

COST EFFECTIVENESS OF WIND PUMPS IN LIFT IRRIGATION

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Abstract:- This paper investigates the financial viability of using wind pumps as a substitute to the conventional engine pump sets used for lift irrigation of highland crops in the Dry Zone. Factors constraining a complete substitution of engine pumps by wind pumps are highlighted. The commercial profitability of the two systems is analysed taking into account different possible cropping patterns and extents irrigated under each system. The analysis shows that wind pumps are financially more viable when the cultivated extent remains below 0.4ha, which is also the most common situation in the Dry Zone.

INTRODUCTION

During the period of South West Monsoon, most parts of the island, the dry zone in particular, experience moderate to strong winds which can be harnessed as a source of Energy. Water pumping for irrigation is one of the promising applications of Wind Energy, which, in the context of dry zone agriculture, has a special significance due to the favourable wind conditions that persist during greater part of the dry season. Currently, most farmers use engine pump sets to lift irrigate their highland cultivation during the dry season.

Though the local wind pump technology has now reached the maturity for commercialisation, the development of a local wind pump industry and its ability to achieve a significant penetration into this market depends primarily on the cost effectiveness of the system.

In evaluating the cost effectiveness of wind pumps, it is important to study the extent to which it can practically substitute the conventional engine pump set. Such an evaluation should encompass not only the system costs but also the influence of their specific performance characteristics on the benefits and investment risk levels to the user. For instance, in the case of intensive year-round cultivation, the engine pump can deliver irrigation water at all times of demand, whereas the wind pump output is restr-

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icted only to the windy season. A farmer using an engine pump set also has the option of increasing his command area beyond what is limited by a wind pump. Due to the reliance on a natural climatological phenomenon, a wind pump user may also have to carry the risk of occasional Energy supply shortfalls which may affect his agricultural operations. A direct implication of these considerations is that the two systems could have different benefits which should be taken into account in the analysis of their cost effectiveness. It should however be understood that these are only potential advantages to the users of engine pumps which may or may not be enjoyed by them under all circumstances. Poor ground water availability, lack of capital and poor prices are some of the major constraints in intensive cropping in most parts of the dry zone.

Earlier studies on cost effectiveness of wind pumps are limited to those by Larsen(1979), Vel and Veldhuizen(1981) and Larsen and Mueller(1981). In all these studies the emphasis has been more on the national economic aspects than on the commercial profitability which ultimately influences marketability of the system. As these studies were carried out at the early stages of Wind Energy development in Sri Lanka, they have been based on a combination of hypothetical scenarios and incomplete pilot scale studies. An attempt is made in this paper to analyse the effects of two variables: the cropping pattern and the extent of land under irrigation, on the commercial profitability of each pumping system.

METHODOLOGY

The financial evaluation of each irrigation system is carried out on the basis of the following different combinations of cropping patterns and extents under irrigation.

Case 1. Wind pump irrigation enables only a single cropping season per year (during the windy period), while two crops are cultivated under irrigation with the engine pump set. In both cases it is assumed that the farmer also cultivates one crop under rainfed conditions. The extent under irrigated cultivation is assumed to be the same.

Assumed cropping pattern and the extent cultivated is as follows -

Wind pump	Engine pump
0.4ha of Chilli : May-Oct (under irrigation)	0.4ha of Chilli : May-Oct (under irrigation)
0.8ha of Soyabean : Dec-Feb (under rainfed conditions)	0.8ha of Soyabean : Feb-April (under irrigation)
	0.8ha of Soyabean : Dec-Feb (under rainfed condition)

Case 2. Same as above, except for the assumption that the extent of chilli under irrigation with the engine pump set is doubled. (As this implies an increased operational time of the pump, in the cashflow analysis the lifetime of pump is taken as 6 years as against 8 years assumed in the case 1.)

Case 3. Cultivation under both irrigation systems is restricted only to the yala season with identical extents under cultivation. Rainfed cultivation is practised in both cases. (Lifetime is assumed to be 10 yrs.)

Assumed cropping pattern and the extent cultivated is as follows -

0.4ha of Chilli : May-Oct (under irrigation)	0.4ha of Chilli : May-Oct (under irrigation)
0.8ha of Soyabean : Dec-Feb (under rainfed conditions)	0.8ha of Soyabean : Dec-Feb (under rainfed conditions)

Costs and Benefits are determined in respect of each of the above cases and the relative commercial profitability is gauged on the basis of the Average Annual Net Benefits (AANB) computed using the formula:

$$AANB = \frac{i(1+i)^n}{(1+i)^n - 1} \left\{ -I + \sum_{t=1}^n \frac{(b_t - c_t)}{(1+i)^t} \right\}$$

where ;

- i - Interest rate
- n - Lifetime (years)
- I - Investment cost
- b_t - Benefits in year t
- c_t - Costs in year t

In this analysis, b_t represents the difference between the revenue from sales and the cost of production (excluding Energy costs) and is termed "Gross Margin". The costs c_t represents only the Energy costs in irrigation.

