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Seedling Raising Nursery Business for Sustainable Mechanical Rice Transplanting in the Southern Delta of Bangladesh

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ABSTRACT

Mechanical rice transplanting needs special seedling raising. The Appropriate Scale Mechanization Innovation Hub (ASMIH)-Bangladesh project trained farmers on raising rice seedling. Extensive field trials were conducted during 2017 to 2019 by the ASMIH-Bangladesh and farmers' groups are now confident to establish seedling nursery on commercial basis. It will solve the seedling raising problem for mechanical transplanting and also increase their income. The main advantages of mechanical transplanting are transplanting of seedlings at the age of 12-30 days with uniform spacing and optimum plant density; higher productivity compared to traditional transplanting where plant spacing and density are not always be consistent; less transplanting shock, early seedling vigor and uniform crop establishment; less time, labor, drudgery and health risks for farm laborers. FAO developed a rural invest software named "RuralInvest" to access the sustainability of rural projects such as mechanization, development projects, entrepreneurial opportunities, investment projects etc. In this study, the RuralInvest software was used to evaluate the seedling raising nursery business. The total time duration of the project was estimated for 5 years with farmer's own investment where the direct beneficiaries were 08 farmers and indirect beneficiaries were 45 farmers. Two types of seedling raising techniques were evaluated with the RuralInvest software, one for mat-type and another for economy plastic tray-type seedling raising. The IRR, NPV, payback period and Investment per direct beneficiaries were found 29.10%, BDT 2056, 2.46 year, BDT 348.75 and 22.52%, BDT 3834, 2.84 years, BDT 911.25 for mat-type and plastic tray-type seedling raising, respectively. To establish the sustainable mechanization of rice transplanting and meet the challenges of labor crisis during rice transplanting season, seedling raising nursery business would generate sustainable entrepreneurship through income generation and raising seedlings for mechanical rice transplanting in the Southern delta of Bangladesh.

Introduction

Bangladesh is self-sufficient in rice production (Shelley *et al.*, 2016) and Rice (*Oryza sativa* L.) is the staple food. Islam (2016) reported that, about 75% of the total cropped area and 80% of the total irrigated area is under coverage of rice cultivation. In Bangladesh, transplanting of rice is common practice and mainly done manually (Islam *et al.*, 2009). For transplanting, seedlings are first grown in seed bed and after a period, seedlings are uprooted and transplanted in a well prepared cultivated land for growing rice (Azme *et al.*, 2016). Transplanting of rice is advantageous over direct showing for higher yield, less time for crop establishment, weed control, water management, intercultural operations, optimum plant spacing, seed requirement etc (Alizadeh *et al.*, 2011; Mishra *et al.*, 2008). Singh et al., 1985 reported that manual transplanting of rice takes about 250-300 man hours/ha which is almost 25% of the total labor requirement for rice crop establishment. Transplanting of rice by transplanter machine over traditional practice has many advantages although it is a new technology in Bangladesh. Mechanical transplanting reduces cost of transplanting and labor requirement (Sarkar *et al.,* 2019; Ashik-E-Rabbani *et al.,* 2018). Moreover, transplanting operation is done in line without an extra cost and which makes weeding and intercultural operation easier. Mechanical transplanting needs special seed bed

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(Hossain *et al*., 2017; Ashik-E-Rabbani *et al.*, 2017). Rice seedlings can be grown on soil in plastic trays or on mud soil placed on polythene sheet (CSISA, 2011). Rice seedling raised on polythene mat is less costly and convenient over tray. The labor engagement in agricultural activities is decreasing (DTDA, 2020). In 2010, the contribution of agricultural labor was 47.3% but in 2016 it was declined to 40.6% (BBS, 2016-17). Besides, the change on wage rate index for agriculture sectors increased from124.51 to 148.52 during 2014-15 to October'2017 (BBS, 2017). The decreasing trend of labor availability in agricultural activities and higher labor wage made the traditional transplanting of rice costly and non-profitable for the farmers. Mechanical transplanting is popular in industrialized countries where labor cost is high, for example in South Korea (Islam *et al.,* 2015a). Different models of transplanters have been introduced in the country and farmers are encouraged to adopt mechanized transplanting of rice. Depending on the variety, dry and wet seasons the age of seedling in is maintained between 12 and 25 days (Islam *et al.,* 2015b). The mechanical transplanting of rice differs from traditional manual transplanting method in seedling raising, seed rate, seed treatment and seedling age. The other production activities like weeding, irrigation, fertilizer application, plant protection, harvesting, threshing and bagging are similar to traditional manual transplanting method (Islam *et al.,* 2015c).

