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RESEARCH ARTICLE

Computing the Cost Economics of Agricultural Machinery in Farms

Tajuddin A[1*], Parthiban M[2] and Suthakar B[3]

[1]Departmant of Agricultural Engineering, Saveetha Engineering College, Thandalam, Chennai - 602 105

[2]Department of Physical Sciences, Agricultural Engineering College and Research Institute,

Tamil Nadu Agricultural University, Coimbatore-3

[3]Department of Farm Machinery, Agricultural Engineering College and Research Institute Tamil Nadu Agricultural University, Kumulur - 621 712

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ABSTRACT

Farm mechanization accelerates faster agricultural growth through the efficient use of machines by ensuring the timeliness of agricultural operations, reducing the cost of operation, and by reducing human drudgery. Farm machinery ownership and operating costs represent a substantial portion of total crop production expenditure. Cost economics becomes important for farm machinery managers to control the machinery costs per hectare. The manual procedure of determining the cost economics of agricultural machinery is a time-consuming process and finally making a smart decision whether to buy a farm machine or to go for custom hiring is a cumbersome process. The web application was designed for naive users to help the users in making the decision. The user is asked to enter the basic data pertaining to the farm machine, and the software decides whether to acquire the farm machine or to go for custom hiring. The cost of operating a farm machine can be computed with ease by using the web application. Further, the break-even-point, payback period and benefit-cost ratio can also be determined with a single click.

Keywords: *Operating cost, Farm machinery ownership, Break-even point, Payback period and Benefit cost ratio*

INTRODUCTION

In the present scenario of Agriculture in the developing countries like India, there is a huge demand of farm labourers especially during peak seasons of agricultural operations. As a result, the labour wages have increased at an alarming rate. As a result, farmers are moving towards farm mechanization. Determining the cost economics of agricultural machinery by conventional method by manual procedure is time consuming and to make a smart decision whether to buy or hire a farm machine is a difficult job. To find the cost of operation of a farm equipment, one has to calculate the following costs viz., depreciation, interest, housing, taxes, insurance, repairs and maintenance, fuel (diesel/petrol), lubricating oil, wages for the operators and helpers, overhead (applicable to government and quasi-government organizations) and profit. By simply entering the data such as tractor engine power, price, field coverage, cost of diesel, cost of lubricating oil and wages, this software will calculate and give the required output in a single click.

Use of farm machinery helps to achieve timeliness of farm operations and efficient use of inputs such as seeds, fertilizers, chemicals and irrigation water to enhance productivity of land and labour. The use of farm machinery also reduces drudgery in the farm (Singh, 2001). Agricultural operations like ploughing, tilling, sowing, harvesting and thrashing are done with the help of suitable farm implements and machinery. It is essential to know how much one is spending to plough one hectare of his land when he owns a tractor or when he hires out his tractor how much he should charge for it (Karunanithi and Tajuddin, 1985).

Burton *et al.* (1994) developed tools to estimate the costs of agricultural machinery ownership and operation and to assist in making machinery management decisions. Hewlett *et al.* (1995)

*Corresponding author's e-mail: atajuddin17@gmail.com

developed Wyoming machinery and operation costs calculation software and it was to be executed from hard disk drive as it was too large to run from a floppy disk alone. Edwards (2001) developed Ag Decision Maker using excel which was a machinery cost calculator for estimating farm machinery costs. Molenhuis (2001) fact sheet used an economic engineering approach which provided a framework for estimating machinery costs. Saurezde *et al*. (2004) suggested windows platform-based decision support system (DSS) with the use of geographical information system (GIS). The above authors adopted the American Society of Agricultural Engineers (ASAE) Standards and determined the operating and ownership costs in dollars (US $).

Mehta *et al*. (2011) developed windows operating systems based decision support system by using Visual Basic 6.0 as front end and Microsoft Access as back end for selection of tractor and matching equipment and *vice versa* for different soils and operating conditions. The software developed were platform specific and in some cases the software was developed in excel, but most of the end users were not well versed in excel. Hence, a web based application with a decision support system for determining the cost economics of agricultural machinery was developed as per the Bureau of Indian Standards (1979). This is a browser based application and the size is around 900 kB and thus it is a light weight component. Moreover, the web application provides separate tabs and customizvned computations for different combinations of agricultural machineries such as prime mover, prime mover and implement, engine operated post-harvest machinery and electric motor operated post-harvest machinery.

