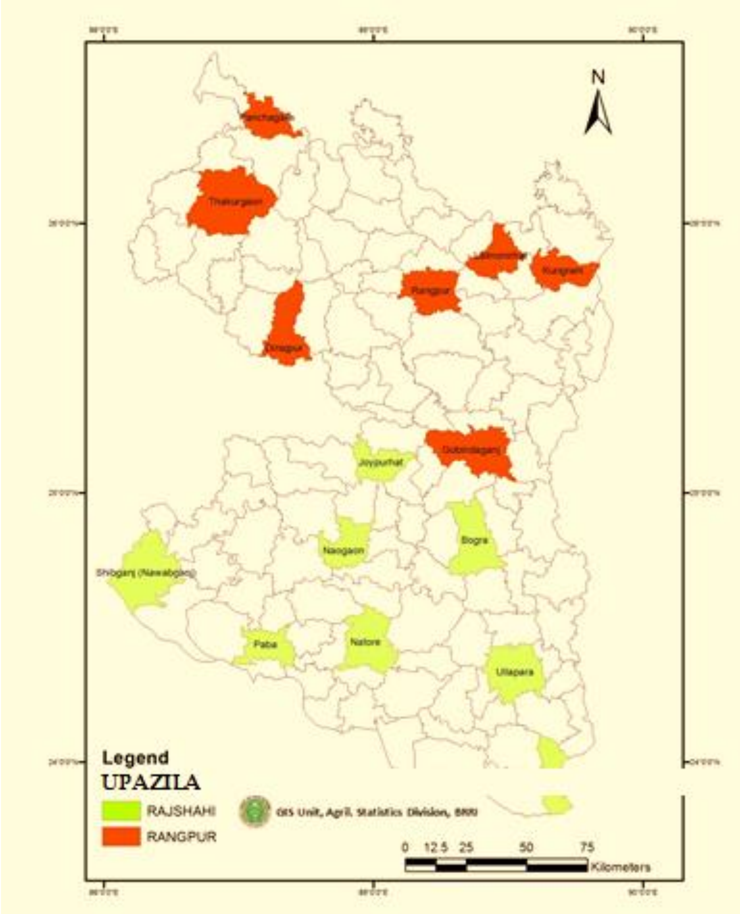
Two administrative divisions, i.e., Rajshahi and Rangpur of Bangladesh were selected purposively. Field survey was carried out in 15 village under 15 upazila in 15 district of Rajshahi and Rangpur (Map 01) to know the existing plot size, shape and length-width ratio of each plot in January-June 2017. The village in each district was selected by using simple random sampling (SRS) method. The total number of sample size was 1500 and the data on plot size, shape and cropping systems were collected from 100 adjacent plots in each village of the respective upazilas. Table 01 and Table 02 show the cropping systems of the selected villages, unions and upazilasin each division. Shape characteristics of the agricultural plots were divided into four categories depending on the percent uniformity of plot shape which was measured by eye estimation. The categories were as irregular (>4%), moderately irregular (2-4%), moderately regular (1-2%) and regular (<1%). Descriptive statistics was applied to analyze both qualitative and quantitative data. 4-row walking type transplanter was considered to interpret the field performance on the existing plot size, shape and plot L/W ratio.

Table 01. Survey locations and cropping systems under Rajshahi division

District	Upazila	Union	Village	Cropping system
Bogra	Sadar	Fapore	Kanar	*Late Boro- Aman*-Potato
Chapainawabganj	Shibganj	Shibganj	Shekhtola	*Boro-Aman*
Joypurhat	Sadar	Bambvu	Hismi Bazar	*Boro-Aman*
Naogaon	Sadar	2 no. Halain	Toruk	*Boro-Aman*
Natore	Sadar	11 Kaforia	Khandarpar	*Boro-Aman*
Pabna	Bera	Aminpur	Fokirkandi	*Boro-Aman*
Rajshahi	Paba	8 Horian	Mohonpur	*Aman*-Mungbean
Sirajganj	Ullapara	Hatikumrul	Choriachockpara	*Boro-Aman*

Table 02. Survey locations and cropping systems under Rangpur division

District	Upazila	Union	Village	Cropping system
Rangpur	Sadar	15 no. ward	Ghaghotpara	Late *Boro-Aman*-Potato
Lalmonirhat	Sadar	Panchagram	Haridev	Late *Boro-Aman*
Dinajpur	Sadar	Sadar	Paschim Khudihar para	Late *Boro – Aman*- Potato
Thakurgaon	Sadar	16 no. Nargun	Kismat Daulatpur	Late *Boro-Aman*-Maize
Panchgarh	Sadar	10 no. Gorinabari	10 no. Gorinabari	*Boro-Aman*-Chili
Gaibandha	Gobindaganj	Kamardaha	Digholkandi	Late *Boro – Aman*-Potato/Onion(Banana)
Kurigram	Sadar	Mogolbasha	Uttar Naowabas	*Boro-Aman*-Brinjal/Onion



Map 01. Upazilla wise survey location in Rajshahi and Rangpur division.

