Assessment of cost-benefit parameters of conservation agricultural machinery for custom hires entrepreneurship in the southern region of Bangladesh

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Abstract: This paper presents, assessment of cost-benefit parameters of conservation agricultural machinery for custom hires entrepreneurship development in the southern region of Bangladesh. The key principles of the study were to determine the economic parameters for developing a conservation agriculture (CA) machine custom hire entrepreneurship and effective schedules for CA machine operation. Field experiments were conducted at Dumuria, Wazirpur, Subarnachar and Kolapara Upazila (Sub-district) of Khulna, Barishal, Noakhali and Patuakhali districts, respectively in the southern region of Bangladesh in the years 2017 and 2018. Two villages in each Upazila were selected for this study. Primary data was collected from these field experiments. Secondary data from various sources were used in this section of research. Annual operating costs were calculated, and project financial profitability was determined by four on farm financial measurement techniques namely, benefit-cost ratio (BCR), net present value (NPV), internal rate of return (IRR), payback period (PBP). The total cost of operation of a CA machine was found US$32 per hectare. Annual savings for replacement and a profit margin for the entrepreneur, the rent-out charge of the CA machine was estimated at US$82 per hectare of machine operation. Considering 15% interest rate, the NPV of CA machine in exiting condition was US$683. The NPV indicates that CA machinery is considered financially sound and the project is said financially viable because IRR (39%) of CA machine was greater that the bank interest rate (14%). The benefit-cost ratio of machine was found 1.10, which was a profitable venture for an entrepreneur. The break-even use of the CA machine was estimated 3.12 ha of machine operation. Therefore, the owners of CA machine or local service providers (LSPs) can start this business right now which will be highly profitable venture for an entrepreneur.

Keywords: benefit cost ratio, CA machine, entrepreneur, operating cost, payback period

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1 Introduction

Bangladesh is predominantly an agricultural country with almost 67% of its total population directly engaged in crop production (Gurung et al., 2017). For crop production, land tilling is one of the most power intensive operations. At present two-wheeled tractor (Power tiller) are using extensively in cultivation of land for lower cost and require less time for cultivation (Haque et al., 2008) in Bangladesh. About 90% of cultivated land is prepared by 0.7 million two-wheeled tractors (Gurung et al., 2017). Land is prepared by 3-4 passes of shallow tilling with rotary tiller followed by laddering. The traditional tillage method reduces soil organic carbon at double rate and

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decreases soil fertility (Grace, 2003), losses irrigation water and soils (Sayre and Hobbs, 2004), and damages ecological environment (Grace, 2003). To establish Rabi (Dry winter, November-April) maize following rice, farmers typically use 3-5 passes by power tiller. Repetitive tillage requires significant amounts of fuel and energy (Aravindakshan et al., 2015) and results in increased production cost and reduced profit (Gathala et al., 2015). Alternative tillage and crop rotation options may however provide a strong foundation for maintaining or raising yields while increasing farmers' income by reducing energy use. Alternative practices include the use of appropriate tillage and planting machinery to encourage faster crop turn-around, which can potentially facilitate higher yields because of the inverse relationship between yields and sowing dates in Bangladesh (Krupnik et al., 2015). Conservation tillage techniques such as zero, strip, reduced tillage, and raised and permanent beds, which further reduce fuel costs by eliminating repetitive tillage, that also can reduce irrigation requirements (Gathala et al., 2011).The zero, strip and rotary till drills recorded effective field capacity of 0.59, 0.46 and 0.49 ha h^{-1}; provided savings in time (74% to 79%), labour (64% to 71%), fuel (67% to 85%), cost (65% to 81%) and energy (67% to 85%) compared to conventional sowing (Singh and Sharma, 2005). Conservation agriculture (CA) machinery is a power tiller operated seed drill and widely used for various crop establishments through conservation tillage, sowing of seeds and laddering operations simultaneously in a single pass in many areas of the country. Three operations could be done in single pass, i.e., prepare lands with fine tilth, sowing seeds at the 2-3 cm depth and planking simultaneously. This machine performs well at 15% to 36% of soil moisture level. If optimum soil moisture exists, the machine could reduce turn-around time up to zero days in between two crops establishment.

