INTERNATIONAL PROGRAMME FOR TECHNOLOGY AND RESEARCH IN IRRIGATION AND DRAINAGE (IPTRID)

Final Report
Survey on Adoption and Techncial Performance Evaluation of the Swiss Concrete Pump (PEP)

May 2008
Rome, Italy

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SUMMARY

The Swiss Federal Office for Agriculture (FOA) has been providing financial and technical support to the development, improvement, promotion and dissemination of a low-cost technology suction-based foot-driven type of pump now known as the Swiss Concrete Pump, or PEP. It is in this regard that the Swiss FOA approached IPTRID in order to explore the possibility of implementing a project with the broad objective of "conducting an evaluation on the PEP to include not only aspects related to the technical performance of the pump but also costs and those concerning institutional issues that may constrain or facilitate promotion, adoption, perceptions and acceptance by users, and socio and agro-economic impacts". In response, the IPTRID Programme submitted a proposal for a 15-month project titled "Survey on adoption and technical performance evaluation of the Swiss Concrete Pedal Pump (PEP)" to be carried out in two countries, namely, India and Tanzania where the PEP has been introduced and adopted by farmers working under various social-economical and technical conditions. With the exception of a very few instances, and in order to address particular circumstances, the activities carried out in both India and Tanzania were very similar.

A field survey on each country was the core activity of project implementation. These were undertaken by national consultants supported by IPTRID staff and an external international consultant. The survey was designed, among other issues, to evaluate the performance and role of manufacturers; assess farmers' adoption of the pumps and to evaluate PEP performance under field conditions. Therefore, for that purpose the survey included visits to manufacturers, interviews with both local managers and workshop keepers, farmers and local authorities.

The surveys revealed that the great majority of the farmers utilizing the PEP in both countries have been satisfied with the performance of the pump and its easy maintenance. The survey further revealed that the weakest link of the PEP system is the workshop network. In India, in particular, it has not been kept active after the distribution of the pump. The situation in Tanzania, in this regard, is better with several manufacturer still very dynamic thanks to micro-credit mechanisms. However, more support is recommended from the W3W NGO.

The design of the pump is well accepted by the farmer and out of different features the *multi position of pedals* gave the highest satisfaction followed by the suitability of the *concrete settlement* and the advantage of the *equalizer.* Despite observed anomalies and variations among various groups and individuals, 95 percent of PEP users felt the equipment to be satisfactory, and a more reliable technology than the traditional methods. One important feature is that farmers feel sure they can maintain the PEPs themselves. Furthermore, farmers perceive the technology as a way of small farmers advancing on poverty through horticultural crop production and also as a domestic asset since the PEP can free women from carrying water. Basically, in Tanzania the PEP is a technology that doubles the area under irrigation.

In addition, farmers were able to learn how to operate and maintain the pump rather quickly. While they received very basic training at the time of pump installation very few got any "refresher training" or additional support. The farmers learned by doing/practical

application and by talking to other farmers. This approach is highly recommended because it also opens up considerable communication channels among farmers and reinforces social interactions.

As it is usually the case when dealing with irrigation matters, the PEP-using farmers faced a number of constraints that went far beyond the irrigation technology itself. Such constraints, like for example the difficulties in being able to buy the pumps due to lack of micro-credit mechanisms; the weak or non-existent support services to advise on cultural practices or proper agricultural inputs; or the lack of suitable capacity development related aid that can support farmers in utilizing the best practices already available; very often supersede the advantages provided by the introduction of the technology and becomes a real constraint to the smooth farmer adoption and/or adaptation of the same.

In consequence, IPTRID feels strongly that lessons learned in this Project can be the basis for subsequent interventions, whether in these two countries or others to be proposed, that would be directed to select a group of innovative farmers willing to try out this new technology and have a parallel and consistent support in order to remove constraints that are now well identified and understood. Such support would further increase the adoption and adaptation of a relatively new low-cost technology that farmers understand and welcome. Of particular importance for further efforts (and in relation to India) to promote the PEP should be the introduction of the technology under a private sector approach rather than the current free distribution of the pump; the latter is not a sustainable proposition. The more commercial angle could also solve the availability of spare parts that has been a weakness of the PEP introduction efforts.

Survey on Adoption and Technical Performance Evaluation of the Swiss Concrete Pump (PEP)

INTRODUCTION

Brief Background:

The International Programme for Technology and Research in Irrigation and Drainage (IPTRID) is a multi-donor Trust Fund managed by the IPTRID Secretariat as a Special Programme of FAO. The IPTRID acts as a facilitator mobilizing the expertise of a worldwide network of leading institutions in the field of irrigation, drainage and water resources management. The Programme aims at improving the uptake of research, exchange of technology and management innovations by means of capacity development in the irrigation and drainage systems and sectors of developing countries to reduce poverty, enhance food security and improve livelihoods, while conserving the environment.

Over the years, one of the particular interests of the Programme has been to keep abreast of emerging new irrigation and drainage technology and adaptation of these to the existing conditions of farmers' fields in the developing world. One of such technologies has been the low-cost so-called treadle pump type of devices that emerged in Asia many years back and have now slowly but surely made in-roads into a large number of African countries. IPTRID has been actively involved in promoting and supporting this technology in Africa. In fact, in 2000 the Programme published its Synthesis Report No. 1 "Treadle Pumps for Irrigation in Africa" which in a way led to the project that is being reported here.

The Swiss Federal Office for Agriculture (FOA) has been providing financial and technical support to the development, improvement, promotion and dissemination of a similar device or Swiss concrete pump, now known as PEP. This suction-based foot-driven pump has been introduced in other countries among which, India, Tanzania, Burkina Faso, Peru, Uganda, Lesotho, Mozambique and Madagascar.

It is in the previous context that the Swiss FOA approached IPTRID in order to explore the possibility of implementing a project with the broad objective of "***conducting an evaluation on the PEP to include not only aspects related to the technical performance of the pump but also costs and those concerning institutional issues that may constrain or facilitate promotion, adoption, perceptions and acceptance by users, and socio and agro-economic impacts***."

The IPTRID Programme prepared and submitted to the FOA a proposal for a 15-month project and a total budget of US$98 050 titled "Survey on adoption and technical performance evaluation of the Swiss concrete pedal pump (PEP)" to be carried out in two countries, namely: India and Tanzania where the PEP has been introduced and adopted by farmers working under various social-economical and technical conditions. The project was approved in December 2006 and became operational in early January 2007.

A summary of specific objectives and activities of the Project includes:

- Carry out inspections of PEPs under field operating conditions. Concentrate on technical operating performance parametres, among others, efficiencies, durability, resilience, vulnerability, stability, wear and tear of components, working and maintenance conditions, ergonomic considerations, etc.

- Prepare and conduct users' surveys to primarily evaluate the impact of the introduction of the PEP. The activities should be field-oriented to determine perception of PEP users on the performance, costs, suppliers and availability of spare parts, marketing arrangements, agro-economic and social benefits, security-based constraints and other pertinent parametres that will help judge the acceptance of the device.
- For each country, carry out visits to government agencies, manufacturers, dealers and other private entities that may be involved in the promotion and dissemination of pumps, with particular attention to the PEP. This component should be considered an integral component of project implementation.
- Prepare a Project Final Report including both Technical and Socio-economic analysis. The report is to include clear conclusions and recommendations for the funding agency, with a strategy for further support and expansion of the PEP, if that is to be the case.

This document is the result of 15 months of project implementation by IPTRID staff and collaborators. It is submitted to the Swiss Government in compliance with the terms of reference of the Project and in line with the reporting requirements.

Scope and structure of the report

The Final Report herein presented is "self-contained", that is the reader will be adequately and sufficiently informed on the implementation and outcomes of the Project without the need for consultation of other material generated by it. Notwithstanding other complementary documents that have been produced through project activities, in particular, the individual country reports from India and Tanzania the Final Report is meant to comply fully with the project reporting requirements.

However, it should be noted that the Indian component of the study has been documented fully through the Report titled "**Orissa-Swiss PEP Assessment Study".** Likewise, the Tanzania component has produced the Report titled "**Survey on the PEP Assessment study - Tanzania.**" These two reports should be considered as "complementary" and absolute components of the final project results although not "integral" part of the same. The reason for such an arrangement is pragmatic. To include all three components - Final, India and Tanzania - under one single body would lead to a very large document difficult to handle in terms of ease of consultation but also equally important for publication and dissemination. An additional reason is that the conditions of introduction of the PEP in Tanzania and India have been completely different. Obviously, the Final report draws heavily from the individual country documents and reflects fully their findings, conclusions and recommendations.

With respect to the structure of the Final Report itself, Chapter One on Introduction provides an overview of how and why the project came about, its objectives and how the activities were planned and implemented. Special attention is given to the methodology for project implementation describing the tools applied. In Chapter Two we deal with the

activities realized; these are presented in terms of each country and in strict accordance to the methodological stages, reflecting the project design. Chapter Three covers the general results, again by country of intervention and in the context of technical, agronomic, economic and socio-cultural components. Conclusions and Recommendations constitute Chapter Four. These are presented first in general terms in relation to adoption of the technology and by country of study. In the latter part of the Chapter we look at recommendations as they relate to issues such as technical matters, extension services and type of support services required, credit and markets required and capacity development needs. In Chapter Five we provide a brief note on potential follow-up of project activities as the IPTRID Programme would like to put forward to the Swiss Federal Office for Agriculture. A final Chapter Six presents a final project financial statement, again in compliance with the Project's reporting requirements.

A note on methodology

For project implementation activities were organized around four distinct stages. The methodology followed was essentially the same in both countries although it should be noted that necessary adjustments to fit particular socio-cultural factors or conditions found in the field was necessary. These are summarized in the following paragraphs.

Stage 1: Preliminary activities and work plan formulation

This stage included ***preliminary office work*** that took place even before the final IPTRID-Swiss FOA Project agreement was reached: preparation of draft terms of reference, the potential scope and work schedule, preparation of the technical proposal and associated financial concerns, work plan and timetables.

This stage also included ***documentation****:* A literature review was carried out in Rome including interventions in previous similar projects. Technical description of the various versions of the PEP, laboratory-based performance tests and information related to the low cost technology were reviewed. General physical, climatic and social conditions of the areas of intervention were documented. Likewise, in relation to the Project itself, the list of beneficiaries, the number of pumps distributed and their location in the field (districts and villages) were obtained.

Finally, Stage 1 included the ***identification of partners and actors***, namely: Institutions, partners, local authorities and other actors involved in the distribution of the pumps, including W3W, the NGO in charge of promotion and logistics of the PEP in the field.

Stage 2: Evaluation Surveys

This stage covered the preparatory work and the ***field missions*** in both countries. Several local consultants were identified and interviewed. At the end of the missions all conditions for the implementation of the survey had been established, the national consultant identified and hired; terms of reference prepared and contracts signed.