III. Results and Discussion

Plot number and size

Table 03 showed that the number of plots per hectare was observed more than 10 in the survey areas of all the districts except Joypurhat and Naogaon in Rajshahi division. High degree of land fragmentation was observed in Chapainawabganj district (22 plots per ha). The lowest degree of land fragmentation was observed in Joypurhat (9 plots per hectare) and Naogaon (10 plots per ha) districts. The average plot sizes were varied from 0.05-0.11 ha. The average plot size was more than 0.10 ha in Joypurhat and Naogaon districts. The plot sizes were observed the lowest in Chapainawabganj district (0.05 ha). Wide range of variation of plot sizes were observed (53-2830 m^2) in the survey areas of Rajshahi division. Mandal (2014) observed the average farm size of 0.5 ha which was below the present findings. This might be due to the variation of sample size and survey methodology. Farmers divided the larger sizes of plots by creating artificial levee to maintain water. In Rajshahi, Chapainawabganj, Naogaon, Natore, Joypurhat districts, the height of the rural road from the plot surface was 1m. However, the height of the rural road from the plot surface was observed more than 2 m in the survey areas of Sirajganj and Pabna districts. Farmers faced problem to move the machine from road to the plot due to high elevation especially in Naogaon, Natore, Pabna and Sirajganj districts. In Rajshahi district, more than 70% plots were terrain where farmers faced difficulty to move machine. However, in other districts, 55-65% of the total plots were elevated than other plots. The survey plots were more than two to three kilometer far from the rural road. The machinery moved into the plots by crossing the other plots, levees and irrigation canal.

Table 03. Plot number per hectare and plot size in the sample location of Rajshahi division

District	Plot, no. ha^{-1}	Plot size, ha	Range, m^2
Bogra	16	0.06 ±0.004	112-2192
Chapainawabganj	22	0.05 ± 0.003	113-1403
Joypurhat	9	0.11 ± 0.006	302-2830
Naogaon	10	0.10 ± 0.005	245-2787
Natore	17	0.06 ± 0.002	53-1380
Pabna	14	0.07 ± 0.005	187-2674
Rajshahi	16	0.06 ± 0.003	123-1653
Sirajganj	12	0.08 ± 0.005	105-2450
Average	**13**	**0.07 ± 0.002**	**53-2830**

The number of plots per hectare was observed 29-35 in the survey areas of Dinajpur, Panchgarh and Kurigram district under Rangpur division. It indicated that the highest degree of land fragmentation was observed in these areas (Table 04). In this division, Kurigram and Gaibandha districts are mostly flood prone. The major rivers located in Kurigram are Brahmaputra, Dharla, and Tista. In flood prone Kurigram district, plots were found larger in size in the studied area. Land sizes were found very small (0.03 ha) in Dinajpur, Panchgarh and Kurigram districts. Larger plot sizes were found in the Thakurgaon district. In Panchgarh district, plots elevation was found higher and few areas were covered by *boro* than *aman* rice cultivation. The larger size of plots (0.11 ha) were observed in Rangpur district. The average plot sizes were observed from 0.03-0.011 ha in the survey area of Rangpur division. The plot sizes were observed very smaller to larger in size (54–4451m^2). Farmers divided the large plot into smaller due to maintain proper leveling of land. The height of main road from plot surface was very much high.

Table 04. Plot number per hectare and plot size in the sample location of Rangpur division

District	Plot, no. ha^{-1}	Plot size, ha	Range, m^2
Dinajpur	29	0.03 ± 0.001	149-682
Gaibandha	17	0.06 ± 0.003	99-2071
Kurigram	29	0.03 ± 0.002	78-1436
Lalmonirhat	11	0.09 ± 0.004	218-2295
Panchgarh	35	0.03 ± 0.002	54-1134
Rangpur	9	0.11 ± 0.007	132-4451
Thakurgaon	15	0.07 ± 0.004	100-2008
Average	**17**	**0.05**± 0.001	**54-4451**