Due to land and capital constrained in rural Bangladesh, owners of agricultural machinery also tend to work as service providers (e.g. providing mechanized land preparation and irrigation) on a fee-per-service basis to other farmers. Power tiller hiring services operate beyond land preparation and include threshing, water pumping and transport (Diao et al., 2014). For example, according to a nationally representative survey in Bangladesh, the 2% of farmers owning power tillers are able to service the 72% of all farmers who have mechanized primary tillage operations (Ahmed, 2014). Custom hiring services for agricultural machinery enable farmers to utilize the appropriate equipment for a defined period of time, only paying for the services. As a result, even the smallest farm households can usually access relatively affordable machinery services through custom hiring systems (Biggs and Justice, 2013; iDE, 2012). Local machinery service providers (LSPs) are making business in the farmers' field as custom hire basis but the numbers of these service providers are not adequate (Hossain et al., 2014). The owners of CA machine can use this machine for their own land cultivation and earn cash income through custom hiring to other farmers. CA machine has not yet reached to all the villages in this region. The service providers of power tiller or a new entrepreneur can be started and they have a great opportunity to spread out this service almost throughout the year. Economic assessment of CA machine has been done for other regions but this is lacking in this region. Therefore, determination of key indicators related to financial management and operation of CA machine for the development of CA machine custom-hire service entrepreneurs are of great importance. Therefore, the present study was undertaken to estimate the cost-benefit parameters of conservation agricultural machinery for developing a CA machine custom hire entrepreneurship in Bangladesh.

2 Materials and methods

2.1 Data collection

Field experiment were conducted at Dumuria, Wazirpur, Subarnachar and Kolapara *Upazila* (sub-districts) of Khulna, Barishal, Noakhali and Patuakhali districts, respectively in the southern region of Bangladesh as shown in Figure 1 during *Rabi* (Dry winter; November-March) and *Kharif*- (Pre monsoon; Mid March-Mid July) season in the years of 2017 and 2018. Two villages in each *Upazila* were selected for the study. CA machinery was used for planting of jute in Dumuria; mungbean, maize, and chickpea in Wazirpur and Kolapara; soybean and cowpea in Subarnachar. Primary data was collected from these field experiments. Secondary data from various sources were used in this section of research. The main sources were from journals, published reports and theses.

Mundopasa, Wazirpur, Barisal
Latitude: 22.863410 N
Longitude: 90.262788 E

Baratia, Dumuria, Khulna
Latitude: 22.82152 N
Longitude: 89.33117 E

Holdibaria, Kolapara, Patuakhali
Latitude: 21.91571 N
Longitude: 90.14235 E

Charwapda, Subarnachar, Noakhali
Latitude: 22.70029 N
Longitude: 91.10641 E

Figure 1 Pictorial view of study area location in southern delta of Bangladesh

2.2 Selection of CA machine

Power tiller operated CA machine was developed by Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute (BARI) (Ahmed et al., 2005; Matin et al., 2008) named BARI seeder or planter as shown in Figure 2. The planter was tested and evaluated for planting different crops like maize, wheat, pulses and oilseeds in field condition. The field performances results were satisfactory. This machine can perform planting operation maintaining standard seed rate and line spacing. Different seed metering (inclined type) plates was used for planting different crops of seed directly. It is able to complete planting operation in a single pass and average field capacity is 0.11 ha h^{-1}. This machine performs well at 15% to 30% of soil moisture level. This machine can finish planting operation in the same day of previous crop harvest, whereas conventional methods it takes 7-9 days from harvest to seeding. Farmer can remove seeding unit from the machine and convert only for tilling purpose. Three different conservation tilling method (zero, strip, minimum tillage) can be operated by this single machine. Inverted T furrow opener is used for different tilling method especially for zero till method and 15° tip angle rotary blade is used for proper back filling of soil in the furrow in strip till method. Strip tillage can be done by removing the rotary blades. In strip tillage the number of blades depends on the number of furrow opener where in front of every furrow opener, four blades are arranged for tillage (Hossain et al., 2005). Technical specifications of the CA machine are given below.