Likewise, this stage included the ***preparation of the field survey***; that is the development of the field working methodology (plan to interview state and district institutions, workshop manufacturers and farmers); and particularly the ***survey questionnaire***. Both were finalized based on field observations during the missions. The PEP conditions based on the operation, maintenance and utilization was assessed and a typology of farmers

developed (considering parametres such as source of water, areas, irrigation techniques, soils, cropping patterns and practices, distance to the farm, poverty level, etc.). The findings in the field constituted the basic hypothesis needed to be verified or adjusted during the main survey itself.

The ***field survey*** was undertaken by a national consultant hired in each country supported by IPTRID staff and an external international consultant. The survey was designed, among other issues, to evaluate the performance and role of manufacturers; assess farmers' adoption of the pumps and to evaluate PEP performance under field conditions. For that purpose the survey included visits to manufacturers, interviews with both local managers and farmers and local authorities.

Stage 3: Data Analysis

The third stage comprises the ***analysis of data/information*** generated by the various survey components. The analysis concentrated on technical operating performance parametres, among others, efficiencies, durability, resilience, vulnerability, stability, wear and tear of components, working and maintenance conditions, ergonomic considerations, etc. The information gathered address the perception of PEP users on the performance, costs, suppliers and availability of spare parts, marketing arrangements, agro-economic and social benefits, security-based constraints and other pertinent parametres to help judge the acceptance of the device.

The evaluation and subsequent analysis on the PEP included not only aspects related to the technical performance of the pump but also to costs and those concerning institutional issues that constrained or facilitated promotion, adoption, perceptions and acceptance by users, etc. A main issue was to assess if farmers could afford to make individual investments at the pump's actual cost and what are the most adequate mechanisms (such as micro-credit) for pump acquisition.

Prior to the data analysis itself, great care was taken with the application of suitable tools like the ***sampling techniques*** and the development and pre-testing of an appropriate ***questionnaire*** in support of the PEP survey. Standard tools like averages, standard deviations, rankings, etc. were applied in the data interpretation processing. Comparisons "with" and "without" were utilized for the analysis.

Stage 4: Synthesis, conclusions and recommendations

This stage is essentially the conclusion of the project and includes the ***second mission*** to the respective countries in order to verify and discuss results in the field with the various actors. It allowed to carry out in-depth consultations on results and conclusions with the national consultant, local authorities, NGOs, manufacturers and, perhaps more importantly, the farmers as the final and direct beneficiaries. This stage was instrumental to clarify findings, to frame recommendations and to establish the setting under which the way forward can be set.

This stage comprises the ***final reporting*** as well as the promotion and ***dissemination*** of results. It was intended to include a final workshop in one of the two countries to present results. It was not possible to hold the workshop, for bureaucratic reasons, although efforts were made and unfortunately it did not materialize. It is now thought to keep in mind such an activity as a component of any follow-up interventions that may be derived in the near future.

ACTIVITIES CARRIED OUT

Overview

With the exception of very few instances, and in order to address particular circumstances, activities carried out in both India and Tanzania were very similar. The IPTRID team developed the project methodology prior to going to the field and only then made the necessary adjustments during the field visits or missions. In the following paragraphs an overview of activities undertaken in both countries are described. It should be noted, however, that similar activities conducted in each country did not necessarily take place at the same time.

Preliminary activities included the project formulation itself and the follow-up leading to the approval process both by FAO and the Donor. Once the project was funded, a first important activity was a general literature review related to the subject matter including studies undertaken previously by FAO, FOA and IPTRID. Subsequently, and more specifically the documentation included those information directly related to the Swiss concrete pump (PEP) technology: History of the project, description of the pump and of each of the various existing versions (technical characteristics), location in the areas of study, agronomy, irrigation and social conditions, etc. Finally, a look into actors involved (dealers, retailers, traders, repairmen, agricultural services, local authorities, NGOs, etc.).

Once all necessary information had been collected and analyzed, a first mission to each country was planned, contacts made with pertinent actors, a preliminary survey drafted, identification of potential consultants, draft terms of reference prepared, etc. These missions were the first step within the second stage of project implementation, the survey of evaluations.

The main objective of these first missions that took place was to verify and adjust the information in the field. Among other things the IPTRID Technical Officers met with relevant authorities, key actors like the "Water for the Third World" (W3W), NGO which has been in charge of the promotion and dissemination of the PEP in the two countries and made visits to pump manufacturers and farmers using the it. Local consultants were interviewed and one each per country was finally selected to be in charge of conducting the survey. The visit allowed adjusting the questionnaire to real field conditions, to become familiar with the pumps' surroundings and context; and to develop a farmer typology based on water source, area, cultural practices, cropping patterns and socio-economic characteristics. This first mission was crucial for the subsequent activities.

With the interactions made during the field visits and the selection of the local consultant the final preparation of the survey questionnaire was in place. Each consultant hired was responsible for implementing the survey but had close technical backstopping from IPTRID staff and an international consultant. The objectives and contents of the survey have been described already under the "note on methodology" section of this report and therefore there is no need to duplicate that information. The survey was the central activity of project implementation.

With respect to the application of the survey, there was a fundamental difference between the two countries. In India, the target selected was 70 individual farmers while in Tanzania the selection referred to 40 farmer groups or individual farmers that included 279

people. The difference stems from the fact that in the former the pump was introduced as a result of an FAO emergency project and in response to a catastrophic event; while in the latter country the PEP activities had been introduced in the context of FAO's Special Programme for Food Security (SPSF). However, in both cases the underlying parametres of evaluating the conditions and success/failure of the adoption of the pumps remain the same. How do farmers feel about the technology and what constraining elements, if any, have intervened in the adoption and adaptation of the same, were integral components of the efforts undertaken.

The third stage of project implementation started with the verification of data collection and had the local consultant as primarily responsible. Forms and tables had been prepared in advance and occasionally local language information had to be translated into English. Simple charts and figures were produced to highlight specific information. The respective reports were prepared by the consultants under the close supervision and support of technical staff. It should be noted that a table of contents for such reports had also been prepared in advance and adjustments made accordingly to fit particular conditions. A typical sample of the survey is provided in **Annex 1.** The specific items contained in the survey have been provided in the methodology section earlier.

A second mission to each country was undertaken when the survey was nearing completion and constitutes the first activity of the last stage of project implementation. The IPTRID technical staff was supported on these mission by an international consultant whose central expertise was sociology/economics. They provided technical support to the local consultant, reviewed findings, talked again to key actors, visited government officials and, most importantly, visited the field and conducted open ended interviews with farmers, manufacturers and local authorities. The missions helped clarify and crosscheck data and set the pace for further data analysis and preparation of country reports. The individual country reports thus provide the basic material to generate this Final Report.

The Swiss concrete pedal pump or PEP

The Swiss Federal Office for Agriculture (FOA) has been the major supporter and sponsor for the development, promotion, upgrading, and dissemination of a device initially referred to as the "Swiss concrete pedal pump" and now more commonly known in the field as the PEP. This suction-based, foot-driven pump operating under normal conditions can draw water up to a depth of 7.5 to 8 metres, and the discharge depending on the operating conditions can reach 80 liters/minutes. The pump body is in concrete with a double plastic (or metallic in Tanzania) cylinder inside with a rubber (or plastic) piston ring. A rubber foot valve permits water to enter and closes when the piston goes down. The pump is then assembled (the two concrete parts joined), installed and tested on the field. Thus, the device cannot rust and is easy to produce locally.

The pump has been improved continuously from its basic design. Two major aspects have been the improvement on the operation of the equalizer assembly mechanism and the ergonomics. In India, iron parts were replaced by plastic (pistons) and wooden pedals were reinforced by iron bars. In addition, the equalizer significantly improves the mechanism by facilitating the alternative motion of the pedals. Some major constraints are linked to the weight of the pump (although it is also an advantage since it limits possibilities of the pump being stolen), and the fact that it is a suction pump system. During the surveys the extent that these characteristic constitute a limitation to the use of the pump were addressed.

The concrete pedal pump has many uses for different purposes. The typology of use includes irrigation only; domestic only; irrigation and domestic combination; irrigation, domestic and livestock; irrigation and livestock combination; and brick-making. The main purpose of introducing the pump was to assist small farmers by bringing water closer to the application point so as to be able to raise their agricultural production.

The surveys

The ***main survey*** was implemented by the national consultant under the guidance and supported by the international expert(s), either IPTRID staff or external. The survey objectives including its design were primarily geared, among other issues to: i) evaluate the manufacturers and their role; ii) farmers' adoption of the pumps; and iii) PEP performance under field conditions. For that purpose the following activities were integral components undertaken during the main survey:

- Visits to manufacturers
- Interviews with farmers
- Conducting farmers' survey (technical and agro-socio economic issues)
- Focus on the changes in farmers' practices (adaptation) as well as profits (benefit-cost analysis)

In both countries the support received from the NGO promoting PEP, namely, the "Water for the Third World" or W3W was invaluable since their in-depth knowledge of the areas of influence of the pumps, their location and their ready access to many of the farmer-owners translated into savings of time and facilitated data collection. However, and for obvious reasons, the local consultants were careful not to introduce bias emanating from the NGO. At all times the survey was handled very professionally and independently.

In India, the survey was undertaken in the State of Orissa. It was aimed to assess the penetration of the pump in the target areas and to determine who benefited most and why. It evaluated the most suitable condition under which this pump could perform efficiently, and if it helped and how to improve the economical and social conditions of its users. In Orissa State a total of 1 329 PEP pumps have been installed to date. The sampling procedure reached over 4 districts, in 8 regional blocks, and 22 *Gram Panchiyat* (councils) across 35 villages. The total number of farmers responding was 70. The sample was picked from the costal districts of the State where the PEP could technically perform as the average water table was higher than in the western areas. The farmer groups' distribution can be seen in Figure 2.1 where small farmers predominate over medium and large ones. Paddy rice is cultivated as the primary crop in the Kharif season followed by pulses and vegetable in the Rabi season. Therefore the pump operation was not limited only to vegetable growers but can cover other crops requiring timely irrigation in the dry spell of the year. The study covered the respondents irrespective of social cast and creed or sex.

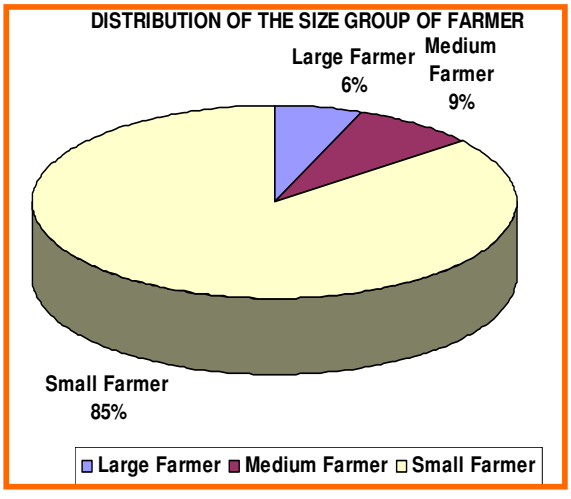


Figure 2.1: Distribution of Farmer Groups

In Tanzania the field survey had essentially the same objectives and was aimed at establishing the degree of adoption of the PEP pump by undertaking a technical and economic evaluation through collection of data on its efficiency under operating conditions, and by assessing and documenting various conditions under which the pumps are being used.