MATERIAL AND METHODS

Before buying farm equipment, one must decide the make, size and type of machine that will be the most efficient for the farm. It is a difficult job to match the equipment to meet the farm needs (Smith and Wilkes, 1977). The end users (farmers) must decide whether it is economical to own the farm equipment and furnish the labour and supplies (seeds, fertilizers etc.) required for the operation of the farm equipment or to hire the equivalent services through custom work. To protect farmers' interests, Government of India has requirement of testing and certification before introduction of new farm equipment. Bureau of Indian Standards and certification are there for quality assurance which are closer to ISO (Alam, 2002). Therefore, systematic procedures for determining the cost economics of agricultural machinery were studied and fact sheet was prepared. Based on the fact sheet, a simple programme was first developed in C programming language and tested for working and credibility of the programme. The same logic was applied for a web application which provided a graphical user interface (GUI). The web application with a decision support system was designed with ease in understanding for the naive users. A decision-making element decides whether it is economical to purchase the machine or to use the machine on custom hiring basis.

The following assumptions were made while developing the web application.

Salvage value : 5 %

Interest rate : 12 %

Taxes, Housing and Insurance : 1 % of average purchase price

(purchase price + salvage value)/2

(Agricultural machines are exempted from taxes in India)

Repairs and maintenance : 12 %

Fuel consumption rate of tractor engine (L/h) : 10 % of engine hp

Lubricating oil consumption rate (L/h) : 3% of fuel consumption by volume

Overhead : 20 %

Profit : 20 %

Break-even-point is the minimum land area required to be owned for cultivation by the farmer to profitably buy the machine. The payback period is the minimum time, in years, required by the farmer to realize his capital investment by way of profit generated by using the machine owned. Benefit-cost ratio is the ratio of the present value of the economic benefits stream to the present value of the economic costs stream, each discounted at the economic opportunity cost of capital. The ratio should be greater than 1.0 for a machine or project or venture or technology to be acceptable.

Algorithm

For developing this web application, the following step by step procedure was followed.

1. Provide the input data such as purchase price, useful life, annual usage, fuel consumption rate, labour required, effective field capacity etc. for determining the cost economics of various agricultural machinery, implements and prime movers.
2. Perform the calculations for the cost economics *viz*., fixed costs (depreciation,

interest on investment, insurance, housing and taxes) and variable costs (fuel cost, lubricating oil cost, repairs and maintenance charges, wages of operators and helpers) of agricultural machinery.

3. Display the results such as cost of operation per h or per ha, break-even point, pay-back period and benefit cost ratio.

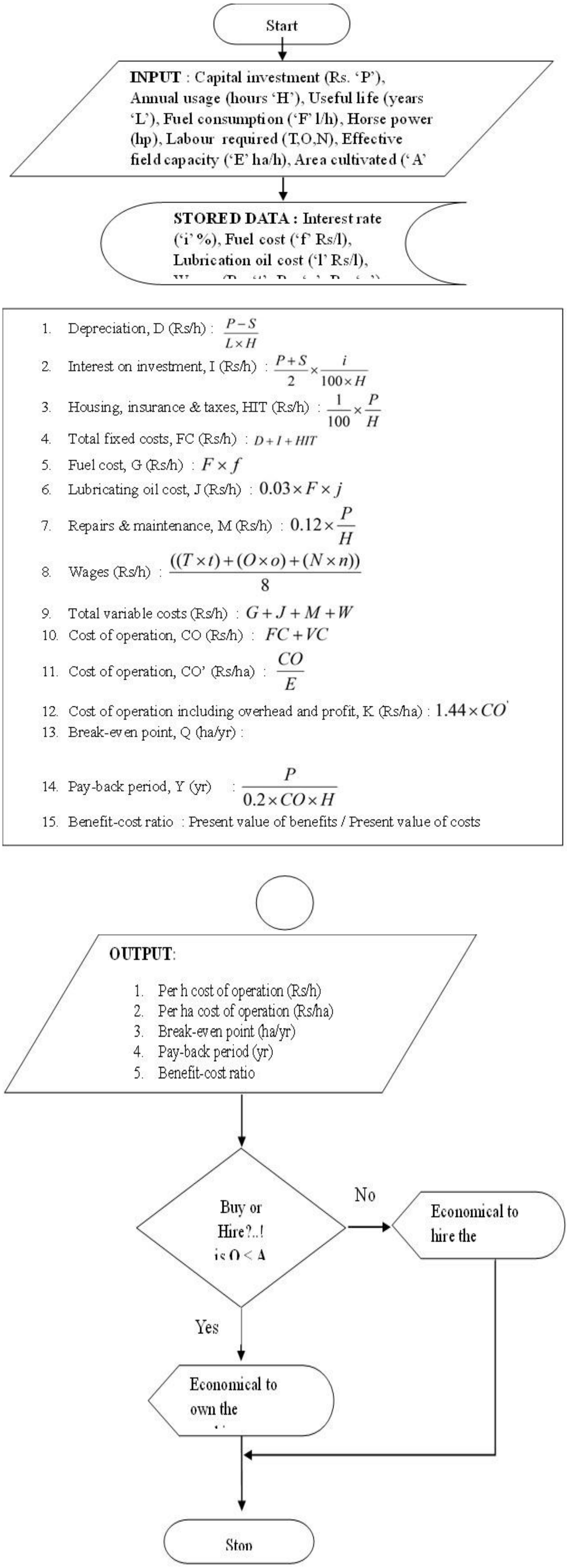
4. Decide whether it is economical to purchase the machine or to custom hire the machine by comparing the break-even point required with the actual cultivatable land area owned.