Specifications of a CA machine

Dimension: 720 mm×1320 mm×700 mm

Weight: 136 kg

Number of rotary blades: 48 (C type for minimum tillage), 24 (Tip angle 15° for strip tillage)

Power requirement: Power tiller (9-12 kW)

Number of rows: 6 (line number adjustable)

Furrow opener: Inverted T type

Row spacing: 200 mm (adjustable)

Normal working speed: 1.0-2.5 km h^{-1}

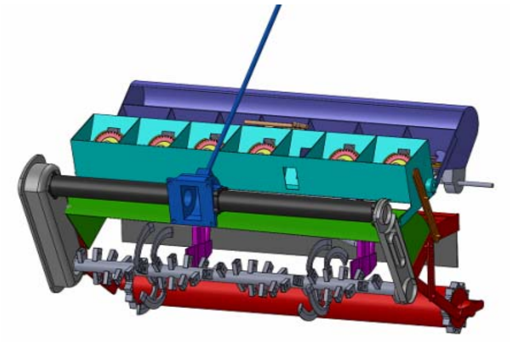
Working width: 1200 mm

Normal seeding depth: 50-60 mm

Type of seed meter: Flute type/inclined plate type

Speed of blade: 480-500 rpm

Price: US$2375 (With 9 kW Power tiller)



(a) Isometric view of BARI planter

(b) BARI planter attached with power tiller

(c) Zero till planting

(d) Strip till planting

(e) Minimum till planting

Figure 2 Isometric and photographic views of BARI planter

Economics of CA machine operation

The total cost of CA machine operations at farm level is comprised of fixed cost (FC) and variable cost (VC). Fixed cost included depreciation, interest on investment, shelter, taxes, insurance and cost of housing, etc. Variable costs include the costs of fuel, lubricant, operator's salary, labour cost, repair, maintenance, and miscellaneous expenses.

2.3 Fixed costs

Fixed costs are expenses incurred regardless of whether the machine is operated or not (depreciation (*D*), interest on investment (*I*), shelter, taxes and insurance (*STI*). Fixed costs are fixed in total, but decline per hectares, as the annual use of the machine is increased (Barnard and Nix, 1980). In calculation of fixed cost is assumed and the following equation was used (Hunt, 2001).

$$\text{Total fixed cost per year, } FC_{yr} = D+I+STI \qquad (1)$$

where, FC = Total fixed cost, US\$ yr^{-1}; D = depreciation, US\$ yr^{-1}; I = interest on investment (bank interest rate on agricultural loans), US\$ yr^{-1}; STI = shelter, tax and insurance US\$ yr^{-1};

$$\text{Fixed cost per hectare, } FC_{ha} = \frac{FC_{yr}}{A_{ha}} \qquad (2)$$

where, A_{ha} = Land area, ha.

Depreciation, (D): Depreciation is the reduction in the value of the machine as a result of use (wear and tear) and obsolescence (availability of newer and better model). In calculation of fixed cost, sinking-fund depreciation is assumed and was calculated by the following equation, (Hunt, 2001)

$$D = \left[(P-S)\left\{\frac{(1+i)^L-(1+i)^n}{(1+i)^L-1}\right\}+S\right] - \left[(P-S)\left\{\frac{(1+i)^L-(1+i)^{n+1}}{(1+i)^L-1}\right\}+S\right] \qquad (3)$$

where, D = depreciation, US\$ yr^{-1}; P = purchase price, US\$; S = salvage value (10% of P), US\$; L = Effective working life of machine, yr; n = age of the machine in years at the beginning of the year, yr; i = annual bank interest rate, decimal.

Interest on investment, (I): The interest on investment in CA machine is included in fixed cost estimation. Interest on investment is the charge for the use of the money invested on the machine regardless of whether the money was borrowed or not. The interest rate is set to 14% as representing a current average rate for capital interest calculation. The following equation was used for the calculation of interest on invest (Hunt, 2001)

$$I = \frac{P+S}{2} \times i \quad (4)$$

Taxes, Shelter and Insurance (STI): In the calculation shelter, tax and insurance was considered for calculating fixed cost of harvesting machine (Hunt, 2001).

$$STI = 2.5\% \text{ of P} \quad (5)$$

2.4 Variable cost

Variable costs are expenses incurred as a result of machine operation (power costs, labour, and other inputs). Variable costs depend on hourly labor cost, fuel, oil, repair and maintenance cost, and the required working hours for each field operations. The cost of operator/labour was calculated as the labor rate in US\$ per day. The fuel and oil costs were estimated from consumption rate and multiplied by their respective prices. In calculation of variable cost is assumed and the following equation was used (Hunt, 2001).

