AN ANALYSIS OF PERFORMANCE AND COSTS

OF

IRRIGATION PUMPS UTILIZING

MANUAL, ANIMAL AND ENGINE POWER

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Introduction

Literature describing Indian agriculture contains many references to the high availability and low cost of manual labor. The opinion expressed is that low labor cost on the one hand and high machinery cost on the other hand make manpower the best agricultural energy source. It is suggested that the development of mechanical energy sources should be delayed until there is full utilization of the rural labor force. However, farmers have not installed manual powered devices even though available.

A basic economic principle is the economics of scale. That is the lower unit costs are achieved by the larger volume producers. Applied to an agricultural operation such as irrigation this principle would suggest that the lowest cost per unit of water lifted would be by mechanical units rather than manual units. In recent years there has been a rapid increase in diesel engine and electric driven pump sets with relatively minor increase in the use of manual pumping equipment. This trend suggests that the economics of scale applied to agricultural irrigation and relative costs of labor and machinery are not favorable to intensive labor use.

The following simple analysis is based on preliminary pump performance data measured at the Indian Agricultural Research Institute in a study of low-life water-lifting devices. The data on well construction

is based upon data from the Food for Work program as well as data from minor irrigation departments. Although wide variations are common, a composite typical or representative situation has been chosen for simple analysis.

The Analysis

General

The irrigation problem selected was a farmer who required a minimum irrigation rate of 2½ Acre inches (A.in.) in a 10 day irrigation cycle. The well was constructed to 60 feet (ft.) with boring in the case of the engine unit and with sufficient size to accommodate the pumping equipment. It was assumed that the irrigation equipment command area and cropping rotation were balanced and required 150 days of pump operation per year.

The total life of water was calculated for 40 ft. in order to represent a wide cross section of farm requirements. A 40 ft. lift is greater than the recommended lift for bullock and manual pumps, therefore, multiple lift stations were assumed. From the pump performance data three stage lifts were found to be most economical; each stage working a lift of 13.3 ft. Data is also reported comparing performance at the optimum lift heights for each of the three power sources.

The labor rates and bullock hire rates are those commonly charged during the irrigation seasons.

Engine Pump Set

The common size of diesel engine pump set is a 5 horsepower unit which can command a 10 acre tract. The total investment in well, pump, and installation would be approximately Rs.10,500/-; Rs. 1,050/-per acre. The unit water pumping cost would be approximately Rs. 60/-per 10 A. in. of irrigation.

The engine pump set operated against a total lift of 25 ft. or less would command 15 acres and reduce the per acre investment to Rs. 700/- while reducing the pumping cost to Rs. 45/- per 10 A. in.

Bullock Powered Units

The two common bullock powered irrigation pumps the bucket chain and washer chain have similar cost and performance data. A three stage investment in well, bullocks, pumps and installation would be approximately Rs. 7,110/-, or Rs. 2030/- per acre. This investment assumes that the entire cost of the bullocks is charged to the pumping operation. The investment per pumping station without bullocks would be Rs. 5310/- or Rs. 1517/- per acre. The unit water pumping cost would be Rs. 345/- per 10 A. in.

Common installation of bullock powered water lifting devices is for single lifts of 15 ft. In this installation a single pump can control 3.3 acres. The total investment in pump, well, bullocks and installation would be Rs. 3000/- or Rs. 910/- per acre. The cost of pumping would then be Rs. 118/- per 10 A. in.

Manual Powered Pumps

Manual powered pumps vary considerably in complexity, capacity and efficiency. Two representative units were considered; one very efficient model and one of average efficiency. In common practice pumping is a heavy work task and few laborers are able to maintain a high work rate for more than a 4-5 hour day.

The most efficient pump tested was a one man pump which could be used in a three stage lift station to handle the 40 ft. total lift. This

installation can command a 1.8 acre tract. The total investment in well, pumps and installation would be Rs. 2180/- or Rs. 1280/- per acre. The unit pumping cost was approximately Rs. 495 per 10 A. in.

A two-man pump of average efficiency for manual powered units had a command area of 2.94 acres with a total investment of Rs. 4040/- or Rs. 1380/- per acre. The cost of pumping with this unit worked out to Rs. 600 per 10 A. in.

Manual pumping devices are commonly installed for low lifts, 5-10 ft. Such installations are for water lifting from canal or tank sources rather than well sources. In such low lifts a single pump has a command area of approximately 2.5 acres. The total investment in pump and installations was Rs. 360/- or Rs. 145/- per acre. The cost of lifting water was Rs. 120/- per 10 A. in.

Conclusions

Under the present labor rates and performance characteristics the most economical means of pumping water is engine-powered units. Electrically driven units were not considered in the study but is generally agreed that they are less expensive than diesel units. Although the total investment for a single engine driven unit is the highest, it has the lowest per acre investment assuming that the installation can be used to command its rated capacity. Farmers owning less than 10 acres will find it necessary to sell water or share the purchase of the pump in order to realize minimum costs.

The cost of labor must be reduced by nearly 90% in order to reduce the costs for the manual powered unit to the costs of the engine

driven unit for water lifting from typical wells. A bullock hire rate of Rs. 1.00 per day or less would be necessary for bullock power to compete with engine power on typical wells.

For common irrigation use, engines for wells of 40 ft. or more, bullock power for 15-25 ft. and manual power for 5-10 ft. the costs are roughly equal but engine power remains the most economical, both in terms of cost per unit of water and total investment required.

From this analysis it appears that the economics of scale does apply to the problem at pumping irrigation water. And further, common reluctance to invest in labor intensive irrigation devices appears to be justified.

Reference: Research Project on Water Lifting Devices, Division of Agricultural Engineering, Indian Agricultural Research Institute, 1966

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