Input Data

The performance characteristics of the wind pump referred to in this paper were determined using the long term data collected at the Water Resources Board's wind pump test site in Anuradhapura. Those concerning the engine pump set are based on field measurements carried out under the phase 1 of the World Bank/UNDP sponsored Global Wind Pump Evaluation Programme in 1987. Agricultural data were extracted from publications of the Dept. of Agriculture. Financial data such as interest rates and loan repayment period are those applied by commercial banks on loans for agricultural implements. System costs are those prevailing in the market.

Wind Pump

o Rotor diameter	3.0 m
o Tower height	7.5 m
o Output(effective day time output available for irrigation=60%of daily output)	30cu.m ³
o Investment cost	
Wind pump	Rs. 15,000
Foundation	1,000
Transport	300
Piping	1,400

Total	Rs.17,700
o Annual maintenance cost	
(estimated as 3% of the machine cost)	Rs. 450
o Estimated Lifetime	10 yrs.

Engine Pump Set

o Rated power of the engine	1.6 kW
o Type of the pump	Centrifugal
o Type of fuel	Kerosene
o Pump output at 8.7m head	8.3 m ³ /h
o Fuel consumption rate	0.8 l/h
o Cost of fuel (kerosene)	Rs. 6.66/h

o Investment cost		
Pump set	Rs. 12330	
Transport	. 50	
Piping	1400	

Total		Rs.13780
o Annual maintenance cost		Rs. 615
(estimated as 5% of the machine cost)		
o Estimated lifetime		8 yrs.

Agricultural Data

Data	Crop	
	Chilli	Soyabean
o Irrigation requirements (m ³ /day/ha)	88	84
o Crop yield (kg/ha) ¹	1400	1200
o Price of product (Rs/kg) ¹	36.40	8.0
o Cost of production (Rs/ha) ¹ (Excluding family labour and irrigation costs)	15520	3140
o Cost of fuel for irrigation (Rs/ha) ²	8470	4235
o Crop duration(days)	150	80

1. Source: "Cost of cultivation of highland crops Yala season 1985", Dept. of Agriculture, Sri Lanka.
2. Computed on the basis of measured field performance of six engine pump sets and the recommended irrigation requirements.

Financial Data

o Interest rate	12.5%
o Loan repayment	8 years
o Lifetime of the systems	10 years

Profitability analysis

The commercial profitability of the two irrigation systems is analysed on the basis of the average annual net benefit (AANB) computed according to the given formula. Benefits (b_c) and Costs (c_c) in respect of each system are presented in Tables 1 - 4. The AANB for the cases considered in the exercise are presented in Table 5.

Crop	Area (ha)	Gross margin (Rs)
Chilli	0.4	14176
Soyabean (rainfed)	0.8	5168
Total		19344

Table 1 - Benefits from the wind pump irrigation system

Case	Crop	Area(ha)	Gross margin (Rs)
1	Chilli	0.4	14176
	Soyabean (irrigated)	0.8	5168
	Soyabean (rainfed)	0.8	5168
	Total		24512
2	Chilli	0.8	28352
	Soyabean (irrigated)	0.8	5168
	Soyabean (rainfed)	0.8	5168
	Total		38688
3	Chilli	0.4	14176
	Soyabean (rainfed)	0.8	5168
	Total		19344

Table 2 - Benefits from the Engine Pump Irrigation system

Year	0	1	2	3	4	5	6	7	8	9	10
Investment	17700	-	-	-	-	-	-	-	-	-	-
Maintenance		450	450	450	450	450	450	450	450	450	450
Total	17700	450	450	450	450	450	450	450	450	450	450

Table 3 - Costs of the Wind pump system

Year	0	1	2	3	4	5
Investment	13780	-	-	-	-	-
Maintenance - (less fuel)		615	615	615	615	615
Total	13780	615	615	615	615	615
Fuel cost (Rs)						
Case 1	6776	6776	6776	6776	6776	6776
Case 2	10164	10164	10164	10164	10164	10164
Case 3	3388	3388	3388	3388	3388	3388

Table 4 - Costs of the Engine pump set

	Wind pump	Engine pump
Case 1 AANB	15697	14298
Case 2 AANB	"	24509
Case 3 AANB	"	12852

Table 5 - Average Annual Net Benefits (AANB)

Conclusions

As could be seen from the values of AANB, it appears that for the assumed cropping patterns, the extent of land under cultivation has a significant influence on the commercial profitability of the lift irrigation systems considered here. The wind pump Energy is a viable alternative in the bases (1) and (3) while for those cultivating chilli it extends beyond about 0.4ha, the engine pump seems to be a more profitable system.

However, available data (Dept. of Agriculture, 1986) pertaining to chilli cultivation shows that the district average extents under the crop lies between 0.11ha in Jaffna and 0.32ha in Matale and Kurunegala districts. In this context, the agricultural operations assumed in case (2) seem to be very much above the average conditions prevailing in the dry zone. It is thus possible to conclude that for most farmers in the dry zone the wind pump seems to offer a financial advantage over the conventional engine pump set.