$$\text{Variable Cost (US\$ ha}^{-1}\text{), VC= L}_b\text{+F+O\&L+R\&M+M}_c \quad (6)$$

where,

L_b = Operator/labor cost,

$$\text{US\$/ha} = \frac{\text{Sum of wages of labor } (\frac{\text{US\$}}{yr})}{\text{Total area coverage } (\frac{\text{ha}}{\text{yr}})} \quad (7)$$

F = Fuel cost,

$$\text{US\$/ha} = \frac{\text{Fuel consumtion } (\frac{\text{l}}{\text{h}}) \times \text{Fuel price } (\frac{\text{US\$}}{\text{l}}) \times \text{Average annual use } (\frac{\text{h}}{\text{yr}})}{\text{Total area coverage } (\frac{\text{ha}}{\text{yr}})} \quad (8)$$

O&L = Oil & lubrication cost = 15% of fuel cost (9)

R&M = Repair and maintenance cost per year = 3.5% of P (10)

M_c = Miscellaneous cost, US\$ ha^{-1}.

2.5 Annual cost of operation

Operating costs are recurring costs that are necessary to operate and maintain a machine during its useful life (White et al., 1989). Total cost of operations of CA machine was divided into fixed costs and variable costs. All calculated fixed costs and variable costs were converted into US\$ per ha and then summation of fixed costs and variable costs was given operating costs in US\$ per ha on the basis of average field data of CA machine operation.

$$\text{Annual cost (US\$ ha}^{-1}\text{), AC= FC+VC} \quad (11)$$

2.6 Payment for replacement

Uniform annual payments to a fund are of such a size that by the end of the life of the machine the funds and their interest have accumulated to an amount that will purchase another equivalent machine. Replacement of machine by new one is essential because beyond economic life it is no longer being useful for operating in field. Performance of a new machine is significantly superior and it makes the old machine obsolete. Anticipated costs for operating the old machine exceed those of a replaced machine. Payment for replacement was calculated by the following equation (Hunt, 2001).

$$PFR = (P - S) \times \frac{i}{(1+i)^L - 1} \quad (12)$$

where, PFR = Payment for replacement (US\$ ha^{-1}).

2.7 Rent-out charge of machine operation

It's important to estimate the cost of rent-out charge of machine operation for an entrepreneur. The contractual work between machine owner and hiring farmer is made directly and agreed on in advance (at the beginning of the season). Machine service rate was calculated on a hectare basis as a common standard practiced by most farmers in the study areas. The rate was considered the conditions of the field being worked, distance and size of field plots, weed growth on the field, and prevailing rate of local wages. An entrepreneur can estimate the CA machine operation rent-out charge from the following expression:

$$\text{Rent-out charge (US\$ ha}^{-1}\text{) = TOC+PFR+PM} \quad (13)$$

where, TOC= Total operating cost (US\$ ha^{-1}); and PM =

Estimated profit margin (US$ ha^{-1}).

The profit depends upon the annual use of the machine. Higher the annual usage, lower is the operating cost resulting in higher returns from the machine. Also, the profit of the entrepreneur depends on the socio-economic condition of the machine user as well as the country.

2.8 Revenue and profit

Revenue, which was estimated by multiplying the number of annual use and the rent-out charge

$$\text{Revenue} = \text{Average annual use (ha)} \times \text{Rent out charge (US\$ ha}^{-1}) \quad (14)$$

Profit, which is estimated from the differences between revenue and total costs (Riggs et al., 1996)

$$\text{Profit} = \text{Revenue (US\$ ha}^{-1}) - \text{Total operating cost (US\$ ha}^{-1}) \quad (15)$$

2.9 Project appraisal

Project appraisal techniques are followed to find out the profitability of CA machine for owner point of view for achieving the purposes of the study. Project appraisal provides a comprehensive review of all aspects of the project. It includes economic and financial analysis, analysis of economic soundness of the project, quantification and valuation of costs and benefits and ensuring financial viability. This appraisal is based on three assumptions which are (1) All the devices are purchased with cash; (2) Operation technology is remaining unchanged throughout the project life; (3) Prices of all inputs and outputs are remaining same throughout the project life and conversion rate of BDT and US$ was used for the year 2018. The methods most often used for evaluating a project are (Sarma, 2010):

a) Payback period (PBP)

b) Break-even point (BEP)

c) Benefit-cost ratio (BCR)

d) Net present value (NVP) or net present worth (NPW)

e) Internal rate of return (IRR)