Thus, the evaluation considered the economic benefit and assessed the sustainability of this low-cost equipment; and the acceptance of users. The survey covered 19 districts and 40 pumps with 17 (43 percent) considered private while 23 (57 percent) were considered Participatory Farmers Groups. In addition 14 pump manufacturers were included. In total, 279 people were visited, of these 141 (50.5 percent) were women while 138 (49.5 percent) were men.

In general, and as can be expected, a number of limitations were faced during both surveys, among these:

- The timeframe turned out to be too short since the majority of farmers were located in remote areas.
- Substantial amounts of time were spent on travel from one location to another, the problem being compounded by poor roads to the locations.
- For some farmers it was very difficult to recall the previous areas cultivated or irrigated and the amount earned and had difficulties or reservations on divulging their information on income.
- In some cases all the required information was not available or revealed and some farmers were not as cooperative as desired.

GENERAL RESULTS

1. INDIA

Technical aspects

1. Management

The PEP pump in India

The PEP was introduced with the support of the Swiss Government to assist farmers to recover losses after years of severe cyclone damages affecting the State of Orissa during the last decade (see map in **Annex 2**). Thus, in India the PEP was introduced through the Orissa State Disaster Mitigation Authority (OSDMA) and implemented by W3W and additional support was obtained from the District Agricultural Services. In addition to rehabilitation of the infrastructures, the PEP was perceived as an adequate technology to directly help farmers who had seen their seasonal crops destroyed. The State of Orissa, and especially the project area selected for the introduction of the pump, is an irrigated rice land during the monsoon period; that starts from July and terminates in late October. An important irrigation network was already in place, delimitating sections in the delta. Table 3.1 below illustrates the installation of the PEPs in different districts in the different years.

Year	Kendrapara		Jagasingpur		Ganjam		Jajpur		Total
	Rajnagar	Mahakal para	Kujanga	Ersama	Ganjam	H. Katu	Jajpur	Dasarathpur	
2002	150	150	150	150	0	0	0	0	600
2003	13	12	12	13	0	0	0	0	50
2004-2006	100	100	100	100	70	70	70	69	679
Total	**263**	**262**	**262**	**263**	**70**	**70**	**70**	**69**	**1 329**

Table 3.1: PEP pump distribution in Orissa State, India

How are the pumps installed?

The PEP is fixed with screws on a solid concrete base (base material can change). In general, the pump is installed at less than 1 metre above field level. Water is lifted through a PVC pipe (d=1.5 in) and feeds the furrows by gravity. Farmers have been observed to make improvements that could be disseminated, for example a cement outlet built directly on the PEP controlling the water flow and an additional PVC pipe between the PEP and plots reducing the water losses and increasing considerably the efficiency of the PEP. The PEP can be and is operated by all family members, old persons and children either for agriculture or domestic purposes.

PEP used in India (Orissa State) for domestic purposes

Manufacturing the PEP in INDIA

It was launched through the non-governmental organization Water for the Third World (W3W). The Don Bosco Institute in Kolkota, an educational and professional school for young adults, was in charge of building the moulds and all the metal parts. Other parts and especially the PVC pistons have been made in a factory in Kolkota.

One workshop per district was established to assemble all parts (concrete body, pistons, wooden pedals, etc.). Workshop keepers were trained to install the PEP in the fields by W3W personnel. The preparation phase of trainees was essential since the concrete part of the PEP requires great care as all working parts are fixed on it. Manufacturing the PEP has taken into account all these factors.

While the PEP was introduced in several countries as a development asset, the long-term objective was to build the PEP locally to ensure the sustainability of the programme.

2. Field Observations

Profile of pump user

The PEP beneficiaries were selected on the basis of information assessing their level of poverty (as per the definition of the Emergency Authorities, OSDMA) but not their commitments or their willingness to use the PEP. The potentiality or proximity to a suitable water source was also a condition for selection of pump users.

A total of 1329 PEPs in three stages have been distributed in the four districts neighbouring the coastal area, as indicated earlier. While farmers' agricultural performance is based on their own capability to adapt to a new technology, like the PEP, in this case their attitudes played an important role. The new asset met adequately the needs of the farmers that used it mainly for agriculture (irrigation) but frequently also for domestic purposes.

However, it should be noted that no specific horticultural programme accompanied the introduction of the PEP, and no specific recommendation were provided in order for the farmer to optimise the income generated by the PEP. It was found that some farmers made profits but some others did not even utilize their PEP preferring to keep their traditional equipment due to the lack of information and support.

Water source

The majority of farmers selected to receive a pump had a permanent source of water; of these 26 percent has a non-permanent source and 74 percent a permanent one. The preceding means that within the sample of 70 farmers 18 did not have full water availability which should have been a condition for the allocation of the PEP. The criteria were surface water nearby or a water depth at less than 7 to 7.5 metres which is the maximum water lifting capacity of the PEP. The surface water especially the ponds are very common in the delta therefore providing some farmers with multiple water sources. The existing well building programme has provided a water resource that was highly valorized by the PEP. Wells and ponds represent nearly 90 percent of the water resource of PEP users, as indicated in Table 3.2.

	Water Source (percentages)				
District	**Nala**	**Pond**	**River**	**Well**	**Grand Total**
Ganjam	0.0	0.0	0.0	25.7	25.7
Jagatsinghpur	0.0	20.0	2.9	2.9	25.8
Jajpur	2.9	8.6	5.7	5.7	22.9
Kendrapara	0.0	24.3	0.0	1.4	25.7
Grand Total	**2.9**	**52.9**	**8.6**	**35.7**	**100.0**

Table 3.2: Primary water source for PEPs across districts

Available alternative water lifting sources are mostly traditional barring a few affluent farmers who are using diesel pumps. It was observed that forty percent (40%) use diesel pumps but are not owners, most of them rent it. In this process they get it very late after

the owners complete their own operations. More than 50 percent use traditional devices. As per table 3.3 below PEPs can be targeted to the users of traditional equipment and farmers hiring pumps.

	Other Available Irrigation Options (percentages)			
Ownership	**Diesel Pump**	**Electric Pump**	**Traditional**	**Grand Total**
Hired	37.1	2.9		40.0
Owned	2.9		55.7	58.6
Shared			1.4	1.4
Grand Total	**40.0**	**2.9**	**57.1**	**100.0**

Table 3.3: Other irrigation devices available

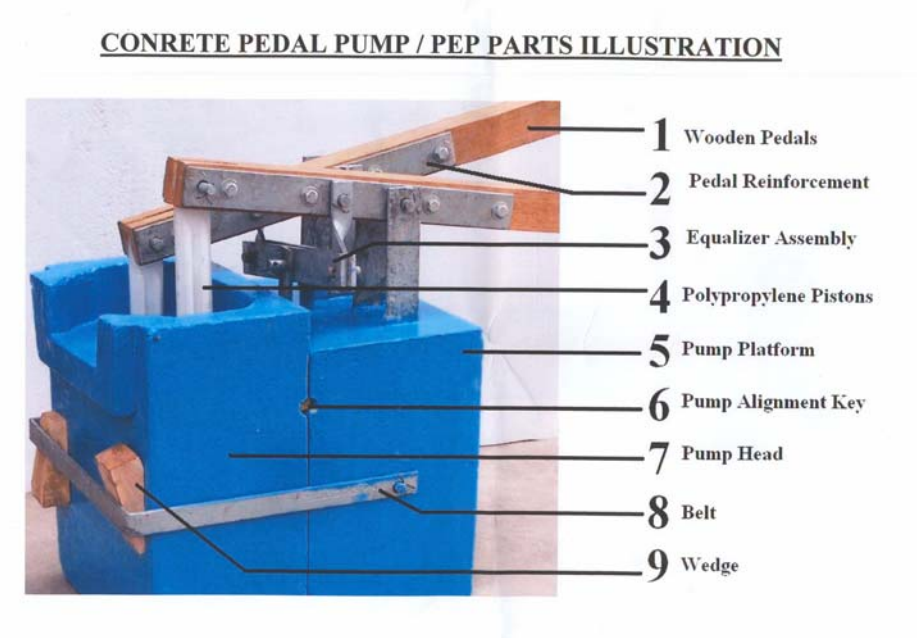
Pumping time

Continuous pumping time seems to be difficult during summer, and the data collected show that farmers do not use the PEP more than one minute continuously. The continuous pumping time by one person depends upon the climatic conditions that are particularly difficult in summer. As the main cropping season is linked to the monsoon period it has been observed that from November to June fields are left fallow unless the water table is reachable by water lifting equipment.

Pump improvements

Field observations revealed that several technical improvements of the PEP have been realized by farmers after the first field introduction in the Orissa Coastal area. These can be described as follows:

- The four districts targeted by the project suffer from salt water intrusion. Field observation show that metal made pumps started to rust rapidly. The metal parts have now been replaced by plastic and a new version of the PEP was created and adapted to the local conditions. The piston is now made of PVC material translating into a real improvement on PEP durability.
- The counterweight-based mechanism to retrieve the pedal observed on original models has been modified and improved. A particular piece of metal has been manufactured and fitted to facilitate an alternative motion of the pedal. This additional piece was found to be a great innovation in the mechanism and translated into benefits for the comfort of the user.
- Additional modifications have been carried out to facilitate the maintenance and the durability of the pump. For example, on the washer, on improving the access to working parts, on the rings to ensuring improved water suction and improvement of the wooden pedals.



3. Performance

Discharge

The theoretical discharge of the PEP can reach 80 l/minute. The observations collected in Orissa are much below this value but can be explained by taking into consideration the water lifting conditions. The discharge reached an average of 50 l/minute that seems low compared to the potential but Indian farmers irrigate a small plot and irrigate often, and therefore can be seen as an additional reason why they do not need to have larger volumes.

Water level and lifting head

The design water lifting head is placed at a maximum of 7 metres. Most farmers use the PEP within the recommended interval but survey results reported indicate that the PEP is able to lift the water at 10 metres depth (an unsustainable maximum that does not ensure the durability of the PEP). Although no specific maintenance-related information has been related to water depth it can be said that the optimum utilization of the PEP is 3 to 5 metres depth on a regular basis. However, farmers obviously are trying to adjust to the variations of the water table.

Laboratory tests

The PEP has been designed by engineers in Switzerland as innovative technology farm equipment that combines low cost, easy maintenance and ergonomics. The technical performances of the PEP has been established under laboratory conditions in Switzerland and reinforced by additional tests that have been made by Orissa University. The PEP was then introduced in the field and its performance tested under field conditions.

The PEP is a suction pump so that the human energy requirements are related primarily to water lifting efforts. It has been found through tests that the maximum lifting is 7 metres which corresponds to a maximum discharge of 80 l/minutes (1.3l/s), as reported elsewhere.

The relationship between power, water depth and discharge is shown on the graphics below.

