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Identification of a Manually Operated Water Lifting Device for Small Scale Cash Crop Growers in the Dry Zone

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ABSTRACT. An appropriate water lifting device had been a long felt need in the dry zone for small scale cash crop growers. Due to escalating prices of fuel and motorized pumps, attention was focused on a machine which could operate with renewable sources of power.

Two surveys, one on small scale dry zone farmers and the other on available water lifting devices were carried out to ascertain the appropriate device required for use under the prevailing dry zone farming conditions. A simple manually operated water lifting device was decided upon after studying the capabilities of the existing manually operated water lifting devices in use. The Chinese Chain and Washer pump proved to be a promising implement. A further step forward would be an animal drawn version of this unit.

Two operators using this machine could achieve a delivery of about 10 m^3/h over a head of about 6 m while only about 1.2 m^3/h could be achieved by using the same man power with the rope and bucket. On the basis of the above output it has a potential of irrigating about 0.4 ha (1 ac) of land depending on the crop and field conditions.

INTRODUCTION

This study is mainly concerned with farmers who have their own wells and limited arable lands below one acre in close proximity to these wells. They are unable to establish any kind of crop satisfactorily without proper irrigation. They need a low cost system to lift water from their wells to irrigate the land. These farmers have limited labour and lifting water manually from a well with rope and bucket to irrigate

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about one acre of farm – land is a difficult task (Farrington, *et al.*, 1980; Silva *et. al.*, 1982). In most cases, a power operated pump is beyond the means of an ordinary farmer. For example, a centrifugal pump with an inlet port of 50 mm (2") diameter manufactured in Sri Lanka was about Rs. 5000.00 in 1980; it is now sold at about Rs. 15,000.00. It is therefore more appropriate to have a simple, low cost, manually operated water pump which could serve the purpose.

Objectives of the study

a. To conduct a literature survey on available water lifting techniques and a field survey to find the present practices in lifting water by small scale farmers, available resources and field problems.

b. To select a manually operated water lifting device which suit the needs of the small scale farmers.

MATERIALS AND METHODS

Information gathered from the literature survey and from the field survey were matched to select the most appropriate device. The following factors were considered in different water lifting devices and with the farmers in view:

Factors considered in different water lifting devices:

a. Construction
b. Head range
c. Power range
d. Output
e. Efficiency
f. Cost
g. Suitability for irrigation
h. Possibility of harnessing animal power

Factors considered with the farmers in view:

a. Presently adopted methods to lift water and reasons for their use
b. Available sources of water and their potential
c. Potential land available and area allocated for cultivation
d. Types of crop cultivated
e. Irrigation requirements
f. Availability of labour and probable cost
g. Availability of draught animals
h. Financial position of farmers
i. Choice of adopting new technology to improve their present farming condition

Selection procedure

Of the factors mentioned above in view of the farmers, some are independent variables which are beyond the farmers' control (*eg.* depth of water available *etc.*), and some are interrelated with high variability. For instance, if the power available and the area to be cultivated are constant, the farmer has to adjust the time spent for irrigation. If there is any difficulty in spending more time in order to maintain the water requirement, either the extent of cultivation or the power input has to be adjusted accordingly. Since the variability is very high it is quite difficult to make a decision as to what pump should be selected. Therefore, the most convenient method of selection would be to bear in mind the worst conditions that could prevail in the study areas and to choose one or two pumps which could continue to work under such conditions. Once the preliminary selection is done, the remaining or the less important factors could be considered to make the final selection.