- Undiscounted measures of project appraisal do not take into consideration the change in the value of money over time i.e. PBP and BEP
- Discounted measures of project appraisal take into account the time value of money through the process of discounting i.e. BCR, NVP and IRR

2.10 Payback period

Payback period is length of time it takes to recover the invested capital or until the net benefits equal the investment cost. The desirably of an investment is directly related to its payback period. Shorter paybacks mean more attractive investment. Depreciation is not included in the computation of cost to avoid double accounting since the initial capital is included in the computation. Payback period of a machine was calculated by the following equation

$$\text{PBP} = \frac{\text{Initial investment (US\$)}}{\text{Annual profit } (\frac{\text{US\$}}{\text{yr}})} \quad (16)$$

where, $\text{Annual profit} = \frac{\sum_{1}^{n} \text{Revenue } (\frac{\text{US\$}}{\text{yr}}) - \text{Total cost } (\frac{\text{US\$}}{\text{yr}})}{n}$;

n = number of years of benefits. The acceptability of the investment is determined by comparison with the investor's required payback period (RPP). Accept the investment when the PBP < RPP, otherwise reject the investment.

2.11 Break-even point

Break-even is the point of zero loss or profit. At break-even point, the revenues of the business are equal its total costs and its contribution margin equals its total fixed costs. Break-even point can be calculated by computing method. The computing method is based on the cost-volume-profit (CVP) formula. The break-even use of a CA machine depends on its effective field capacity of machine operation, power requirement, working life of machine; average machine operation per year, labor requirement and other charges. Break even use for capital recovery was calculated by the following equation

$$\text{BEP} = \frac{\text{Total investment (US\$)}}{\text{Revenue } (\frac{\text{US\$}}{\text{yr}}) - \text{Total cost } (\frac{\text{US\$}}{\text{yr}})} \quad (17)$$

2.12 Benefit-cost ratio

Benefit-cost ratio is the ratio of present worth of benefit stream to present worth of cost stream. The method of benefit-cost analysis is simple in principle. It follows the systematic approach used in selecting between economic investments alternatives (Gittinger, 1994) and is given by the equation below.

$$\text{BCR} = \frac{\sum \text{Present worth of Benefits (PWB)}}{\sum \text{Present worth of Cost (PWC)}} \quad (18)$$

The investment is said to be profitable when the BCR is greater than one. Depreciation and interest of investment are not included in the costs to prevent double accounting. Depreciation is accounted for by the inclusion of the investment cost while interest of investment is accounted for by the discount factor.

2.13 Net present value

Net present value (NPV) is computed by finding the difference between the present worth of benefit stream minus the present worth of cost stream. It is simply the present worth of the cash flow stream, since it is a discounted cash flow measure of project worth along with IRR.

$$\text{NPV} = \text{PWB} - \text{PWC} \quad (19)$$

where, PWB = Present worth of benefits; and PWC = Present worth of costs.

2.14 Internal rate of return

Internal rate of return is that discount rate which just makes the NVP of the cash flow equal zero. The IRR is also a relative measure which may be defined as the average earning power of the money invested in a project over the project life (Jaim, 1993). It is considered to be the most useful measure of project worth. It represents the average earning power of the money used in the project over the project life. The IRR is not affected by the rate of discount, while the NPV may change as a result of using different discount rates (George and Shorey, 1978; Miah and Hardaker, 1998). It is the maximum interest that a project can pay for the use of resources if the project is to recover its investment and operating cost and still break even. At this point, the BCR is equal to unity. This is usually found by trial and error, by interpolation and using following equation

$$\text{IRR} = \left[\text{LIR} + (\text{HIR} - \text{LIR}) \times \frac{\text{NPV}_{\text{LIR}}}{\text{NPV}_{\text{HIR}} - \text{NPV}_{\text{LIR}}} \right] \quad (20)$$

where, LIR = lower interest rate and HIR = higher interest rate.