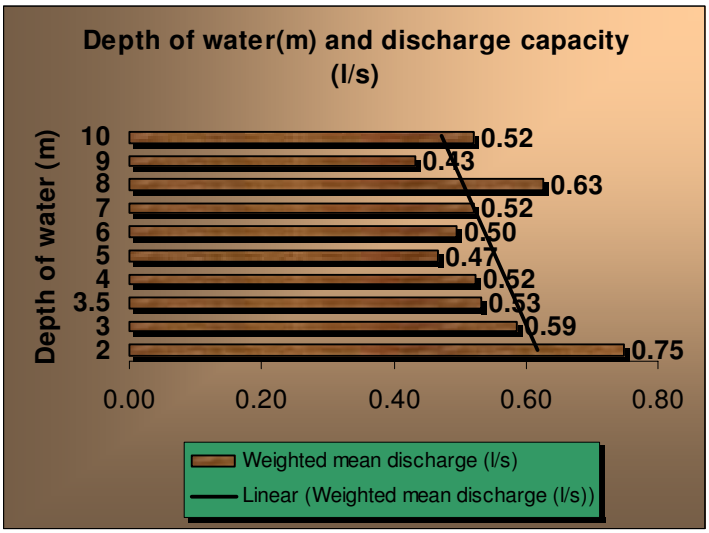


Figure 3.1*:* Power-Depth-Discharge relationships

Age of pump

As presented earlier, based on the introduction of the PEP in India, the oldest pumps would have at the moment 6 years; but about half of the pumps are only two years old. There was no specific analysis done in the survey to determine the performance of the pump based on the age. In general, the owners have been satisfied with the equipment as reported elsewhere and maintenance has been relatively minor.

Area covered

From the surveys it is learned that the areas of farmers using the PEP is seldom above one acre. However, this information needs to be considered carefully as very often the PEP is used to cover only a portion of such a field. The surface serviced under the PEP is in all cases a function of the availability of water, its location in relation to the field and the alternatives to irrigation that the particular farmer may face. The areas under private farmers are somewhat larger, ranging from one to three (1-3) acres, but again subject to the same parameters just discussed for farmer groups. As a comparison, information from Orissa State indicates that the land holdings for marginal farmers stand at 0.50 acres, with small and medium farmers set at 1.80 acres. The large farmers, on the other hand, report an average holding of 6.4 acres.

4. Maintenance

Training to farmers

As the PEPs were distributed as part of emergency projects there was less time to prepare formal training for the recipients. However, the pump has been designed in such a way that the regular maintenance is required of only a small percentage of the parts; it has been estimated that 75 percent of the pump is maintenance free. As part of the PEP package farmers receive some very basic tools as part of their training and are shown how to use them during the installation. In addition the installer, normally a person with ties to the manufacturer, shows the basics on greasing, cleaning the foot valve, changing of the piston

ring, etc. This "on-the-spot" training seeks to prepare the farmers to then be able to keep carrying out the maintenance by themselves. In special cases the farmer can approach the W3W for support.

Current Maintenance

The concrete settlement and body of PEP are strong enough for a long lasting utilization but some operating parts such as washer, piston rings and pistons, can be damaged and require regular maintenance and more careful handling. On the other hand, minor maintenance is relatively easy and it is being done by the farmer on a regular basis. Also, there is an on-going effort to always try to simplify the maintenance as further support to users. Thus, the philosophy of the PEP is to eventually achieve the full maintenance by the farmers themselves. This has been observed already in the fields when spare parts have been readily available in the workshops. In Table 3.4 the responses of farmers in respect to maintenance is provided.

Maintenance Aspects	Response
Continuously making problems	1
Easy to maintain	48
Yet no maintenance	21
Grand Total	**70**

Table 3.4: Farmers perception on easy of maintenance

Breakdowns

Data was collected during the survey to identify the weakest parts of the PEP. With respect to washer defects percentage-wise the year 2006 had the highest reports; but the largest number of absolute cases occurred in the year 2005, the year of the highest number of installations. The washer was found to be the weakest part of the pump, as reported by 68.6 percent of users. The study shows that two of every three pumps require washer replacement after normal utilization. On the basis of reports the washer held the first position followed by the small metallic parts and the plastic piston. In general, 11.4 percent mentioned that the PEP had weak parts. See Table 3.5.

Defects mentioned	Reported percentages
Washer problem	68.6
Small metallic parts	32.9
Plastic piston	12.9
Weak parts of pump, in general	11.4
Lever jam	1.4
Respondents had multiple options	

Table 3.5: Maintenance problems reported in survey

The weakness of the washer had been identified even at the concept stage since it is a critical working (movable) part of the PEP. For that reason the breakdowns had been anticipated and already several holes had been made available in order to provide several options on how to fix the washer. This intervention is very easy and can be made by the farmer without any assistance. In addition a new washer can be locally made.

As reported earlier, the introduction of the PEP led to various improvements of the device. In particular, the local salty condition of the coastal area caused damages to the first metal piston version of the PEP which rusted easily. Studies were then conducted to introduce plastic components to the PEP, which replaced successfully the metal parts. The quality and resistance of the plastic were controlled, then tested in the field, and finally locally produced.

Washer showing screw attachment, bottom of piston

General Satisfaction

As per the survey, the great majority of the farmers (67 out of 70) reported to have been satisfied with the performance of the pump, with the remaining 3 farmers in the sample being dissatisfied. The survey further revealed that the weakest link of the PEP system is the workshop network that was not kept active after the pump's distribution. The network has not been able to provide the required spare parts or really provide close supervision to the maintenance process. The workshops and keepers still exist but they have been shifted to other activities dealing with cement or iron work not specifically related to the PEP. This void in the maintenance has been discussed with responsible staff of the OSDMA. A complementary project for the distribution of spare parts allocated to key farmers in charge of the maintenance should be envisaged. Under this setting the spare parts could be sold at a cost to farmers.

The design of the pump is well accepted by the farmer and among the different features the *multi position of pedals* gave the highest satisfaction followed by the suitability of the *concrete settlement* and the advantage of the *equalizer.* With respect to the *wooden pedal* it may be advisable to broaden the pedal resting area so that the foothold will be stronger and the operator can run the pump without any need for external support. Figure 3.2 shows the comfort factor on some of these features as reported by the survey.

From additional questions posed to farmers, it was found that the demand for the PEP is high, among the reasons given: its low maintenance cost; the profitability for vegetable cultivation; and the possibility to intensify significantly the traditional cropping system (even the possibility of introducing paddy rice. Among the weaknesses farmers reported: the weight of the pump; that some spare parts need to be replaced but are not readily found in the

workshop (washers is the main example); and finally the tiredness produced to operate the pump in the summer.

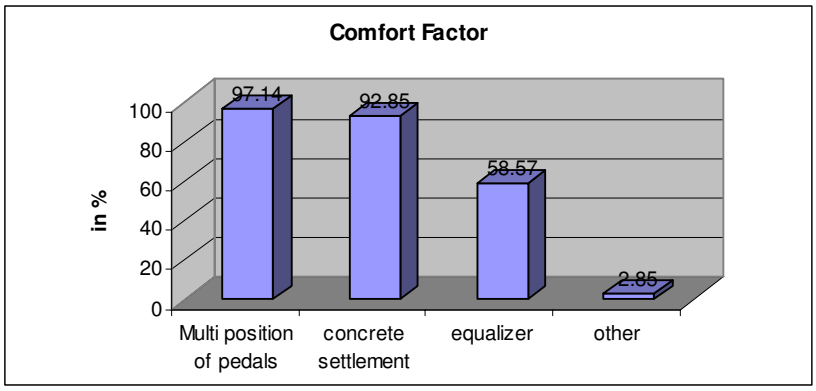


Figure 3.2: Comfort factor of pump features as perceived by farmers

Farmer satisfaction was also analyzed by exploring what buying decision would the farmer take in case of any problem with the existing PEP pump. The survey reveals that 67 percent of the current users would purchase the same pump. Out of those farmer willing to buy the same pump 66 percent have permanent water source and the remaining 34 percent have non- permanent water source, with 76 percent of those farmers having ponds as their water source.

Agronomic aspects

1. Crops

Cultural practices

PEP users are mostly small and marginal farmers that do not use mineral fertilizer in their fields; however, organic manure is available. Some improved seeds of vegetables are available and adopted by farmers since they have already experienced better yield and quality of produce with them either directly or heard from fellow farmers. Normally, they have no access to modern equipment and they prepared their land with family labour or by themselves.

In relation to crops, the survey revealed than more than 50 different crops are grown in the project areas. Paddy rice is a central crop in two districts. Other traditional crops like potato, beans and plantain (cooking banana) are part of the patterns. Horticultural crops are then the core of the patterns with tomato, brinjal, chilli and pumpkin taking centre stage. Others like gourds, cucumber and watermelon appear often in some localized areas.

2. Cropping patterns

The survey in the four districts revealed the existence of large number of cropping patterns in each area. The basis of these cropping patterns is horticultural crops although sometimes other

crops such as plantain can be introduced. In the districts of Jajpur and Kendrapa, paddy rice is the primary crop in the Kharif [rainy] season followed by pulses and vegetables in the Rabi [dry] season. The cropping patterns are based on high market value crops associated with secondary intercrops used as household food. Those high value crops are pumpkins, potatoes, chilli, etc. Farmers combined the possibility of enriching the daily diet and getting cash. At this stage of the introduction of PEP the potential for the increase of income was obvious since horticulture could not be possible prior to the PEP period.

Crop productivity

The agricultural practices were analysed in the four concerned district. The results reflect the income that can be obtained with the PEP but also the specificity of each district. The differences are due primarily to the water availability but also and to certain extent to the ability of farmers to use the PEP efficiently. The crop productivity analysis can be summarized as follows:

- Five cropping patterns were identified in the Ganjam district giving an income varying from USD3 248 per acre for cropping pattern N° 1 (mehed-radish-plantain-palua-tumeric) based on culinary banana to USD625 for cropping pattern N° 5 (tomato-saru) based on tomato. The cropping pattern N° 1 is based on high value market oriented crops, while other cropping patterns are directed to household consumption which improved significantly the quality of the daily diet.
- Six cropping patterns were identified in Jagatsingpur generating an income ranging from USD578 per acre to USD244 per acre. Brinjal and pumpkin are the most valuable crops in this area. However, results obtained here are far below those from Ganjam.
- In the Jaipur district four primary cropping patterns were identified. Paddy cultivation provided the maximum revenue at USD1 457 per acre. Other cropping patterns based on brinjal, lady fingers and chilli reported an income ranging from USD1 099 to USD734 per acre. However, given the relatively high water requirement levels of paddy crop it is not widely advisable for other PEP users. Cropping patterns including brinjal, potato, ladies finger, cabbage, tomato, chilli, onion and pumpkin etc. produced financially viable patterns. These are also better fitted to address water availability, water management practices and the cost of water lifting pumps.
- In Kendrapara four cropping patterns were identified**.** The Paddy based arrangement is a major beneficial crop at around USD390 per acre. Other socio-economically and environmentally suitable cropping patterns included crops like spinach, potato, chilli, ladies finger, peas and pumpkin with gross revenue ranging from USD215 to USD96 per acre.