RESULTS AND DISCUSSION

In order to make the preliminary selection, the two most important factors, namely the depth of water and the available power were considered (*i.e.* 7 m depth and 0.12 kW power). From the figures 1, 2, 3 if the area demarcated above the 6 m (head) line and below the 0.125 kW (power) line were observed assuming two operators could be employed to operate the device. Chain and Washer pumps, Centrifugal pumps, Persian Wheel and Noria, Diaphragm pumps, and Piston pumps

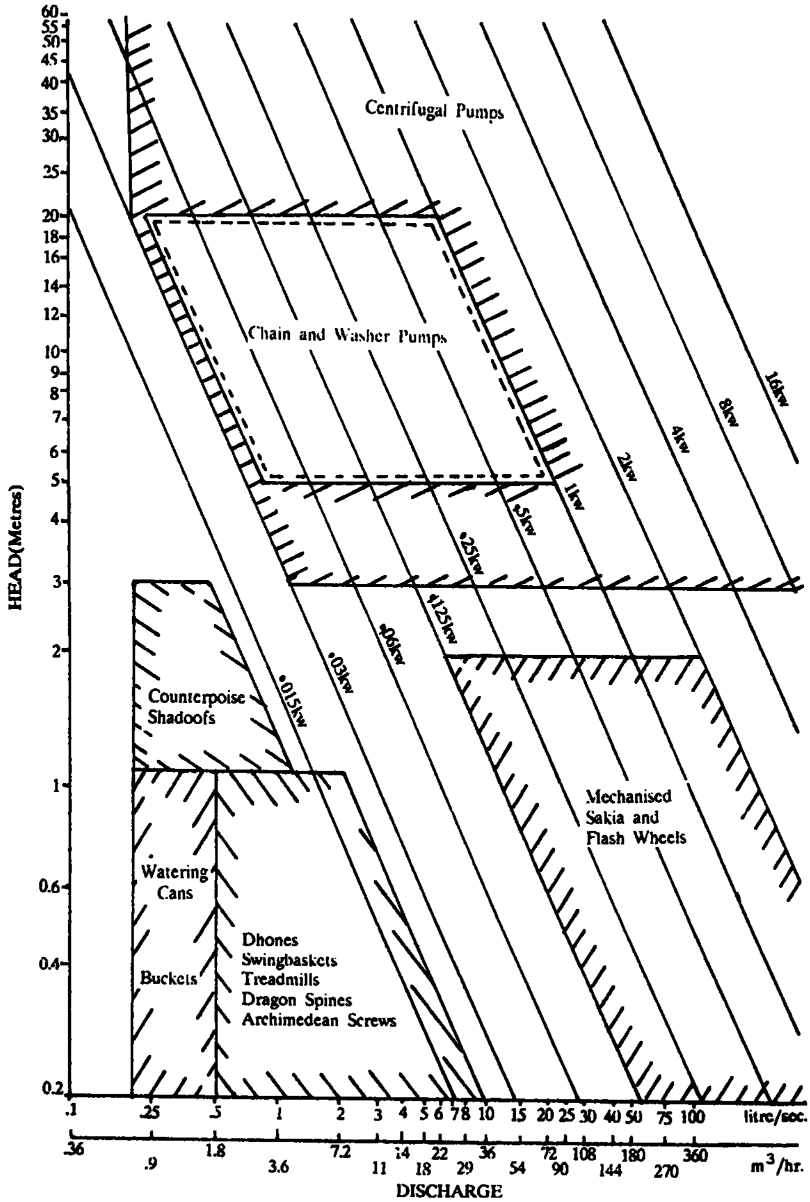

Figure 1. Typical head and discharge capacities for different types of pumps and water-lifting devices on a log-log scale (Fraenkel, 1986).