Distribution of farm plot size

The distribution of plots sizes reflected that different sizes of plots were prevailed in the survey areas of Rajshahi division (Table 05). Chapainawabganj (21%) and Bogra (10%) districts possessed the highest small plots (<250m^2) than other districts of Rajshahi division. Most of the plots in Joypurhat (67%), Naogaon (62%) and Sirajganj (50%) districts dominated the sizes more than 750 m^2. Very few larger sizes of plots (>1000 m^2) were observed in the survey areas of Chapainawabganj and Natore districts. At the moment, 65% plots were categorized under classification of 500->1000 m^2. Those plots were suitable to operate 4-row walking type transplanter efficiently. However, 28% of total plots were categorized as 250-500 m^2 which was needed further enlargement of plot size to operate the 4-row walking type transplanter in an efficient manner. Besides, 7% plots were categorized as below 250 m^2 in Rajshahi division which were not suitable to operate the 4-row walking type transplanter. Islam *et al.* (2017) stated that plot size of 1000 m^2 or higher seemed to attain field efficiency of 75% or higher with a field capacity of at least 0.15 ha hr^{-1}. The authors also mentioned that field capacity was very low for the field size less than 250 m^2.

Table 05. Classification of plot based on size in the survey locations of Rajshahi division

Districts	Plot size, m²				
	<250	250-500	500-750	750-1000	>1000
	% of total sample				
Bogra	10	29	38	10	13
Chapainawabganj	21	52	13	9	5
Joypurhat	0	14	19	16	51
Naogaon	1	15	22	17	45
Natore	8	26	46	13	7
Pabna	6	33	29	9	23
Rajshahi	7	35	31	13	14
Sirajganj	6	22	22	18	32
Average	**7**	**28**	**28**	**13**	**24**

In Rangpur division, the largest share of smaller plots (<250 m²) were observed in the survey areas of Panchgarh (54%) followed by Kurigram (34%) districts (Table 06). The largest share of plot sizes having 250-500 m² were obtained in Dinajpur (72%) followed by Kurigram (52%) districts. The distribution patterns indicated that the plot sizes more than 750 m² accounted 57-64% of total plots in the survey locations of Rangpur and Lalmonirhat districts. On an average, 44% of total plots were under the category of 500->1000 m². Those plots were suitable to operate 4-row walking type transplanter efficiently. On the other hand, 37% plots were categorized under 250-500 m² which were needed further enlargement of plot size to operate the 4-row walking type transplanter in an efficient manner. However, 19% plots were categorized as below 250 m² in Rangpur division which were not suitable to operate the 4-row walking type transplanter. Islam *et al.* (2015) observed that among the transplanting plots, 15% were under <400 m² and 14% were under 450-550 m² in Bogra region.

Table 06. Classification of plot based on size in the survey locations of Rangpur division

Districts	Plot size, m²				
	<250	250-500	500-750	750-1000	>1000
	% of total sample				
Dinajpur	18	72	10	0	0
Gaibandha	15	32	30	14	9
Kurigram	34	52	11	2	1
Lalmonirhat	5	17	21	26	31
Panchgarh	54	35	7	3	1
Rangpur	4	18	14	26	38
Thakurgaon	4	36	22	19	19
Average	**19**	**37**	**17**	**13**	**14**

Slow and fast operation of the farm machines were frequently happened during operation in the small size of plots due to more turning events. Those kind of plots incurred huge loss of time and fuel during turning which were not recommended for operating 4-row walking type rice transplanter due to more turning events and less maneuverability of machine. Those plots should be avoided to operate transplanter in commercial purpose. Emphasize should be given to enlarge those plots to a great extent for operating the rice transplanter in an efficient manner.

Distribution of plot length

In Rajshahi division, the survey areas of Chapainawabganj (50%), Bogra (33%), Natore (26%) and Rajshahi (21%) districts accounted the largest share of plot length having less than 25 m (Table 07). Most of the plots in Rajshahi division belonged to the length having 25-35m. Presently, 41% of total plots were under the category of plot length 35->55m which were not needed to enlarge the length. On the other hand, 38% of total plots were classified under the length of 25-35m which may need further enlargement to get the better performance of the 4-row walking type transplanter by reducing the turning events. On an average, 21% plots were grouped as plot length of below 25m in Rajshahi division which was not suitable to operate the 4-row walking type transplanter in an efficient manner. The length of those plots should be enlarged to more than 25 m to get good machine performance.