3 Results and discussion

3.1 Financial analysis of CA machine operations

CA machine custom hire service business is a seasonal business for an entrepreneur during non rice crop planting. The total cost of CA machine operations at farm level comprised of variable cost and fixed cost. Depreciation of machine was calculated by sinking fund method and as taken as fixed cost. The results noticed that investment on CA machinery was profitable for an entrepreneur. Major cost and returns items of CA machine operation business in custom hire entrepreneurship are as follows (Table 1).

Table 1 Estimated major cost and return items of CA machine operation business in custom hire entrepreneurship

Cost items	Unit	Price
Purchase price of CA machine with Power tiller, *P*	US$	2217
Annual use in area, *A*	Ha yr^{-1}	26
Economic life of machine, *L*	yr	5
Effective field capacity of machine, *EFC*	ha h^{-1}	0.11
Depreciation, *D*	US$ yr^{-1}	360
Fixed cost, *FC*	US$ ha^{-1}	30
Variable cost, *VC*	US$ ha^{-1}	21
Total cost of operation, *TOC= FC+VC*	US$ ha^{-1}	51
Payment for replacement, *PFR*	US$ yr^{-1}	315
Rent out charge	US$ ha^{-1}	82
Revenue, *R*	US$ yr^{-1}	2160
Marginal profit, *PM= R-AC*	US$ yr^{-1}	805
Benefit cost ratio, *BCR*		1.10
Break Even Point, *BEP*	ha yr^{-1}	3.12
Pay Back Period, *PBP*	yr	2.88

Note:1 US$ = BDT 82 (2018); Average work day = 8 h at 0.11 ha per hour or approximately 2.17 acres or 6.50 Bigha per day; Price of diesel = US$ 0.792 $litre^{-1}$; labor/operator charge = US$6 per day (8h day^{-1}).

The financial analysis was computed from the viewpoint of machine owner. Based on field data, the present total cost of operation and effective field capacity of the CA machine were estimated as US$51 per hectare and 0.11 hectare per hour respectively. Fixed cost and variable cost for the machine operation were estimated US$30 per hectare and US$21 per hectare respectively based on the average field data and collected through personal interview of custom-hire service providers of two wheeled tractor. Among cost items, the highest cost was for depreciation of (US$360). The area under land preparation by machine operations per year was 26 ha. Again, the custom hiring charge of machine was estimated US$82 per hectare. Based on this information, the annual gross revenue received from machine service was worked out. The average revenue can be received by an entrepreneur US$2160 per year. Therefore, an entrepreneur or a local service provider (LSPs) can earn marginal profit US$805 over annual cost of operation and variable cost calculated as US$1355 and US$551 per year respectively.

3.2 Project worth analysis

Discounted measures of project were used for financial analysis since undiscounted measures of project worth is quite unable to be taken into consideration the timing of benefits and costs (Table 2). By discounted cash flows analysis an alternative evaluation of use of CA machinery, which is evidently a little more acceptable, can be done using internal and external cash flows joined with the measures of NPV, ratio of profitability and BCR. In Bangladesh, the net present value of different agricultural machinery with existing inflation conditions was estimated at 15% discount rates where the minimum percentage of interest rate associated with agricultural loans to purchase agricultural machinery was 5% during 2018 year. The results revealed that investment on CA machinery was profitable. Considering 15% discount rate, the NPV of CA machinery in exiting condition was US$683. The NPV indicates that CA machinery was considered financially sound and the project maybe said financially viable because IRR (39%) of CA machinery was greater that the bank interest rate (14%). The payback period was analyzed to be 2.88 years of the machine operation. It means that the CA machine investment would pay for itself after that period. The result also shows that the average rate of return on investment was found 1.10 that is higher than unity, which is profitable venture for an entrepreneur.