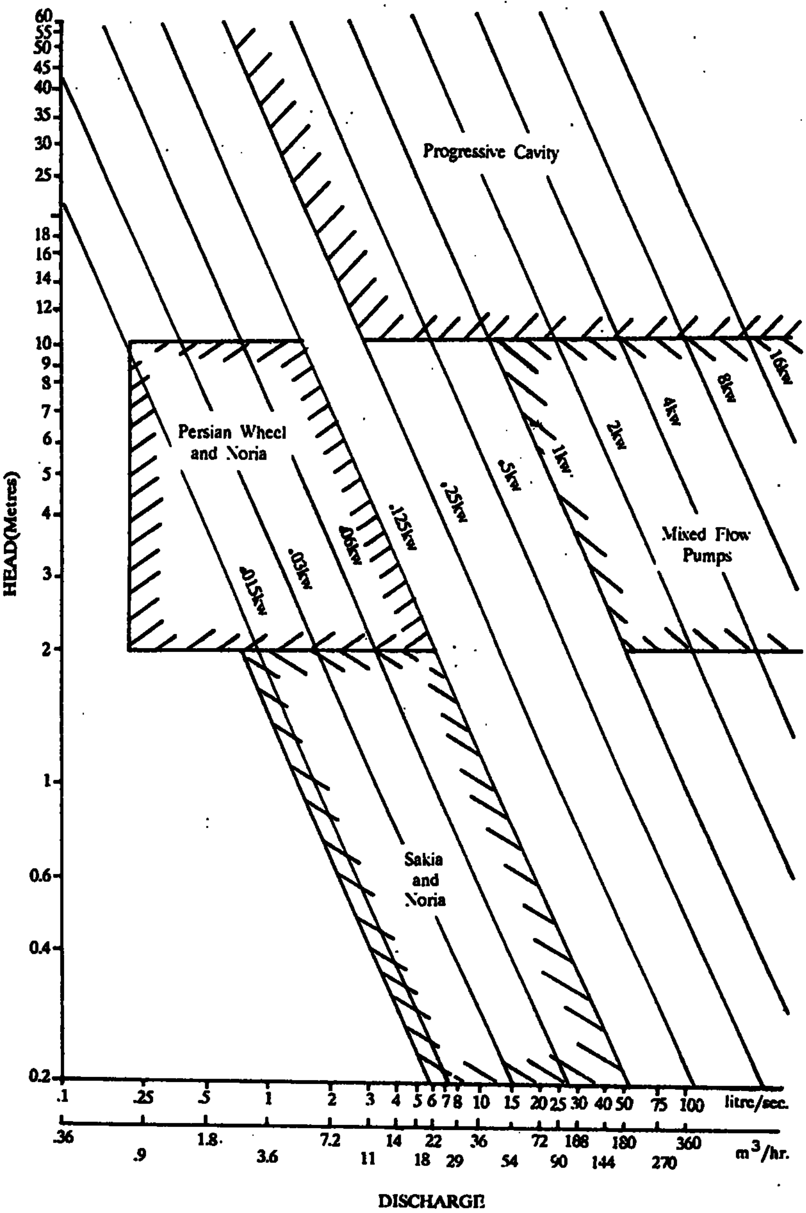

Figure 2. Typical head and discharge capacities for different types of pumps and water-lifting devices on a log-log scale (Continued).