Paddy crop showed a wide variation in gross revenue in both Jajpur and Kendrapada due to hybrid and improved varieties and agronomic management practices. However, because of the high water consumption of paddy crop, the PEP farmers are not to be encouraged to follow this pattern. The average benefits from agriculture in Orissa reveal that PEP irrigated cropping patterns are substantially better in these two districts than in Jagatsingpur.

On Cropping Pattern in PEP irrigated area

Implementation of all these cropping patterns is possible only due to sustained and affordable irrigation with the PEP. The survey reveals that a small holding supported by irrigation through PEP can generate the capacity to move a poor person out from below the poverty level. (The Below Poverty Level family has an annual income of less than US$300).

In terms of the most suitable (profitable) cropping patterns those in Ganjam appear the best followed by Jajpur, Jagtsinghpur and Kendrapada. The success is a function of intensive crop planning, labour input and attitude and effort of the concerned farmer. These traits are to be encouraged and transferred to PEP farmers in other localities; through proper training and extension services. Farmer training and exposure based on Ganjam and Jajpur conditions should consider farmer category, farming situation, landholding size, financial capacities of farmer and the input and product prices in the market.

Economic aspects

1. Benefit-Cost analysis

Costs

In Orissa State the average cost of the PEP was estimated at US$50 (roughly INR2 000), based on local production. In addition, it is necessary to include the cost of transport for the installation in the field. Likewise, other costs such as training of technicians, mobilization of qualified personnel, etc. are not included. Unfortunately the PEP was never advertised for sale and farmers were provided with a free (no cost) pump and assisted from the beginning to end including the transport of the PEP concrete settlement to the field. This was verified when the survey revealed that the vast majority of the respondent (97 percent) did not have any idea about the cost of the pump.

Profitability

Through the survey an attempt was made to establish the relationship between PEP irrigation and the average income/acre. In order to do this, both the 20 lowest and 20 highest incomes per household recorded for 2005 and 2006 were selected for the analysis; the results are discussed below.

In the case of the 20 lowest income households with the PEP, the average income per acre was only US$7.74 (Rs309.80) and interestingly the average landholding was rather high at 2.75 acre. However, only 9 farmers have less than 2 acres, 11 have more than 2 acres with 3 having more than 5 acres The PEP irrigation covered a little over 23 percent of the land.

On the other hand, in the case of the 20 highest income households per acre the average income was relatively high at US$200.21 (Rs8 008.41) and where the average land holding was only 0.833 acre. In these cases the PEP irrigated 69.5 percent of the holdings on average. For the small and marginal farmer of these 20 highest income group the size of the farm varies from 0.08 to 3 acres. The majority of farmers own less than 0.5 acres, and only 4 farmers were using other means of irrigation besides the PEP.

The previous results imply that there is a strong correlation between small farm size, higher income and the use of PEP. This analysis would need to be carried out further in depth for a better understanding: the smaller the field the better the farmer's results. It can probably be advanced that the farmer has better control the smaller the land and the PEP can be better managed and hence made more effective. The PEP is used and valorised by the vegetable cultivator as 68 of the 70 PEP users cultivated vegetables.

Although no market price per unit of production were collected as farmers were either reluctant to provide that information or claimed not to have the information at hand, those

gross production income were taken as a lump sum for each cropping system and then linked to areas irrigated with the PEP. When compared to the level of poverty of these farmers the additional income contributes significantly to the improvement of family daily life; but when compared to the cost of the PEP it seems difficult to expect that farmers can cover those expenses from the farm budget without some sort of financial support.

Socio-cultural aspects

Field Observations

From the survey it was learned that farmers perceive that the introduction of the PEP produces immediate social benefit since it represents ownership of a productive asset and allows control over a crucial productive resource: the water. The ownership of the pump provides a sense of self-confidence and promotes self-reliance. It is also seen as an opportunity for the farmer to free himself from the exploitation of the money lenders. It is also perceived as being able to generate some employment for landless farmers.

Farmer------Land Holding Group	Farm area (acres)	Irrigated land (% of total land)	Irrigated by PEP (% of total irrig.)
Marginal	16.44	63.8	77.5
Small	44.10	51.0	50.6
Medium	27.90	69.9	18.4
Large	32.00	34.4	14.5
Grand Total	**120.44**	**54.7**	**40.2**

Table 3.6: Ownership and irrigation by PEP

Table 3.6 shows the PEP ownership versus areas irrigated by PEP. The marginal and small farmers are the main users of the PEP, they have a limited access to the irrigation networks and irrigation facilities provided with infrastructure. In addition to those considerations of household size, case studies reveal that sharing the PEP between farmers has been found during the field work.

Gender relations

It has been documented that ponds and wells are the main sources of water in the four states of Orissa. The PEP was designed and funded as an appropriate device to irrigate land owned by small farmers. It is considered to offer advantages when, for various reasons, the householder was a woman with children. Several case studies were undertaken to illustrate the adoption of the device by farmers. One of these case studies was dedicated to a woman getting benefit after the death of her husband. She was able to take care of her three children by using the PEP. The device has been proven suitable to be operated by all family members, including children, providing an easy access to water source at no more than 5 metres depth. It can provide multi-usage like irrigation and domestic water consumption, avoiding human transport of water over long distances. Table 3.7 shows gender relation in the operation of the PEP.

Pep Operation	Reported numbers
Male	36
Female	0
Child	7
M+F	6
All members	28

Table 3.7: Gender relation in PEP operation

Livelihoods
The PEP has proved to be a valuable tool for poverty eradication since most users have increased their income. It has to be reminded that the selection made by OSDMA was based on the poverty level of farmers. The survey has provided evidence that the introduction of PEP has doubled the income in some cases.

There seems to be no doubt that a PEP correctly utilized and maintained can give an additional income to farmers for several years. It has been documented that PEP can last 4 or 5 years and needs a minimum of 2 years for a return on investment. The use of the pump for domestic purposes constitutes an additional benefit and was not included in the income [returns] calculations. Water lifting equipment operated by all family members is a considerable advantage. Ponds and wells not exceeding 7 metres depth become a source of water for agriculture without a heavy constraint.

Obviously the PEP fits well with the need of small farmers; it is an easy alternative to watering with bucket or using traditional water lifting devices. The latter are still kept by farmers aware of possible deficiencies or damage of the PEP.

Institutions
In Orissa the OSDMA was the Institution in charge of supervising the introduction of the PEP. At that time other programmes of treadle-type pumps were on-going. During the survey it was found and confirmed that the PEP was the only remaining programme for low cost irrigation asset in Orissa, with other programmes already discontinued.

In case of reinvestment in PEP in Orissa, the decision should be made to locate the project in Institutions that can support technically the programme. It seems that the agricultural sector could be the appropriate Institution with a specific attention to horticulture and agricultural inputs such as improved and certified vegetable seeds.

2. TANZANIA

<u>Technical aspects</u>

1. **Management**

The (PEP) pump in Tanzania
The PEP was introduced in Tanzania exclusively by the Non-Government Organization W3W (Tanzania) and cannot be purchased directly in the market. The main manufacturing workshop of W3W was established in 2001 in the town of Morogoro.

The evaluation survey covered the PEPs installed under FAO's Special Programme for Food Security Programme (SPSF) financed by the Swiss Government and targeted primarily the so-called participatory farmer groups (PFG) and some private users. For a few years now the pump is being distributed through other mechanisms (NGOs such as World-Vision and Caritas or micro credit with SACCOS (Saving And Credit Co-operatives)). The NGO estimates that 600 PEP were installed in Tanzania, available at the web site: [http://www.w-3-w.ch/english/pep_general_information_tz.pdf]

How are the pumps installed?

The way the NGO operates in Tanzania is as follows: the W3W Morogoro office promotes the pump and selects manufacturers (often former farmers, carpenters or mechanics) that show interest. The NGO then trains them on the production of the pump, its maintenance and how to carry out demonstrations. The NGO helps manufacturers establish a small workshop, providing them with toolkits and moulds on a lending basis with ownership remaining in W3W hands. Currently, there are more than 15 workshops installed in different places around the country. Presently, four different manufacturer "networks" in different regions of the country have been established, namely: Central, Kilimanjaro, Lake Victoria and Islands.

Once trained the manufacturer should be capable of preparing the pump's cylinder block, a key element of the assembly (it takes about a week since concrete should be well cured) and to assemble the pump properly. Often an assistant is needed for this and other complementary activities (such as plumber, mechanic, etc.).

After fabrication the manufacturer brings the pump to the farmer's field. Transportation is a key problem for manufacturers, since some pumps are often installed in remote places. Even if the manufacturer has a bicycle, the transportation of the pump is often cumbersome because of the bad access roads. One common problem met by manufacturers is the lack of proper measuring tools for estimation of the best location for the pump in the field (to measure the proper elevation). Manufacturers train farmers on basic principles of maintenance and provide them with specific tools to allow them to do self-maintenance. The farmer pays in the order of Tsh25 000 (USD22) to the manufacturer for installing the pump.

In Tanzania in the majority of cases the pump is installed on a wooden platform at a height of around one metre. This base is built by the farmers themselves but with assistance from the manufacturer. There are also other types of installation such as a concrete cistern for permanent installation that can provide water directly to a distributor canal.

The pump is provided with a PVC suction pipe (diameter 1.5 inches) with a length depending on the distance to the water, generally ranging from 3 to 25 metres. The pipe would be preferable if installed underground but this is rarely done. There are also several complementary pieces of equipment such as a distribution hosepipe, elbows as needed and a non-return valve or foot valve (generally, but not always in bronze designed to protect the pump against sand).

Finally, a most important element of the entire installation is the accompanying storage system that is assembled just after the pump. Normally, it consists of a 200-litre drum but it can also be a bigger storage facility (such as a 2 m^3 metallic tank). A typical PEP installation with wooden platform is shown in Figure 3.3 while two other types are shown in the photos.

