APPLICATION AND EXPERIENCE OF PHOTOVOLTAIC PUMPS
FOR IRRIGATION IN PAKISTAN

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Summary

In recent years considerable interest has been expressed in the use of solar power to pump water for either irrigation or water supply, in remote regions of developing countries where grid electricity does not exist and diesel oil is difficult and expensive to obtain. There is a need for a suitably sized small scale pumping system capable of supplying the water requirements of small-holder farmers, farming less than 3 hectares.

Intermediate Technology Industrial Services (ITIS) of the UK purchased 20 solar powered micro-irrigation units (Sun pumps), of which 18 were supplied by Solar Electrical International (SEI) and 2 units, incorporating batteries, were supplied by Lucas Energy Systems of the UK.

Sun pumps were installed at research farms and private farms in Pakistan for a one year trial period with the objective of demonstrating, testing and evaluating the suitability of this technology to the needs of irrigated small holdings.

The trials have proven this technology to be acceptable to the farmers who readily appreciated the benefits of using sun pumps; the absence of running costs, the ease of use and the independence gained by controlling their water supply. It was also very evident that the effectiveness of this low flow irrigation system is more dependent, than conventional irrigation water supplies, on the plot layout, channel conveyance system and the farmer's water management technique.

INTRODUCTION

Pakistan is a most suitable country in which to carry out a project to field test sun pumps for a variety of reasons:

(a) an average of 8 sun hours per day, throughout the year,
(b) a long history of irrigation,
(c) over 8 million hectares of land has ground water, suitable for irrigation, within 6m of the surface,
(d) over 44% of farmers in Pakistan own less than 3 ha.

In Pakistan there are a number of sources of water for irrigation, namely:
(a) canal water supplied by either gravity or lift,
(b) pumped water supplied from diesel or electric powered tubewells with farmers owning their own tubewells or purchasing water from other tubewell owners,
(c) water from shallow open wells, lifted by an animal driven Persian wheel.

It is possible to use sun pumps either to replace the farmer's present method of irrigation or to supplement it, thereby allowing the farmer to change his cropping pattern to include cash crops requiring a perennial water supply or to allow irrigation of a larger portion of his land throughout the year.

Two organisations in Pakistan were involved in the trials, the Pakistan Agricultural Research Council (PARC) and the Agricultural Development Bank of Pakistan (ADBP). Four units including the two units incorporating batteries were installed at PARC research stations and the remaining units were installed at a number of farms throughout the country.

Of the two types of sun pump used in the trials data was collected from only the SEI units as neither of the Lucas units could be made to operate for an extended period of time. The SEI system as shown in Fig.1 produces 250 watts under insolation of 1000 mW/cm² at 30°C and is designed to pump 2.5 litres/sec at a head of 5 metres. The panels are mounted on two trolleys which can be easily manoeuvred to track the sun throughout the day. The system uses a submersible pump/motor set which is placed in a well as illustrated, and is suspended just below the surface of the water by a flotation buoy. A master power point tracker (MPPT) is incorporated, which matches the load of the pumpset to the varying power available from the solar array, thereby ensuring optimal use of the power available. The SEI design was well received by the farmers who in general encountered little difficulty in using this system.

FIELD TRIALS

During the initial trial period, units were allocated to 14 farmers in different regions throughout the country. This procedure was adopted for two reasons, firstly to promote and introduce solar pumping to a large number of farmers, and secondly to identify the regions where the introduction of solar pumping might be most beneficial. Following this initial period three regions, Peshawar, Muzaffargarh and Sukkur, were chosen as the most suitable because:

(a) The three regions illustrate the various cropping patterns practised in Pakistan.
(b) There were a large number of open surface wells in existence, permitting installation of the solar pumps without incurring additional costs of well construction.
(c) Groundwater was available within 3m of the surface throughout the year.
(d) A large percentage of the farmers used the Persian wheel to irrigate small, (less than 1.5 ha), plots.

At each of the farm sites, weekly data regarding hours of pump use, area of crops irrigated per day, and depth to the water table before and after pump use was collected by ADBP personnel. This information gives an idea of the effectiveness and capacity of the solar pumps as used by farmers throughout the year.