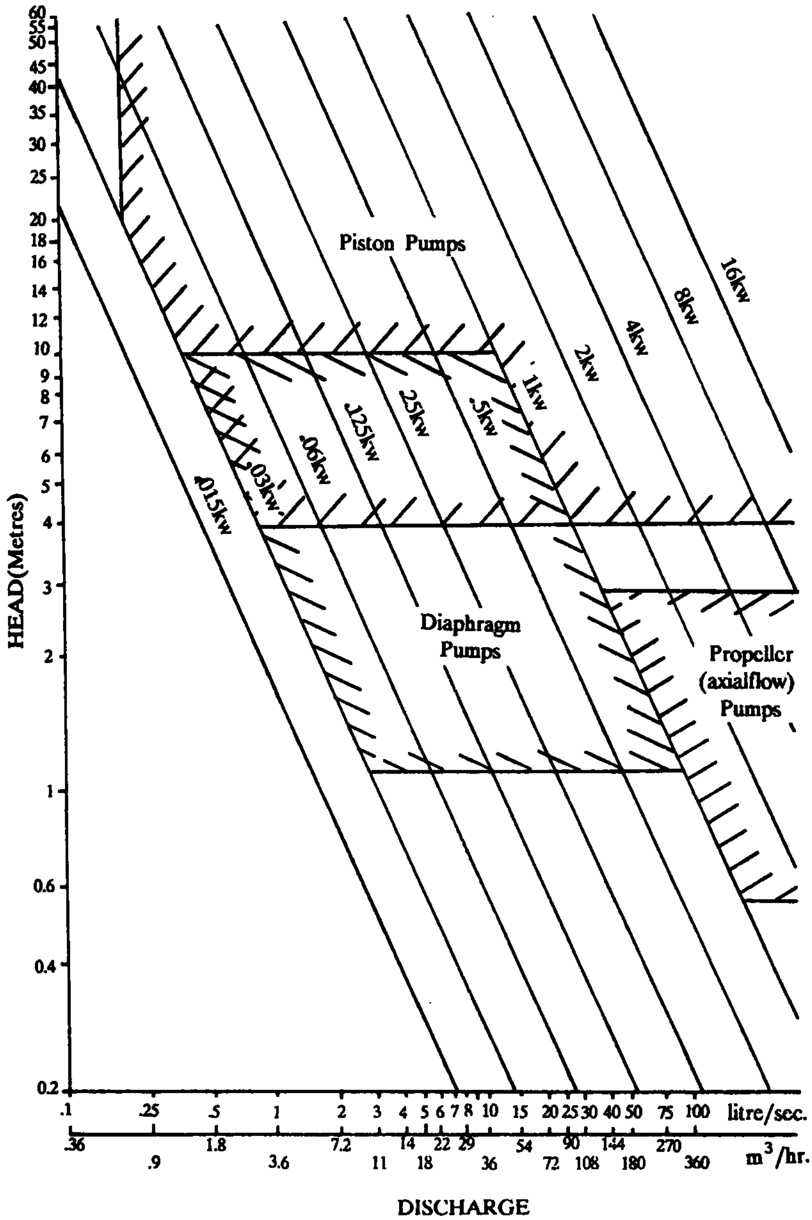

Figure 3. Typical head and discharge capacities for different types of pumps and water-lifting devices on a log-log scale (Continued).

are included within the area. From these selected devices, Centrifugal pumps, Persian Wheel and Noria could be dropped, since normally they are not powered by humans. Finally, the selection was simplified and reduced to two devices – Chain and Washer pumps and Piston pumps (Twin Treadle pump). The Table 1 indicates pump characteristics of these two types of pumps. However Diaphragm pumps were eliminated due to their relatively low efficiency, dependability on specialized spare parts which cannot easily be improvised in the field and very high operating forces.

Table 1. Review of pumps and water lifts

Pump	Head Range (m)	Input Power (kW)	Flow Range (m^3/h)	Efficiency (%)
Chain and Washer pump	5 – 20	0.02 – 1	5 – 30	50 – 80
Treadle pump	1 – 7	0.05 – 0.1	3 – 7	40 – 85

Source: Fraenkel, (1986); Stickney, (1985).

Selection was done by analyzing the performance of two mechanisms (Chain and Washer pump and Treadle pump, see figures 4 and 5) more closely when they were lifting water at a depth of 6 m below ground level using only 0.125 kW of power. If these pumps are operated under the conditions described earlier, the power input would be 0.125 kW, the total irrigation requirement would be 10 mm/day the depth of water as 6 m and the time spent to pump water as 4 hours. It can be calculated that the area that could be irrigated is about 0.4 ha and 0.29 ha for the Chain and Washer pump and Treadle pump respectively (Carruthers, 1985). The respective discharge rates are 10 m^3/h and 7.2 m^3/h. Under the above conditions the Chain and Washer pump showed much better promise than the other (exceptionally good discharge rate).

