

**Evaluation of Technical and Economic Performance of Smallholder  
Pumped Irrigation Systems**

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## **ABSTRACT**

Pump fed irrigated agriculture has been on the increase particularly in the arid and semi arid regions of Kenya. Smallholder farmers practicing irrigated agriculture apply water to supplement the scarce and unreliable rainfall common in these areas. However, smallholder pumped irrigation systems is faced by many challenges such as lack of appropriate skills during irrigation system selection, design and operation as a result of inadequate technical assistance. Other challenges include lack of appropriate irrigation system components matching farmer's needs, high operation costs, low water use efficiency and labour intensive irrigation activities. The end result of these challenges has been poor smallholder irrigation system performance. It is therefore imperative to investigate the causes of such challenges and offer possible solutions in order to improve pumped irrigation system performance as well as make it more profitable. This research was carried out in semi arid areas of Yatta and Kakuzi divisions which are in Yatta and Thika districts respectively. The research entailed evaluation of the smallholder pumped irrigation systems used in terms of their technical performance, economic viability and the related agricultural water use. The challenges encountered by the smallholder farmers are also documented. Finally an ideal irrigation design system was developed.

The study methodology involved observational study as well as field transect walks to identify the farming systems, irrigation technologies used as well as their adoption rate. Socio - economic surveys using semi structured questionnaires were done covering 80 smallholder farmers. Detailed study was carried out in 10 sample farms where technical performance of pumped

irrigation systems was evaluated as well as agricultural water use efficiency. An ideal irrigation design kit suitable for smallholder pumped irrigation system was developed.

The results of the survey found out that there was high uptake of pump fed irrigated agriculture with over 80% of the sampled farmers practicing supplemental irrigation. 94% of the smallholder farmers surveyed were found to use furrow irrigation methods. Only 2% used sprinkler irrigation while none used drip irrigation. Farmers used small motorized pumps to pump water and either conveyed it using pipes or canals for gravity fed systems.

Main challenges facing smallholder pumped irrigated agriculture can be grouped into 5 categories such as lack of information, high cost of running irrigation systems, laxity on the government side, overreliance on traditional irrigation methods and water shortage. The problem of lack of information in market needs for agricultural produce and market prices of the produce, irrigation system component selection, design and operation and amount of water needed for irrigation was noted. High cost of running the irrigation system due to high energy cost (as cited by 65% of the respondents) and high cost of other agricultural inputs was noted. The laxity of the government in providing experienced technical assistance to the farmers particularly during irrigation system component selection, design and operation (as cited by 73% of the respondents), and unregulated water use with only 5% of the studied population having been issued with water permits was noted. 79% of the respondents revealed that there was shortage of irrigation water particularly during the time of high demand of the agricultural produce. Water shortages could have emanated from use of traditional irrigation methods such as furrow irrigation and lack of modern irrigation techniques at farm level.

Different makes and models of the pumps were being used by farmers in the study area. Small motorized pumps in the range of 4.0 to 6.5 horsepower were being used. An assessment of 10 pumps showed that 60% of them operated below the optimal recommended design efficiency of 60% during irrigation. Analysis of water flow in the pipes indicated that it was within the design flow rate for 40% of the systems evaluated. Head losses for 60% of the pipes assessed exceeded the design limit. The head losses for 9 out of the 10 fittings and accessories used in the 10 irrigation setups operated within the design limit.

The economic analysis of smallholder pumped irrigated agriculture under horticultural crop production is a highly profitable investment. The calculated gross margin analysis showed that on average, 1 hectare of land can result to 1,687,764 Ksh, 236,497 Ksh and 180,892Ksh respectively on season basis for Tomatoes, Water melons and French beans. Tomatoes were found to have the highest net returns per hectare. The benefit cost ratio of the same investment for the three crops considered was greater than one, an indication that the investment is highly profitable and beneficial.

The calculated overall seasonal energy cost showed that on average, over half of the total cost of production resulted from energy use. This was true for the three crops considered and for the two seasons considered.

The water conveyance efficiency was high at 81.42%. Water application efficiency in the ten sample farms under different crops was however low and ranged between 19.5% and 30.0 %.

In the design of an ideal irrigation kit, it was found that pumps with horsepower ranging from 0.7 to 2.26 were suitable for elevations ranging from 0 to 15m. Unlike the most widely pumps with horsepower ranging from 4.0 to 6.5, small motorized pumps can offer a great solution in smallholder pumped irrigated agriculture. However, the small motorized pumps were missing from the Kenyan market and this offers an area that can be explored and started.