Market liberalization, globalization, rapid urbanization, rising incomes and changing diets; they are all changing agriculture at an unprecedented speed and in diverse ways. They are creating new markets, stimulating demand for high-value products, and making it possible for farmers to produce food and other products for the market. These developments offer opportunities for farmers, but they also produce challenges and risks. The majority of farmers, particularly smallholders need to expand their understanding of markets and economic opportunities if they are to achieve success in running their farms as sustainable and profitable businesses. To create a viable livelihood from farming, they need to move from a sole focus on production for home consumption and occasional marketing of surpluses, and producing also for the market, responding to the continuously changing market demands. Even though farmers are innovative and entrepreneurial, they often lack the know how to do so alone. They need advice from others; they need services (Wongtschowski *et al.,* 2013). Department of agricultural extension (DAE), Agricultural Universities, importers of machinery and NGOs mainly served the farmers for adoption of new technologies. In response to the trends, the challenges to link farmers to markets and adopting technologies a more business oriented and demand driven, approach to provide advice to farmers and entrepreneurs is needed. Food and Agricultural Organizations of United nations (FAO) developed a tool named "RuralInvest toolkit" to assess the business viability of such businesses. In this study RuralInvest toolkit software was used to evaluate the financial performance of the rice seedling nursery and to identify the entrepreneurial opportunity for seedling raising business for mechanical rice transplanting (FAO, 2019).

Materials and Methods

The rice seedling nursery business was focused on both polythene mat type and economy plastic tray type seedling beds for mechanical transplanting in *Aman* and *Boro* seasons (Figure 1 and 2). This study was conducted on 450 trays or equivalent mat type seedling trays. The economic life of the plastic tray was assumed 5 years and for the mat type seedling polythene sheet life was assumed once for each season. The total time duration of the project was estimated for 5 years with farmer's own investment, where the direct beneficiaries were 08 farmers and indirect beneficiaries were 45 farmers.

Figure 1. Seedling on tray

Figure 2. Seedling on polythene mat

Data collection and analysis

The experiments on both tray and mat type seedling nursery business focused on the viability of the nursery business for mechanical transplanting.

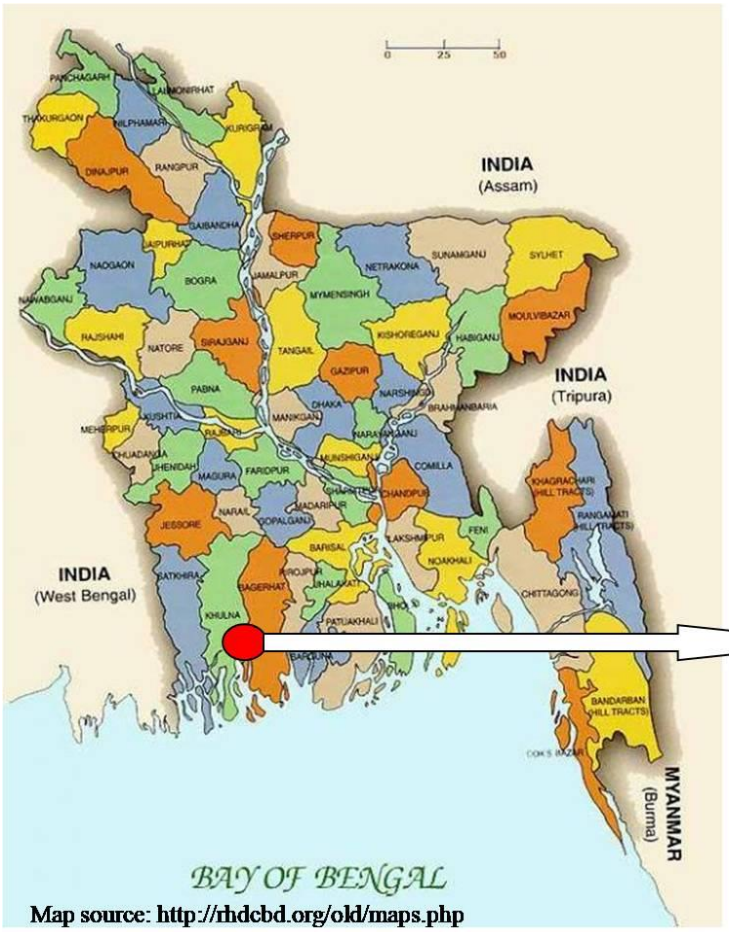

Figure 3. Location of the experiment

Figure 4. RuralInvest software interface

Appropriate Scale Mechanization Innovation Hub (ASMIH)-Bangladesh has been conducting research on mechanical transplanting of rice at Boratia village of Dumuria Upazila of Khulna District of Southern Delta region of Bangladesh (Figure 3).