Development of the web application

The web application providing a graphical user interface has been friendly designed with easy understanding for the naive users to equally accessible through keyboard or mouse. The flow chart of the web application to determine the cost economics of agricultural machinery is shown in Figure.1. Tab order has been set for the controls in the form. Hypertext mark- up language (HTML) is used for describing the web page and designed using mark-up tags. HTML forms have been generated by using the inputs like label elements, text field and drop-down list with the pre-selected values and submit buttons. Cascading style sheet (CSS) has been blended to display HTML elements. It provides external style sheets to enable the end user to modify the appearance of the layout of all the pages in the web site just by editing a single file. Java Script has been employed for providing functionality and to validate forms. Java Script works in all major browsers such as Internet Explorer, Firefox, Chrome, Opera and Safari. It adds interactivity to HTML pages and is embedded directly. As a consequence, this web application is a light-weight component. Testing is a fundamental part of building an application. Testing demonstrates the occurrence of errors and aids in debugging. In the initial phase, sample data were taken and tested. Before deploying the web application to the end users, a subset of users has been chosen to act as beta testers. The bugs that were encountered have been debugged. A top-down strategy of system testing has been adopted.

RESULTS AND DISCUSSION

Owing to the need of the day, the web application has been designed with flexibility to accommodate any future changes. Software has been designed efficiently for the naive users which aids in decision making. The web application provides separate tabs and customized computations for the variety of agricultural machinery (Figure. 2). The sample input data that



were used for determining the cost economics of farm machinery are shown in Table 1 and Figure.3.

The web application provides a separate interface to farmers, research scientists and others. A minimum number of results are sufficient to the farmers in the output window whereas for the research scientists detailed output is needed. The web application has been designed with the options like label elements, text field and drop-down list with the pre-selected values and submit button (Figure.4).

After entering the basic input data pertaining to the prime mover and implement, the web application decides whether to acquire a machine or to go for custom hiring. The cost of operating a farm machine per ha can be computed with ease. Further, break-even-point, pay-back period and benefit-cost ratio can also be determined with a single click (Figure. 4). The web application was hosted in Linux web server (IBM System X3400) and the Linux distribution is Cent OS. The software was tested for credibility with the real-time data and manually calculated solutions and results obtained were the same.

The web application is developed keeping in mind that the end user may not have technical knowledge of computer or the technical procedure of calculations. The users can work without extensive training on the above aspects since the system is developed with a high degree of user friendliness. Hence it is possible for the farming community to explore these features to get maximum benefits. The web-based technology can be used to test and verify the results of newly developed agricultural machinery. A decision can be arrived at whether to buy or to hire the agricultural machinery. This web application serves as a ready-reckoner and it will be beneficial to the end users like farmers, agricultural bank managers, agricultural equipment manufacturers, State officials of the Agriculture Department, Horticulture Department and Agricultural Engineering Department, agricultural scientists, teachers, research scholars and students.