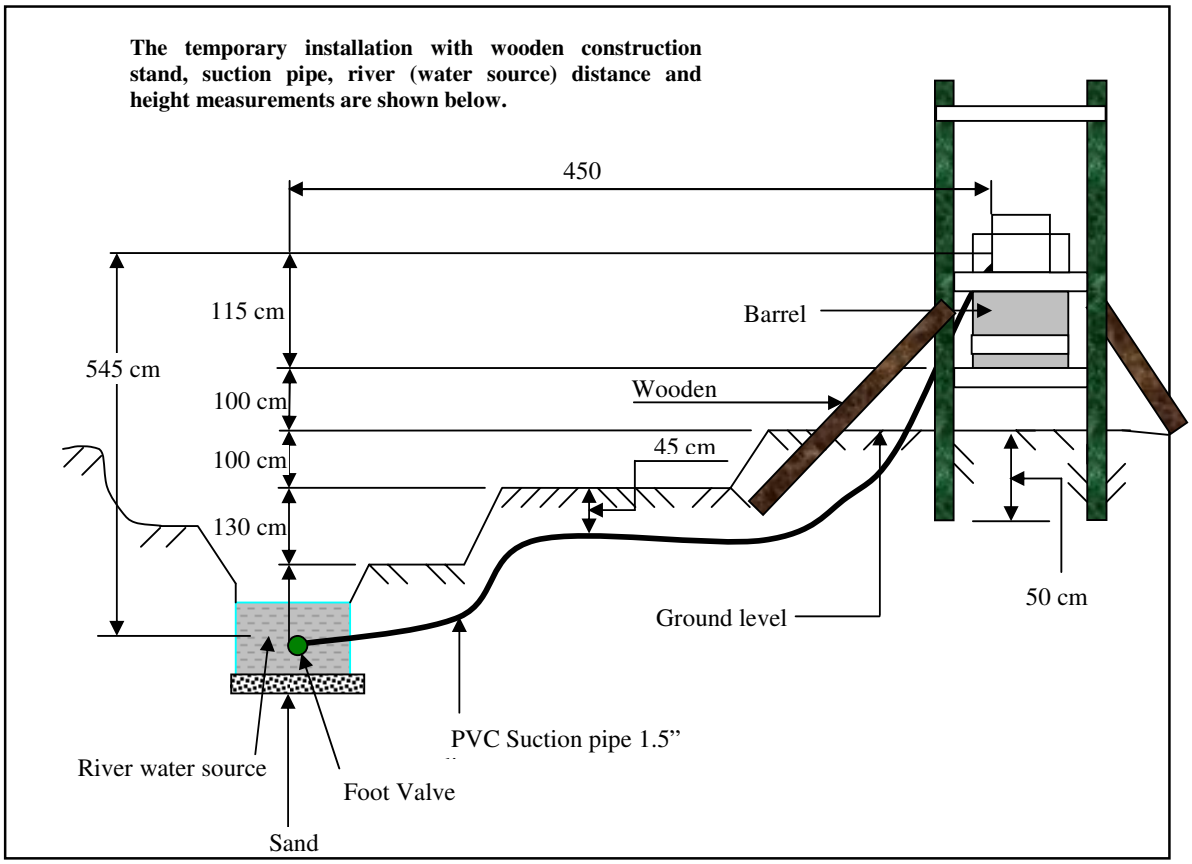


Figure 3.3: Shows details of wooden installation

Mobile system

Permanent installation

Two types of PEP installation

2. Field observations on PEP utilization

Profile of Pump user

Observations were made both by the national and external consultants who visited in total 40 sites. These were either private (43 percent) or belonging to farmer groups (57 percent); about half of the 279 people contacted were women.

The typical current PEP user belonged to a group of poor farmers using traditional water buckets before the introduction of the pump. Only a couple of them were using diesel and petrol pumps before. Interestingly enough, most groups are still using also traditional buckets to irrigate their crops in complement to their PEP. The main usage of the PEP is for irrigation but sometimes it includes its use for domestic purposes as well and (less frequently) livestock and brick-making.

Water source

The pump can be utilized with different sources of water. In this case, it was mainly wells (40 percent) followed by rivers (37.5 percent) with 10 percent from irrigation canals, 5 percent from ponds, 5 percent from springs and 2.5 percent various others. The water source is generally permanent but sometimes it can also be semi-permanent or even non-permanent (dries up every dry season), but the pump is well adapted for these changes.

Pumping duration

The time the pump can be run continuously is of key importance for the estimation of application rates and the total area that can be irrigated. The majority of respondents operated their pumps less than one hour with a few operating up to one hour continuously, the longest time (in 2 cases) being greater that 4 hours.

Storage system

The size of storage is obviously very important to the previous parameter. For example, a 200-litre drum can be filled between 2 and 3 minutes depending on who is pumping and it takes from 8 to 20 minutes to empty depending, among other things, on the distance from the drum to the point of application, the gravity head and size of hosepipe (if using pipe). Under such an arrangement of duration of pumping mentioned above, and depending on the size of the plot and soil conditions, 6 drums could be needed to be used twice per day). On average, there was a time buffer of about 15 minutes between filling and emptying of the drum.

3. Performance

Discharge

The maximum discharge measured was 93 l/min and the minimum discharge was 35 l/min with most pumps having their discharges around the mean (66.6 l/min). The variation in discharge is attributable to distance from the water source, lifting head, foot valve condition, suction pipe and fitting condition, the person pumping and, indirectly, the general maintenance of the pump facilities.

Water level changes and lifting (pumping) head

Most water sources were found varying seasonally leading to fluctuations in pumping head. As can be expected pumping levels are deeper when it is very dry and shallower during the wet periods.

The total operating head was found to range between 1 and 10 metres, with the majority operating at a head of 3 metres. Generally, most pumps were within the recommended operating head of less than 7.5 metres which is regarded as the upper limit of a beneficial operating head. During dry periods the water source can get deeper even sometimes reaching 9 metres from ground surface but the pump still can pump water.

Age of the pump

The oldest pump was installed in 2001 (6 years). Six are 4 years old. They are generally between 20 and 35 months old, mostly installed in the late 2004 and 2005. The majority of the pumps visited are in good pumping condition and performing well despite some few minor faults. In Table 3.8 the age and pump discharge parameters found in the survey are provided.

	No. of respondents (N=40)	Minimum	Maximum	Mean	Std. Deviation
Age of pump (months)	40	1	74	27.32	17.29
Measured discharge (l/min)	30	35	93	66	0.25

Table 3.8: Statistics for age of the pump and measured discharges

Area covered

The NGO W3W-Tanzania advertises an irrigation potential ranging from 1 to 2 acres as a function of distance of the water source, pump maintenance and conditions, etc. Notwithstanding the above, for this particular case field visits documented an average irrigated area of 0.66 acres for PFGs and 3 acres for private entrepreneurs. What is more interesting is that the introduction of PEP increased the irrigated surface by 36 percent for PFG and by 13 percent for private (between 2006 and 2007).

4. Maintenance

Training to farmers

As indicated earlier farmers receive some basic tools (screwdriver, wheel spanner) as part of their training. In addition the manufacturer provides training in basic maintenance: greasing, cleaning the foot valve, changing of piston ring, etc. The main objective of the training seeks to prepare the farmers to be able to carry on these basic functions by themselves. However, if they have problems they can always seek support from the W3W pump manufacturer. It is interesting to note that on these latter occasions farmers do not want to spontaneously pay for the service. It has been recorder that some have provided Tsh2 000 but generally they are only willing to provide some food or transportation to the repairman.

Current maintenance

There is generally no provision for preventive maintenance but some manufacturers indicated that they are visiting the farmers from time to time. In terms of actual maintenance provided so far the most common part needed to be repaired was the plastic ring piston which is

normally designed to wear, followed by the wooden pedal leg, and plastic rubber valve, while others (piston, equalizer, equalizer support and cylinder) were sometimes quoted.

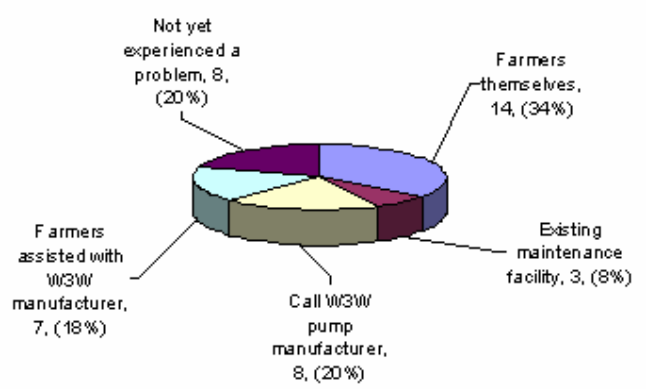


Figure 3.4: PEP problem solving

Breakdowns

Most pumps have not yet experienced any major breakdowns. The only breaks reported by farmers are the piston, rear block, cylinder and pedal leg. Minor breaks concern mainly the piston ring, followed by seat valve and pedal leg. It is interesting to note that many pumps visited and which have not yet experienced a break are more than 4 years of age. It is clear from the respondents that PEP pumps are strong and durable and could last long. In Figure 3.4 some of the alternatives to problem solving recorded are shown.

General Satisfaction from users about maintenance

The ability of an individual to perform maintenance of a particular system depends on the training received. In addition to that follow-up and continued guidance, especially for farmers, are very important. The majority of farmers view PEP maintenance as being easy to implement. The great majority of the respondents considered PEP to be the most reliable pump (compared with others). When asked what they would do in case of pump failure many indicated that they would consider buying a new one. For manufacturers also the pump is very robust, even more reliable than other existing treadle pumps. The findings of the study suggest that this technology can also be widely accepted by farmers for horticultural production and domestic water supply. Table 3.9 records farmers' opinion on how easy the perceive maintenance of the pump.

Response	No. of respondents (N=40)	Percentage of N
Easy to maintain	33	82.5
Yet no maintenance	7	17.5
Total	40	100.0

Table 3.9: Farmers' opinion on PEP maintenance

Agronomic aspects and profitability

1. Crops

Horticultural crops grown

Around 25 different crops are grown in the study area; among them tomato is of high priority. However, marketing tomato is often a problem either due to oversupplies/surplus in the market or poor infrastructure (roads) which lead to large losses. The other most common crops grown are African eggplant, Amaranth, *Chinese*, okra and sweet pepper. These are frequently grown by farmers for their own consumption and regarded by the families as highly nutritional; but also for their good market prices.

Finally, other crops found in the area are banana, papaya, passion fruit, Onion, sweet potatoes, cowpeas, carrots, cassava, zucchini/marrow, turnip, maize, coriander, watermelon, spinach, *Chinese*, cucumber, orange, pineapple and African nightshade. The richness of the crops grown in the study areas can be seen in Table 3.10 where the importance given to particular crops are also shown.

Number of crop cycles and growing seasons

The number of cycles depends on the type of crops grown and the climatic conditions. There are some places where vegetable production was carried out throughout the year regardless of the season. Most of these included Amaranth, African eggplant, eggplant, okra and *Chinese.*

Water availability allows multiple crops to be grown within a growing season and some of these are repeated more than once within the cycle. For example, Amaranth has a three-week cycle to harvest. On average, each month Amaranth is being planted and harvested; thus in a year it can be grown 12 times signifying a twelve-cycle crop.

In general, the number of crop cycles has increased following the introduction of the PEP pump. Indeed before the pump, it was hard to have more than one crop cycle for crops with a growing period of more than two months before their harvest. After the pump was introduced the cycles have tripled as water is now made easily available through use of the pump. Farmers have realized that the pump not only allows them to increase the number of crop cycles but also it has ensured timing of crop harvesting at a time when it fetches the highest price.