Collected data on tray and mat type seedling raising were analyzed by the RuralInvest software (Figure 4) as per RuralInvest toolkit guideline. The RuralInvest toolkit comprises a methodology, manuals, training materials and computer software. Together they provide a simple, yet reliable, approach to identify, formulate, implement, monitor and evaluate small-scale community or family investment projects. The RuralInvest software, developed by FAO, automates many financial calculations needed to analyze project proposals. It considers all elements, allows for comparison of alternatives and can also be used to monitor and evaluate proposals. Major outputs generated by RuralInvest include annual cash flow, internal Rate of Return (IRR), Net Present Value (NPV), payback period, costs, income and net income. Number of direct and indirect beneficiaries was given from farmers household related to business.

Unit of production (UoP) and block

Unit of production describes the input/output relationship per a defined reference unit for one production cycle. All operational costs and all revenues related to the unit are given for one production cycle. Annual operational costs, revenues and income are obtained by multiplying the results with the number of production cycles per year (FAO, 2007).

Payback period

Payback period refers to the time period within which the costs of investment can be covered by revenues (Rahman and Alam, 2013). Payback period (PP) can be computed by applying the following formula:

PP = Investment (total initial, BDT)/ Net benefit (BDT/yr.) (i)

Benefit-Cost ratio

The benefit cost ratio is an important factor to measure the profitability of a business. If the benefit cost ratio (BCR) ratio is greater than unity, then it will be economically viable. BCR was calculated by using the following formula:

BCR = ∑Present worth of Benefits /∑Present worth of costs (ii)

Net present value (NPV)

Net present value (NPV) was calculated by using the following formula (Gittinger, 1982):

NPV =∑ Present worth of Benefits – ∑ Present worth of costs (iii)

Internal rate of return (IRR)

Internal rate of return (IRR) is called discount cash flow (DCF) yield or DCF return on investment or effective rate of interest method or marginal efficiency of capital. The IRR is the value of discount factor when the NPV is zero (Gittinger, 1982). The internal rate of return is a rate in quantity. It is an indicator of the efficiency, quality and/or yield of an investment. IRR can be computed with the help of this formula:

IRR = Lower discount rate + (Difference between the discount rates) × {Present worth of cash flow at lower discount rate/(Sum of the present worth the of cash flows at the two discount rates, signs ignored)} (iv)

Results and Discussion

Financing of investment & working capital requirement (breakdown by source)

Financial and working capital for starting the seedling nursery business was observed BDT 10337.50 for plastic tray type and BDT 6300 for mat type seedling tray. Where, the percentages of initial investment from own resources were 46.82% and 41.11%, respectively. The percentages of amount to be financed were 53.18% and 58.89%, respectively. Working capitals were found BDT 3047.50 and BDT 3510, respectively (Table 1).

Investment breakdown by type

The investment breakdowns were found BDT 6290 for tray type and BDT 1790 for mat type seedling tray where the investment percentages were 86.28% and 64.16%, respectively. BDT 1000 for professional extension service was considered for seedling nursery and the percentage of investment for these purposes were found 13.72% and 35.84%, respectively (Table 2).

Investment per beneficiary (Household, men, women and children)

Beneficiary for the Investment in household and individual level was calculated by the RuralInvest software. For direct beneficiaries at household level, it was found BDT 3645 for tray type and BDT 1395 for mat type seedling raising. Similarly, for individual level (Men, women and children) the investments were found BDT 911.25 and BDT 279, respectively. For indirect beneficiaries, the investments were found that BDT 729 and BDT 279; BDT 162 and BDT 62, respectively (Table 3).