Table 2 Project worth analysis

Operation year	Gross cost ($)	Gross benefit ($)	Discount factor at 15%	PW of cost at 15%	PW of benefit at 15%
1	3672	2160	0.87	3193	1878
2	1355	2160	0.76	1025	1633
3	1355	2160	0.66	891	1420
4	1355	2160	0.57	775	1235
5	1355	2160	0.50	674	1074
Total	**9093**	**10800**		**6558**	**7241**
IRR =	39%	**BCR =**	1.10	**NPV =**	683

3.3 Break-even analysis

An attempt was made to calculate break-even point of CA machine operation for the service providers based on fixed cost and variable cost of machine operation which are calculated from farm level data on machine price, depreciation cost, interest on investment, machine life, and income from machine operation, etc. The Figure 3 shows that the break-even use of machine operation was estimated as 3.12 ha of land per year which implying that a service provider has to cultivate more than 3.12 ha of land per year for make it profitable. This result suggests CA machine owners to prolong economic life of the machine by taking good care of them and maintenance practices in order to shorten break-even area and also reduce costs. Table 3 shows the summarized sketch of project worth evaluation of a CA machine operation as custom hire service provision. As can be seen from table that the BCR, PBP, BEP, IRR and NPV (at 15% discounted factor) was estimated as 1.10, 2.88 yrs, 3.12 ha yr^{-1}, 39%, and US$683, respectively that are above their accepting range such as BCR>1, PBP<economic life of machine, BEP<annual machine service area, IRR>annual interest rate, and NPV>zero,. These results support that investments on CA machinery using custom hire service method in the study areas are attractive and profitable for a small holder farmer or an entrepreneur or LSP.

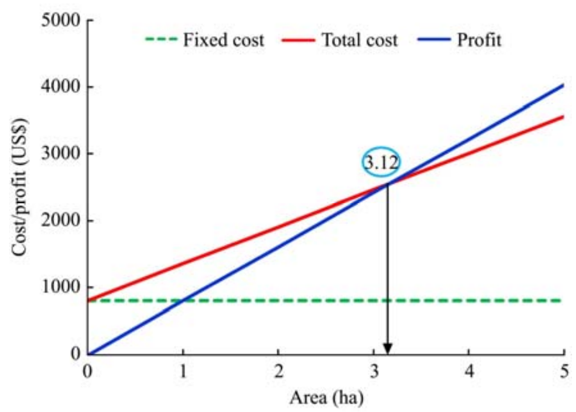


Figure 3 Economic use of CA machine operation

Table 3 Project worth evaluation

Items	Value	Remarks
Payback period (PBP)	2.88 yr	If less than economic life (2.88 yr < 5 yr) Accepted
Break-even point (BEP)	3.12 ha yr^{-1}	If less than service area (3.12 ha yr^{-1} < 26 ha yr^{-1}) Accepted
Benefit-cost ratio (BCR)	1.10	If greater than unity (1.10 >1.0) Accepted
Internal rate of return (IRR)	39%	If greater than prevailing interest rate (39% > 14%) Accepted
Net present value (NPV)	US$683	If greater than zero (US$683>0) Accepted

3.4 Payment for replacement

CA machine entrepreneur has to save money to buy the new one. Uniform annual payments to a fund are of such a size that by the end of the economic life of the machine, the funds and their interest have accumulated to an amount that will purchase another equivalent machine. Based on present database and analysis an entrepreneur has to deposit US$315 per year (Table 1) in a bank account so that he/she can purchase a new machine when the economic life of old machine expires for tilling and seeding operation

4 Conclusion

The CA machinery was found suitable in terms of technical and financial performance over traditional system, and recommended for development of custom-hire service entrepreneurship. Based on the findings and their interpretations it can be concluded that this work is describing a novel idea of developing a proper business schedule for sustainable CA machine custom hire entrepreneurship. There were higher overall profits because of the lower costs of the CA machine and the fact that CA machines could be used for more area per day and more days during the year. For replacement of the existing CA machine on expiry of economic life, the entrepreneur has to save an amount of US$315 per year in a bank account. Based on the operating cost, annual savings for replacement and a profit margin for the entrepreneur, the rent-out charge of the CA machine are estimated as US$82 per hectare of machine operation. The benefit-cost ratio of machine was found 1.10, which was profitable venture for an entrepreneur. The break-even use of the CA machine is estimated 3.12 ha of machine operation. The CA machinery was not familiar to the farmers and custom hire service providers of the study areas. A CA machine owner or local service provider (LSPs) can be started this business right now which will be profitable venture for an entrepreneur. To extend the benefits of CA machinery among the farmers and custom hire service providers, appropriate adoption and dissemination programs must be launched all over Bangladesh.

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