Eventhough this analysis provides some insight to the commercial profitability of the two irrigation systems, more studies need to be undertaken under field conditions to enable validation of these observations.

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Mr. K S Fernando obtained his MSc in Mechanical Engineering from the People's Friendship University in Moscow, USSR, in 1966. Since graduation he worked in the industrial sector and in 1978 he joined the Water Resources Board as the Head of the Wind Energy Programme. During the last eleven years he has been working primarily on the design and development of wind power systems. Currently he works in the Ceylon Electricity Board as the Project Engineer in-charge of the Wind and Solar Energy Resources assessment study. Mr. Fernando has carried out consultancy assignments on Wind Energy for several international organisations.

He is a corporate members of SLEMA.

SLEMA NEWS

A public lecture and a demonstration on Energy efficient home appliances organised by SLEMA was held on Friday the 12th of May 1989 at the Auditorium of Sri Lanka Association for the Advancement of Science. The demonstration was co-sponsored by four companies in Sri Lanka who deal with electric and gas operated home appliances. The day's proceedings began with Mr. D.G. Senadhipathy, President SLEMA welcoming the guests and the participating organisations to the event. He elaborated the efforts made by SLEMA to educate the general public about the Energy efficiency of appliances at home as well as in commercial and industrial applications.

The first lead lecture was delivered by Mr. Alex Fonseka, Marketing Director, Colombo Gas and Water Company Limited. Coupled with an interesting demonstration, Mr. Fonseka dealt in his talks with the safety aspect, proper use of gas, maintenance of gas cookers and other auxiliaries. He also gave a detailed description of the applications of gas in Sri Lanka.

The second lead lecture was given by Mr. G.T. Fernando, Secretary (Seminars and Training Programmes) SLEMA on electrically operated home appliances. In his lecture, Mr. Fernando discussed a wide range of home appliances, their Energy efficiencies, operational safety and other detailed aspects of these equipment.

The two lead lectures were followed by three individual demonstrations by the sponsoring agencies. Abans Limited who mainly deal with a popular brand of microwave ovens presented an interesting demonstration in which the Energy consumption of a microwave oven and an electric cooker were compared. Two meals were prepared, one on the microwave oven and the other on an electric cooker. Electricity meters connected to these appliances measured the electricity consumption of each process.

The Maharajah Organisation presented the manner in which a pressure cooker can now be used to prepare a complete meal. Live demonstration with a full meal prepared on the front table attracted much enthusiasm from the audience.

The final demonstration was by Singer Sri Lanka Limited, whose presentation covered a wide range of home appliances marketed by the Company. These included refrigerators, washing machines and other similar equipment. The interesting point in this lecture was the presented details of the operations of a refrigerator the important points that should be noted by housewives. Aiding a refrigerator to obtain maximum possible efficiency.

Mr. Shavi Fernando, a director of SLEMA presented the vote of thanks in which he expressed the appreciation of SLEMA to two lead lecturers and the four co-sponsoring organisations for their contributions in making the evening a success. The meeting was attended by about 30 SLEMA members and about 50 members of the public.

Training Course on Steam Generation and Distribution Systems for Technicians

This training course has been rescheduled to begin in October 1989 for the boiler operators selected from a number of industries in the country. The Course Director is Mr. Upali Daranagama, Secretary SLEMA and the lectures will be held over six consecutive weekends. The lecturers will mainly be members of SLEMA who specialize on steam generation systems and distribution systems, their construction and maintenance.

SLEMA Annual Sessions and the Annual General Meeting

The annual sessions of SLEMA and the annual general meeting is scheduled to be held on Monday the 7th of August 1989. As in the previous year, the annual sessions will be held in the morning and in the evening, the annual general meeting will be held at the same venue as we plan to hold the annual dinner. The theme of the annual sessions in this year will be notified later. Members and others who are interested in participating in the annual sessions are kindly requested to make a note of this date. Individual notices are being sent to the members.

Training Course on Micro Hydro Systems

This training programme organised by Intermediate Technology Development Group (ITDG) of UK has now been re-scheduled to be held in September and October of this year. As reported in the previous issues of this journal, the course is being conducted by ITDG in collaboration with the Energy Unit of the Ceylon Electricity Board. Members and other who are interested in participating or sending nominees to this course should contact ITDG or CEB Energy Unit. The course will cover the design and operational aspects of mini and micro hydro systems and especially aspects of refurbishment of machines in disused micro hydro system in the country.

Updating of Membership Directory

The Editor informs all members of SLEMA that the membership directory of SLEMA is being updated in the month of July. You will receive individual notices about the information which is being held about you in the SLEMA Database. You are kindly requested to make any correction, alterations and addition to the directory and to return to the Editor or to Joint Secretary at the annual general meeting which is on 7th of