Table 07. Classification of plot based on length in the survey locations in Rajshahi division

Districts	Plot length, m²				
	<25	25-35	35-45	45-55	>55
	% of total sample				
Bogra	33	48	15	1	3
Chapainawabganj	50	32	3	15	0
Joypurhat	2	34	30	16	18
Naogaon	10	27	28	20	15
Natore	26	47	22	4	1
Pabna	10	36	20	15	19
Rajshahi	21	50	23	5	1
Sirajganj	16	28	26	15	15
Average	**21**	**38**	**21**	**11**	**9**

The distribution pattern on plot length indicated that the survey areas of Dinajpur (76%), Panchagarh (56%), Gaibandha (37%) and Thakurgaon (34%) districts under Rangpur division dominated the largest share of plot length having less than 25 m (Table 08). The plot length having more than 45m was accounted 39 and 30% in Rangpur and Lalmonirhat districts. Presently, 31% plots were under the category of plot length 35->55m which were not needed to enlarge the length. On the other hand, 29% of total plots were classified under the length of 25-35m which may need further enlargement to get the better performance of the 4-row walking type transplanter by reducing the turning events. On an average, 40% plots were grouped as plot length of below 25m in Rangpur division which was not suitable to operate the 4-row walking type transplanter in an efficient manner. Length of those plots should be increased to more than 25 m in all the districts under Rangpur division to get the less turning events of the transplanter.

Table 08. Classification of plot based on length in the survey locations in Rangpur division

District	Plot length, m				
	<25	25-35	35-45	45-55	>55
	% of total sample				
Rangpur	10	22	29	21	18
Lalmonirhat	12	23	35	11	19
Dinajpur	76	24	0	0	0
Thakurgaon	34	39	17	6	4
Panchgarh	56	35	3	4	2
Gaibandha	37	33	20	10	0
Kurigram	52	30	10	4	4
Average	**40**	**29**	**16**	**8**	**7**

Turning events and maneuverability depended on the length of the plot. Plots having larger lengths substantially reduced the loss of time, hence increased the field capacity of the farm machine. More turning events increased the turning loss. The loss time during turning in headland depended on the frequency of turning which was affected by the plot length. Turning loss was reduced with the increase in plot length. The turning loss was observed 5 times more in the plots having the length of <25 m than that of 45-55 m which could be used to cover an additional area of 0.04 ha at the same time. Field capacity was influenced by the plot length and increased with the increase in plot length due to less turning loss. Plot length having less than 25 m increased the frequent turning events and decreased the performance of the 4-row walking type rice transplanter (Islam *et al.,* 2017). The length of plot can be enlarged through mutual cooperation of the land owner by keeping the plot sizes remain same.

Distribution of plot shape

In Rajshahi division, the distribution pattern on the uniformity of plot shape indicated that very few portions of plots having regular in shape were observed in the survey areas of Chapainawabganj (5%)

and Natore (13%) districts (Table 09). Most of the portion of plots in the survey areas of Chapainawabganj (48%), Rajshahi (41%), Natore (33%) and Naogaon (21%) districts possessed the irregular and moderately irregular in shape. On an average, 25% areas were categorized as irregular and moderately irregular shape in Rajshahi division where transplanter was inaccessible and initiated manual labor to transplant seedlings.

Table 09. Classification of plot based on uniformity in the survey locations of Rajshahi division

District	Regular	Moderately regular	Moderately irregular	Irregular
	% of total sample			
Bogra	42	33	20	5
Chapainawabganj	5	47	36	12
Joypurhat	64	34	2	0
Naogaon	25	54	16	5
Natore	13	54	30	3
Pabna	40	42	18	0
Rajshahi	16	43	36	5
Sirajganj	45	40	10	5
Average	**32**	**43**	**20**	**5**

In Rangpur division, most of the plots in the survey areas of Lalmonirhat (93%), Rangpur (84%), Gaibndha (78%), Kurigram (78%), Dinajpur (77%), Thakurgaon (74%) and Panchgarh (74%) districts possessed the regular and moderately regular shape (Table 10). The highest portion of plots having moderately irregular and irregular shape were observed in the survey area of Thakurgaon (26%), Panchgarh (26%), Dinajpur (23%) and Kurigram (22%) districts compared to other districts in Rangpur division which influenced the manual transplanting. The least amount of irregular shape (4-8%) of plots was observed in Rangpur, Dinajpur and Thakurgaon districts. Currently, 19% areas were categorized as irregular and moderately irregular shape in Rangpur division where transplanter was inaccessible and initiated manual labor to transplant seedlings.