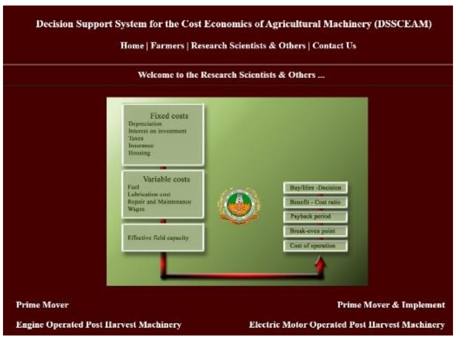


Figure 2. Tabs for different combinations of prime movers and equipment

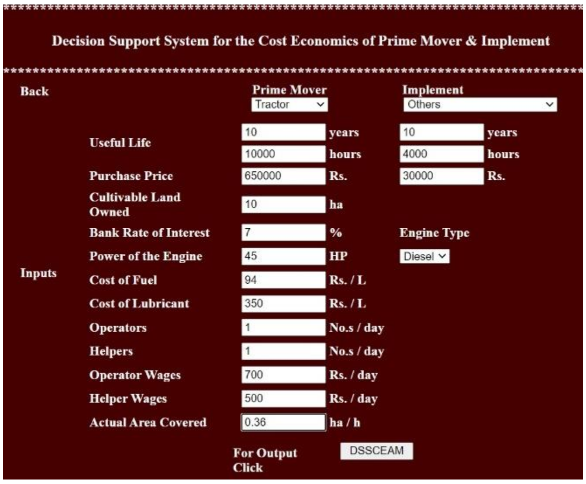


Figure 3. Sample input data for prime mover and implement

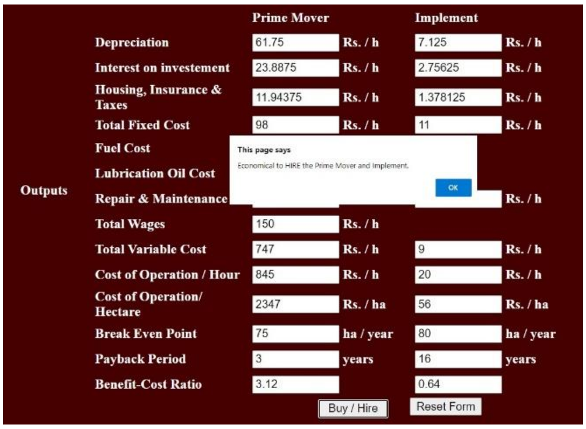


Figure 4. Output data and decision making

Table 1. Sample input data used

Input parameter		Prime mover	Implement
Select options		Tractor	Attachment (Others)
Useful life	yr	10	10
	h	10000	400
Purchase price		Rs. 650000	Rs. 30000
Bank rate of interest		12 %	
Power of tractor engine		45 hp	
Engine type		Diesel	
Cost of fuel		Rs. 94 /L	
Cost of lubricating oil		Rs. 350 /L	
Operators		1 no/day	
Helpers		1 no./day	
Operator wages		Rs. 700 /day	
Helper wages		Rs. 500 /day	
Actual area covered (EFC)		0.36 ha/h	

Conclusion

The web application has been developed keeping in mind that the end-user may not have technical knowledge of the computer or the technical procedure of the calculations. The system has been developed with a high degree of user-friendliness. The web-based technology can be used to test verify the results of newly developed agricultural machinery before release by any State Agricultural Universities or Central or State Release Committees. A decision can be arrived at whether to buy or to hire the agricultural machinery. This web application serves as a ready-reckoner and it will be beneficial to the end-users like farmers, agricultural bank managers, agricultural equipment manufacturers, officials of the state Agriculture Department, Horticulture Department and Agricultural Engineering Department, agricultural scientists, teachers, research scholars, and students. Determining the operational cost of machines in farms is a time consuming process. By using the web technology operational cost of farm equipment can be computed easily. Break even point, pay back period and benefit cost ratio of farm machines can also be determined quickly. The web technology can also be made mobile responsive for the benefit of farmers and other end users.

Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Originality and plagiarism

We ensure that we have written and submitted only entirely original works, and if we have used the work and/or words of others, that has been appropriately cited.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There was no conflict of interest in the publication of this content

Data availability

All the data of this manuscript are included in the MS.

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