Before the introduction of the pump, farmers had to wait until the rain fell and thus plant the crop just like everybody else. Thus, all farmers would then harvest at the same time lowering the prices due to high supply. Thanks to the pump, they can plant slightly earlier than the rest such that their crop would hit the market before and fetch higher prices. The crops grown are also of higher quality due to a more efficient water management and therefore cultural practices.

Type of Crop	DISTRICTS																		
	Mbarali	Mbeya rural	Kilolo	Dodoma Rural (Chamwino)	Kilombero	Morogoro Municipality	Mvomero	Temeke	Chakechake	Wete	North Unguja	West Unguja	Korogwe	Bukoba urban	Misungwi	Magu	Musoma	Musoma urban	Tarime
Tomato	xx	xxx	xxx	xx	xxx	xxx	x	xxx	xxx	xxx	xx	xx	xxx	xx	xxx	xxx	xx	x	x
Banana	0	0	0	xx	0	0	0	0	0	0	0	0	0	xx	0	xxx	x	0	x
Papaya	x	xx	xx	xx	x	xx	0	x	x	x	x	x	x	xx	0	x	x	x	x
Sweet pepper	x	x	0	0	xxx	xx	0	xx	0	xxx	0	0	xxx	x	0	0	0	0	0
Eggplant	xx	xx	xxx	xx	xxx	0	0	xx	xx	xx	xx	x	x	xx	0	0	0	0	0
Passion fruits	0	0	0	0	0	0	0	xx	0	0	0	0	0	0	0	0	x	xx	0
Onions	xx	xx	xx	0	0	0	0	x	0	0	0	0	0	xxx	0	0	0	0	0
Cow peas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	xxx	0	0	0
Maize	xx	xxx	0	0	0	0	0	0	0	0	0	0	0	0	xx	0	0	0	0
Sweet potatoes	0	0	0	xxx	x	0	0	0	0	0	0	0	0	0	0	0	0	0	xx
African eggplant	xx	xxx	xxx	x	xxx	xx	x	xx	x	x	x	x	xx	xx	0	x	x	x	x
Carrots	x	x	0	0	0	0	0	0	0	0	0	0	0	xxx	0	0	0	0	0
Cassava	0	0	0	xx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cucumber	x	x	x	0	x	0	0	x	0	xxx	0	0	0	0	0	0	0	0	0
Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	xx	0	0	0	0	0
Pineapple	0	0	0	xx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turnip	xx	xxx	x	0	x	x	0	0	0	0	0	0	0	xx	0	0	0	0	0
Coriander	0	0	0	0	0	0	0	0	0	0	0	0	0	xxx	0	0	0	0	0
Watermelon	0	0	0	x	x	x	0	xx	0	0	0	0	x	x	0	0	0	0	0
Spinach	x	x	0	0	0	0	0	x	0	0	0	0	0	x	0	0	0	0	0
Chinese	xx	xxx	xx	0	xx	xx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	0	0	0	0	0
Okra	xx	xx	xx	x	x	x	0	xx	xx	xx	xx	xx	xx	xx	0	x	x	x	x
African nightshade	xx	xxx	x	0	x	0	0	0	0	0	0	0	xx	0	0	0	0	0	0
Amaranth	0	0	0	0	xx	x	0	xxx	xxx	xxx	xxx	xxx	xx	xx	x	0	x	x	x
Zucchini	0	0	0	0	0	0	0	0	xx	x	0	0	0	0	0	0	0	0	0

xxx = high priority crop; xx = medium priority crop; x = least priority crop; 0 = not mentioned

Table 3.10: Vegetables and fruit crops grown, from survey

Economic aspects

1. Costs and Benefits

Production per area

Unfortunately, it was not possible to collect this data since farmers reported that they had not kept this type of information. Farmers paid much more attention to information related to their expenses and revenues.

Costs of production

The cost of production per season includes costs for paying wages and buying inputs. Likewise, they include costs associated with land preparation, seeds, nursery preparation, transplanting and planting, watering, weeding, fertilizer, pesticides, spraying, harvesting and transport. These costs varied among individuals and farmer groups. The variations in costs correlated with the farm size, the type of crops grown, location and number of crop cycles.

The cost of production was generally high due to high costs of fertilizers and pesticides. Frequent attack of tomatoes by pests in some areas was reported by farmers. The number of times that a crop is sprayed has increased as compared to periods when there were no attacks. The increased price for fuel has made hiring of tractors difficult and farmers have to depend largely on hired labour.

Costs of the PEP

Information obtained from W3W places the cost of the pump for farmers ranging from Tsh 90 000-110 000 (USD71-89) excluding installation and accessories. The cost with full equipment it ranges from Tsh150 000 to 200 000 (USD122 to 161). The data obtained from the survey revealed that based on revenues most farmers (groups or private) were capable of buying at least one pump after a full growing season.

Gross returns

Total benefits are considered to be actual amount of money that is put into people's pockets at the farm level after subtracting the costs. The two years, 2005 and 2006, were considered for this analysis. On average, 0.17 hectares were cultivated by PFGs in 2005 and increased to 0.27 hectares in 2006 indicating a 36 percent increase in the area under cultivation in one year. For private a entrepreneur, the average area cultivated in 2005 was 1.06 hectares and increased to 1.21 hectares in 2006 indicating a 13 percent increase. In general, the gross margin values indicate that almost all the groups and individuals (private entrepreneurs) benefited from PEP during the period. See Table 3.11 below.

	Area cultivated (ha)	Total Revenue (Tsh)	Total Costs (Tsh)	Gross Margin (Tsh)	Gross return to an average farm (Tsh/ha)
FARMERS GROUP					
Average 2005	**0.17**	**1 059 645**	**158 470**	**1 018 913**	**5 993 606**
Average 2006	**0.27**	**1 098 859**	**182 859**	**916 000**	**3 392 593**
PRIVATE					
Average 2005	**1.06**	**2 544 667**	**474 667**	**2 070 000**	**1 952 830**
Average 2006	**1.21**	**2 261 333**	**353 000**	**1 908 333**	**1 577 135**

Table 3.11: Gross returns for PEP farmers (1 USD= 1 265 Tsh).

Revenue from sales

Detailed information on the revenues of sales was scanty. However, it was possible to get better information on retailed prices by products. For example, for tomatoes the wholesale price ranged between Tsh350 and 600 per kilogram depending on place and season. The retail price, again in function of place and season, ranged between Tsh500 and 900 per kilogram.

2. Variation between farmers' categories

Variation in gross margins among PFGs and private entrepreneurs was mainly due to the differences in areas cultivated, type of crop grown, marketing conditions and other factors such as soil-related problems, outbreak of diseases, reliability of the water source or occurrence of floods. Another problem reported which is related to production was inadequate extension services.

Socio-cultural aspects

1. PEP ownership and adoption

In relation to reasons for ownership and adoption of PEP, all respondents (100 percent) revealed that the PEP without a doubt delivered higher discharge in comparison to traditional systems - mainly buckets. One of the main reasons cited by respondents was that PEP reduces the travel distances between the water sources and the application point unlike other traditional methods. Consequently, the use of PEP was believed to relieve the user from tiredness associated with higher number of trips to fetch water. Also, a high reason for pump adoption seems to be the fact that it ensures higher crop production.

Actors involved
Peddling operations can be handled by almost everyone (including children) although sometimes aged people have limitations. Many operators acknowledged the fact that they enjoyed peddling the pump not only because it helped them by providing a business opportunity in their farms but also because it gave them a chance to exercise for their physical fitness. Sometimes the argument of bringing coherence in the family was put forward.

Comfort
The ability to handle pumping operations was associated with comfort during pumping. Comfort in this case is regarded as a sensational feeling of an individual during peddling. The survey revealed that in relation to comfort, feelings varied between individuals and among groups. About 72 percent felt the pump was very comfortable, flexible and easy to use, 18 percent felt the pump was comfortable because of its stability due to its concrete settlement and the remaining 10 percent perceived the pump as hard and very difficult to pedal.

Overall satisfaction
Despite observed anomalies and variations among various groups and individuals, 95 percent of PEP users felt the equipment to be satisfactory, and a more reliable technology than the traditional methods. Finally, they saw it as a way of small farmers advancing on poverty through horticultural crop production.

Awareness on costs for equipment and maintenance
The cost of the PEP was often known but many respondents were not aware of the costs of other types of pumps like Diesel or Petrol or of their costs associated with maintenance, etc. and therefore cost comparisons were not readily forthcoming. Only 2 respondents (5 percent) thought of upgrading to diesel or petrol, provided that they would have money to cover the associated costs. This suggests the trust farmers have in their PEP as opposed to other alternative pumps. Some farmers had already bought a petrol pump but could not use it because of the increased cost of fuel and resorted to continuing using PEP.

2. PEP dissemination

Number of pumps

The number of pumps manufactured and installed can be seen among the indicators to assess the adoption of the PEP technology. The number is also related to collaboration between manufacturers District Action Officers and NGOs such as World Vision (able to buy 40 pumps in the Korogwe district) or Caritas (Mwanza district). Based on the interviews of manufacturers and the central workshop in Morogoro it is assumed that 370 pumps have been disseminated. The NGO W3W estimates that around 600 pumps are functioning in the country at present.

Institutions

According to discussions and observations in the field we concluded that there seems to be a lack of support from the Ministry of Agriculture at national level but a strong support from extensions officers who are engaged in the PEP installation. It is perhaps that this activity is too small to draw the attention of the Ministry. However, it is felt that in the case that the utilization of the PEP was to expand, there is no apparent reason why the governmental organization would not be prepared to step up its support.

CONCLUSIONS AND RECOMMENDATIONS

Adoption

In the case of the India intervention there was a pressing need to identify opportunities, constraints and appropriate actions on water-lifting technologies for agriculture in the region. The successful use of surface and groundwater by resource-poor families depended greatly upon their access to appropriate low-cost water-lifting technologies and the availability of suitable sources of water. In this context the PEP had come to the rescue of the farmers since it is mostly helpful for the small and marginal farmer. The farmers felt that this device was easy to operate, cost effective and sustainable in nature. All the members of the family could operate it and due to its simple design most of the time it could be maintained and/or repaired by the farmer himself. The efficacy of the PEP was well accepted by the farmer so the future trend for adoption is promising. However, to establish it fully among the farming communities some further development has to be done, in particular on improving technical specifications and ease of effecting repairs and maintenance. Of great importance for increased pump adoption will be the need to improve on its marketing and linking these plans with Government policies for potential subsidies and providing credit facilities.

In the case of Tanzania, effective promotional methods were fundamental towards technology adoption. The PEP was promoted through demonstration sites, leaflets, agricultural shows, traditional dances, and word of mouth from friends, relatives or neighbours. Promotion of the pump through the Participatory Farmers Groups themselves was considered by the project to be an appropriate mechanism and in the process a means of ensuring food security to farmers. However, success in technology promotion through these groups depended on many factors. Variability in creating suitable awareness among different farmer groups was reflected by inadequate extension services and partly due to group dynamics. Generally, how the groups were formed and the expectations of the groups reflected on the promotion achievement. Some PFGs had other alternatives for their

livelihoods and felt more secure with the original arrangement, thus the introduction of the PEP for horticultural crop production to these groups was regarded as additional work rather than a means for increasing their food security. Thus, in some cases groups adopted the pump but after a short period they stopped production when the returns meant extra work and there was little or no extra extension service support.