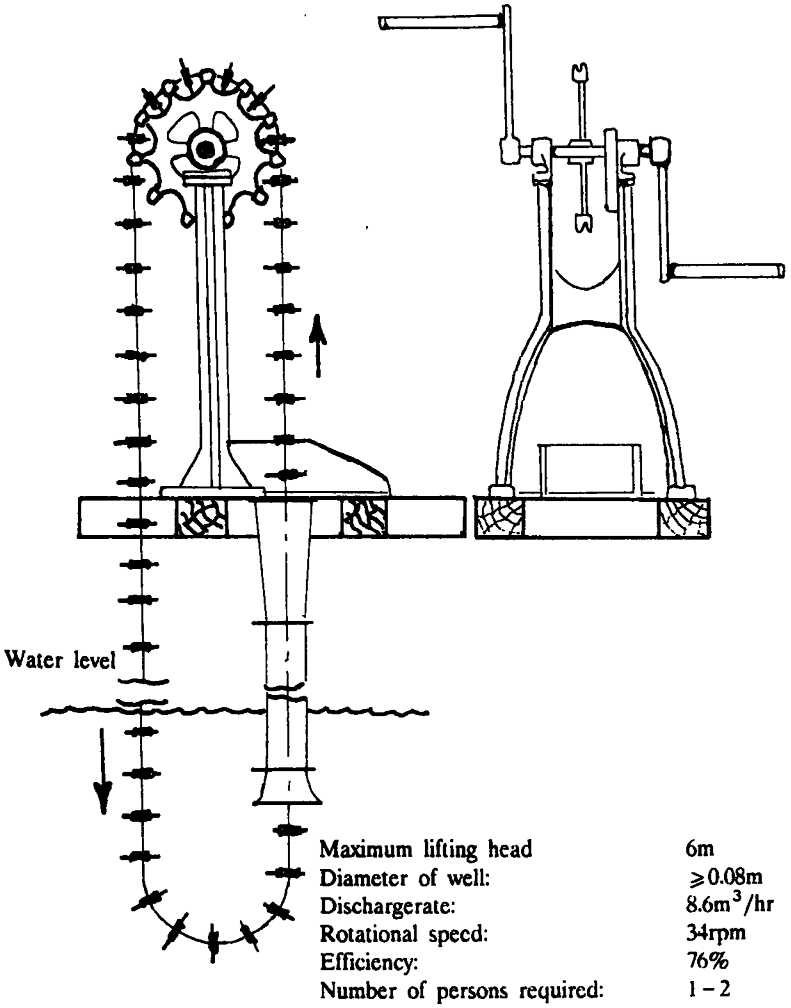

Figure 4. Chinese Liberation Chain and Washer pump (Fraenkel 1986, Watt 1977)

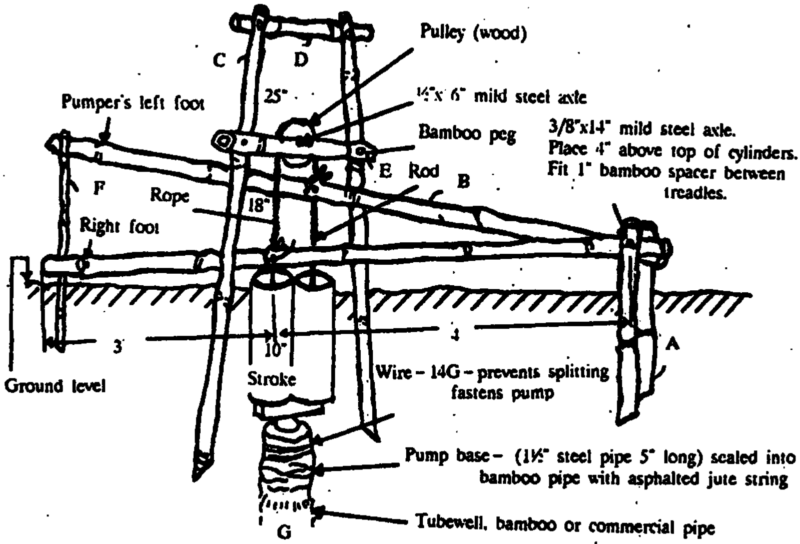

Figure 5. Sketch of a Twin Treadle pump (Trasp 1989)

CONCLUSION

The Chain and Washer pump appeared to be a better solution. This choice is made especially because of its assumed low maintenance cost in comparison to the other two pumps, durable and ergonomic design, high efficiency and prospects for introducing an animal drawn version (Shoufan *et al.*, 1982; Stern, 1979). Although at this point it is beyond the objectives of this study, if an animal drawn version is introduced (since there are plenty of draught animals in most of the areas) the operating costs would be minimal. Further, when power input is high, water could be pumped from even deeper wells and a greater yield could also be expected by using larger working pipes (Breuer and Netzband, 1980; Darrow and Saxenian 1986; Heber, 1978; Rushan and Zhongde, 1979)

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