Blocks

Production chronologies for *Aman* and *Boro* seasons were shown in blocks (Figure 5). Where the production/activity indicated the seedling raising season and the harvest/sale indicates the time of transplanting. It was considered that the nursery owner will be paid immediately after the sales of rice seedling. The production chronologies of tray and mat type seeding raising were found similar (Figure 5).

Table 1. Financing of investment and working capital

Type	Tray		Mat		Tray		Mat	
	Financing of investment				Working capital			
	Amount (BDT)	%	Amount (BDT)	%	Amount (BDT)	%	Amount (BDT)	%
Donation	0	0	0	0	0	0	0	0
Own resources	4840	46.82	2590	41.11	0	0	0	0
To be financed	5497.5	53.18	3710	58.89	3047.50	100	3510	100
Total	10337.5	100	6300	100	3047.50	100	3510	100

Table 2. Investment breakdown

Type	Tray		Mat	
	Amount (BDT)	%	Amount (BDT)	%
Assets	6290	86.28	1790	64.16
Labor	0	0	0	0
Professional services	1000	13.72	1000	35.84
Total	7290	100	2790	100

Table 3. Investment per beneficiary (Household, men, women and children)

Beneficiary type	Tray		Mat	
	Investment per beneficiary (Households)		Investment per beneficiary (Men, women and children)	
	Amount (BDT)		Amount (BDT)	
Direct beneficiaries	3645	911.25	1395	348.75
Indirect beneficiaries	729	162	279	62

Figure 5. Production blocks for tray and mat type seedling raising

Table 4. Financial profitability for tray type seedling raising

Year	1	2	3	4	5
Income			Amount (BDT)		
Sales and own consumption	17100	17100	17100	17100	17100
Salvage	0	0	0	0	0
Residual	0	0	0	0	70
Total	17100	17100	17100	17100	17170
Costs					
Operation	13490	13490	13490	13490	13490
Replacement	0	0	140	0	140
General	1000	1000	1000	1000	1000
Maintenance	0	0	0	0	0
Investment	7290	0	0	0	0
Total	21780	14490	14630	14490	14630
Net income	-4680	2610	2470	2610	2540

Table 5. Financial profitability for mat type seedling raising

Year	1	2	3	4	5
Income			Amount (BDT)		
Sales and own consumption	17100	17100	17100	17100	17100
Salvage	0	0	0	0	0
Residual	0	0	0	0	70
Total	17100	17100	17100	17100	17170
Costs					
Operation	14940	14940	14940	14940	14940
Replacement	0	0	140	0	140
General	1000	1000	1000	1000	1000
Maintenance	0	0	0	0	0
Investment	2790	0	0	0	0
Total	18730	15940	16080	15940	16080
Net income	-1630	1160	1020	1160	1090

Table 6. IRR, NPV and payback period for tray and mat type seedling nursery business

Items	Tray	Mat
IRR	22.52%	29.10%
NPV (BDT)	3834	2056
Payback (years)	2.84	2.46

Financial profitability for tray and mat type seedling raising

For the five (5) year project for tray type seedling nursery, net income was found BDT – 4680, 2610, 2470, 2610 and 2540 for 1st to 5th year, respectively. The negative cash flow for the 1st year was observed due to initial investment (Table 4). Similarly, for mat type seedling nursery, net incomes were found BDT – 4680, 2610, 2470, 2610 and 2540 for 1st to 5th year, respectively. The negative cash flow for the 1st year was achieved due to initial investment for both types of seedling raising nursery business (Table 5).

IRR, NPV and payback period

The IRR, NPV, payback period and Investment per direct beneficiaries were found 29.10%, BDT 2056, 2.46 year, BDT 348.75 and 22.52%, BDT 3834, 2.84 years, BDT 911.25 for mat-type and plastic tray-type seedling raising, respectively (Table 6).

Therefore, both the rice seedling raising techniques were found financially viable.

Conclusion

The financial parameters of seedling raising nursery revealed that for successful dissemination of mechanical rice transplanting technology with rice transplanter backed by the seedling raising nursery is suitable for entrepreneurs and farmers. The FAO developed RuralInvest software is helpful to determine the financial parameters for decision making process of establishing of a seedling raising nursery. Tray type seedling raise need more initial investment than mat type seedling raising. Farmers and entrepreneurs can do both type of nursery as per financial capability as the seedling raising type has a little effect on seedling raising. In the Southern delta of Bangladesh, rice seedling raising nursery business will be an excellent venture to meet the challenges of labor crisis during rice transplanting seasons.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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