Table 10. Classification of plot based on uniformity in the survey location of Rangpur division

Districts	Regular	Moderately regular	Moderately irregular	Irregular
	% of total sample			
Dinajpur	43	34	17	6
Gaibandha	52	35	9	4
Kurigram	48	30	16	6
Lalmonirhat	79	14	7	0
Panchgarh	53	21	18	8
Rangpur	50	34	10	6
Thakurgaon	42	32	20	6
Average	**53**	**28**	**14**	**5**

The shape characteristics of the plots showed noticeable share of irregular portion. Irregular shape of plots caused extra travel, offered low transplanting capacity and high cost. Machines are unable to transplant in the pocket area due to inaccessibility which influenced the manual transplanting (Islam *et al.,* 2015). The irregular shape of plot decreased the performance of the transplanter (Islam *et al.,* 2017). Irregular shape of plots influenced the intervention of manual labor in transplanting. The shape of the plots should be converted to regular shape to harness the benefit of mechanized transplanting by escaping the burden of manual transplanting.

Distribution of plot length-width ratio

In Rajshahi division, the distribution of plot L/W ratio revealed that more than 40% plots were found under the category of L/W ratio of 1-1.5 in the survey areas of Bogra, Natore, Joypurhat, Rajshahi and Chapainawabganj districts (Table 11).Pabna district (63%) accounted the highest portion of land under L/W ratio of >2 and lowest in Bogra district (9%). On an average, L/W ratio of 1-1.5, 1.6-2.0 and >2 accounted 43, 25 and 32% land, respectively in Rajshahi division.

Table 11. Classification of plot based on plot length-width ratio in the survey locations of Rajshahi division

District	Plot length-width ratio		
	1-1.5	1.6-2.0	>2
	% of total sample		
Bogra	61	30	9
Chapainawabganj	43	24	33
Joypurhat	48	15	37
Naogaon	39	33	28
Natore	51	27	22
Pabna	16	21	63
Rajshahi	47	24	29
Sirajganj	38	19	43
Average	**43**	**25**	**32**

Table 12 stated that L/W ratio of 1-1.5 was found the highest in Dinajpur followed by Thakurgaon district under Rangpur division. Plot L/W ratio of 1-1.5 was obtained as 24-45% in survey areas of other districts in Rangpur division. Turning events of farm machinery will be much higher in those areas of Dinajpur and Thakurgaon districts than other districts in Rangpur division. Turning events will be less in those areas where L/W ratio of greater than 2 in the survey areas of Kurigram, Lalmonirhat and Panchgarh districts. On an average, L/W ratio of 1-1.5, 1.6-2.0 and >2 accounted 43, 29 and 28% land, respectively in Rangpur division.

Table 12. Classification of plot based on plot length-width ratio in the survey locations of Rangpur division

District	Plot length-width ratio		
	1-1.5	1.6-2.0	>2
	% of total sample		
Dinajpur	74	25	1
Gaibandha	45	31	24
Kurigram	30	23	47
Lalmonirhat	35	23	42
Panchgarh	31	25	44
Rangpur	24	51	25
Thakurgaon	63	27	10
Average	**43**	**29**	**28**

The plot L/W ratio has great influence on the performance of farm machinery. The total number of turns depended on the L/W ratio of the plots and transplanting path (length or width-wise). The L/W ratio for 60% of the plots was observed 1.5-2.5. The least number of turns were observed for L/W ratio of 2-2.5 and length-wise transplanting. With the increasing of L/W ratio, number of turning events reduced in length-wise operation and increased in width-wise transplanting lay out. Length wise operation of farm machinery is preferable to minimize the turning events. Plot length should be increased by keeping the same plot size (Islam *et al.*, 2017). Taniyama (1975) stated that the operation efficiency of machines generally becomes higher in proportion to the size of field plots and the L/W ratio of plots. The efficiency of transplanter will be increased with the increase in L/W ratio. Land improvement works by consolidating the smaller plots may not be possible at this stage due to socio-economic condition of farmers. However, entrepreneur may follow the operational consolidation i.e. plot shape, size and plot to plot distance while operating the transplanter machine in the field. Mandal (2017) and Islam *et al.* (2015) also emphasized the importance of operational consolidation to get the maximum daily area coverage of the farm machine.

IV. Conclusion

High degree of land fragmentation and irregular shape of plots were observed in the survey areas of two administrative divisions. Smaller size and irregular shape of plots hindered the movement of mechanical rice transplanter and influenced the manual transplanting in the pocket areas. Those plots should be enlarged and reshaped to ensure the accessibility of transplanter machine. Plot elevation from rural road was high and hampered the movement of farm machinery from road to the plot. Land improvement work is suggested to facilitate the accessibility of the farm machine into the field by creating farm road and to improve the better performance of the farm machine.

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