Related to Indian efforts

The use of the PEP by small and marginal farmers can result in a remarkable improvement of their situation with regard to:

- yields of traditional subsistence crops can be boosted, due to a regular and reliable water supply;
- the cultivation of HYV gets within the reach of the rural poor as the water scarcity factor is minimized; and
- loss of entire crops, due to unexpected dry spells during the monsoon season, can be avoided since supplementary irrigation can be applied at any time; this option remains viable on an individual farmer basis with no additional direct costs involved, once the pump has been made available.

The future pump network should be based on pilot farmers already identified during the survey. The distribution and maintenance network should be carefully prepared and disseminated at strategic key points otherwise they could not be reached by farmers. Those farmers belong to the top 20 highest income [Rs 8 000 or USD133.33] and own on average 0.833 acres of land. While they are small and marginal farmers, they demonstrated their capability to deal with a new technology almost without any external support. They are open to innovation and development and able to disseminate results.

The positive socio-economic impact of PEP technology for the small and marginal farm-families is significant. There is potential for further dissemination of PEPs to poor farmer households in the Orissa State and other parts of India. Ownership of PEP by small and marginal farmers means ownership of a productive asset and control over a crucial productive resource, namely water. It also means freedom from the exploitative patterns of moneylenders and pump owners who often force them to accept unfavourable terms and conditions for water use.

The PEP offers the following advantages among some economic-related factors:

- Timeliness and intensity of irrigation are under the farmer's control. He does not have to rely on other parties for the access to the water resources.
- The labour cost for irrigation with PEP is much lower if compared with the energy cost of mechanised irrigation.
- PEP is a labour-intensive and capital-saving innovation. It saves the most expensive and scarcest resource (capital) and mobilizes the abundantly existing resource of labour.
- PEP is an innovative technology with a high return on capital invested. Farmers relying on credit can repay it after one or two harvests as intimated from the survey.

Related to Tanzanian efforts

The locally achieved impact of the use of PEP-technology is significant thanks to the positive adoption of the pump in the selected PFG areas under the umbrella of the FAO Special Programme for Food Security as well as in the NGO-related areas. Results are visible in terms

of improved food security, decreases in poverty, income generation at farm sites and job creation opportunities in manufacturing. A countrywide expansion supported by Government and Donors is a great challenge and could definitely promote countrywide increases in the productivity of agricultural produce and employment thanks to an enhancement of small-scale irrigation with use of the PEP.

Findings have indicated that the adoption of PEP technology by farmers can make considerable contributions to food security through increased horticultural production and thereby reduce poverty. This horticultural crop production has increased since the start of the project and this is reflected in the increased incomes of groups and/or individuals. Some groups have opened bank accounts and some joined SACCOS (Savings and Credit Cooperatives). Also because of the increased opportunities some groups have diversified their activities by opening small kiosks or shops.

The project succeeded in ensuring food security to beneficiaries. There is a general declining trend of food shortage in the project area and the surrounding communities. Improved extension services have contributed significantly to increasing agricultural productivity and production in the areas of influence. Nevertheless, there is still lack of adequate training and mechanisation in small-scale irrigation technology countrywide which hinders the diffusion of pedal pump technology.

Finally, improved community interactions became obvious through the project, as farmers informally exchanged knowledge on farming techniques. It is evidence of improved interaction between communities, for example in the Islands where farmers exchange knowledge on overcoming pests by using traditional methods (use of bitter and "bad" smelling plants). Also, collective decision and planning has increased social coherence among the members. At the family level, the project has enhanced togetherness and mutual planning.

Recommendations

The following general recommendations are the result of the PEP survey:

On more technical matters

The farmers have been able to learn how to operate and maintain the pump rather quickly. While they received very basic training at the time of pump installation very few got any "refresher" or additional support. The farmers learn by doing and by talking to other farmers. This approach is highly recommended because it also opens up considerable communication channels among farmers and reinforces social interactions.

On pump spare parts

Main body pump parts available within the reach of manufacturers would lessen the time it takes to produce a pump. Also, other spare parts like piston rings and the bottom valves should be provided or made available at the time of sale. This can shorten time wasted in looking for replacement and the time saved could be put to other beneficial use."

On Training

Training on horticultural crop production should be emphasized to improve crop production. Likewise, training on effective use of the pump should be strengthened. For example, training on pump operations and maintenance to make it easy for entrepreneur to repair the pump on

the farm without having to go to the manufacturer and save crop from failure in the case of pump malfunctioning is required.

Farmer training: formal and field-oriented; participation of women

Regarding General Extension Services

Foremost, regular extension service to farmers is necessary to provide basic crop production information, of particular importance will be to ensure technology adoption of new low-cost technology like the PEP. Since there seems to be considerable possibilities for strengthening horticultural crop production, more support and institutional strengthening will be required to ensure extension services to all the communities involved or with potential to be involved in this particular task. Pilot farmers should also be supported by the agricultural extension services and in charge of field demonstrations, experiments and trials. Agricultural inputs should have to be available (improved seeds, fertilizer) to obtain the highest return.

Regarding Credit

Provide loans to farmers through a special arrangement and possibly through existing credit schemes to enable farmers buy pumps and agricultural inputs. This should take the form of a hire-purchase program as many people who are willing to buy the pump cannot raise the required amount at once. Having such an arrangement in place would make it possible for many people in the rural area to own a pump. Micro-financing mechanisms have to be introduced since the PEP will be sold at cost along with the spare parts. This financial mechanism is the cornerstone for the development of PEP. On the other hand, if the PEP is provided free of cost, the beneficiaries should be carefully selected and they should be committed to use the PEP.

Market for the produce

Farmers should be helped to market their produce by building their capacities, also value adding should be considered as a way forward towards improving farmers' income and poverty eradication. Crops like tomatoes (perishable crop), fails to fetch good market prices when the supply becomes higher than the demand causing farmers to sell at very low prices, thus making less realization of the technology impact. A partially market-oriented production should ensure the sustainability of the PEP programme.

A NOTE ON POTENTIAL FOLLOW UP

The implementation of the project revealed that in both countries, India and Tanzania, farmers have in general been pleased with the introduction of the PEP as a relatively new technology into their farming systems. In many cases, the surveys revealed a direct positive impact in farmers who used the pumps to support their traditional practices by removing the water-scarcity risks, or improve on their cropping patterns with the introduction of horticultural crops, or were able to use it for drinking purposes or in some cases to utilize the pumps for non-agricultural purposes like making bricks. All these options resulted in an increase in the farmers' income albeit over a wide range: from almost nothing to a significant amount as compared with the "without" pump situation. Thus, it can be concluded that the PEP technology if properly dealt with could have a real impact in those areas.

As it is usually the case when dealing with irrigation matters, the PEP-using farmers faced a number of constraints that went far beyond the irrigation technology itself. Such constraints like, for example, the difficulties in being able to buy the pumps due to lack of credit mechanisms, or the weak or non-existent support services to advise on cultural practices; proper agricultural inputs; the lack of suitable capacity development related aid that can support farmers in utilizing the best practices already available, very often supersede the advantages provided by the introduction of the technology and becomes a real constraint towards smooth farmer adoption and/or adaptation of the same.

The activities undertaken by IPTRID on the project sites were able to provide a good understanding on how the PEP is being utilized by farmers, what are the constraints being faced and what are the prospects for further expansion of this type of technology. The reader can readily understand that the areas of influence of the PEPs in each country are simply too small to be able to derive general conclusions as to how far the technology could go. However, the activities have provided a very good insight as to some of the issues that need to be tackled seriously if an expansion of the technology is really a goal. Another significant constraint faced by the IPTRID activities was the lack of suitable data information - in both amount and quality. To put it simply, the farmers involved have no reason to keep track of any kind of intervention that derived from the introduction of the PEP. In the best of circumstances the farmers' surveys made a "recollection" to the best of their abilities as to what had taken place during the growing season when the PEPs were utilized.

The preceding paragraphs show that any general conclusions drawn as a result of the interventions are based more on the field experience of the participating professionals or technicians and less on the figures or numbers derived from the intervening activities. Nevertheless, it should be clear that the Project, as implemented, provided exciting information to be able to shape future activities in support of the expansion of the PEP in the respective country areas and beyond.

In consequence, IPTRID feels strongly that lessons learned in this Project can be the basis for a subsequent intervention, whether in these two countries or others to be proposed, that would be directed to select a group of innovative farmers willing to try out this new technology and have parallel and consistent support in order to remove constraints that are now well identified and understood. This new project would be designed to cover the introduction of the pump from start to finish, having a permanent extension service type provided by the Project and where more proper documentation could be obtained allowing a

more scientific evaluation on the technical, economic and even social parameters that can influence PEP adoption under more controlled field conditions.

FINANCIAL REPORT

The officially approved Project Budget was USD98 050 (see Table 6.1). In accordance with the Project agreement signed between the Swiss Government and FAO, on behalf of IPTRID, on 19 December 2006 the disbursement was to be done in three instalments (also linked to Project reporting) as follows: USD29 000 in the year 2006; USD45 000 in the year 2007; and USD24 050 in the year 2008; all three within an intended project period of 15 months. The first instalment was disbursed on 26 December 2006 and the second one on 15 July 2007. Table 6.1 has been prepared indicating the actual and committed expenses made up to 30 April 2008 which is the closing period covered by this Final Report.

A total amount of USD98 050 has been spent representing 132.5?? percent of funds disbursed until now and representing 100 percent of the total Project approved budget. The table presented is self-explanatory. The expenses correspond to efforts undertaken for activities in both India and Tanzania. With the exception of the line items related to professional staff and international travel costs, line item expenditures have been kept pretty much in line with the initial amounts budgeted at project submission. With regard to staff, IPTRID made an effort to keep expenses lower than projected by contributing some time of its staff travel at no cost to the project. On the other hand, it should be noted that the high amounts of transportation costs have coincided with international air traffic cost increases and with new regulations established by airlines which provide very little flexibility when travel had to be undertaken during certain "window periods" in line with Project needs. To offset this overrun, the Project Management has reduced the charges on the IPTRID Secretariat's professional staff as indicated above.

IPTRID anticipates drawing from other sources in order to cover any other expense that might come related to the project after this Final Report has been submitted. For example, IPTRID, at its own cost, is sending a project consultant that did work in Tanzania to an international conference to present his findings. Also, if final cost of the publishing of the Final Report should exceed the value allocated in Table 6.1, the IPTRID programme would finance from its own resources any excess amount incurred.

Thus, this statement of account is herein submitted to the Federal Office of Agriculture in order to request disbursement of the final payment of project allocation in the amount of USD24 050, as per project agreement.

Table 6.1: Project: Survey on adoption and technical performance evaluation of Swiss Concrete Pedal Pump (PEP). All in US Dollars

DESCRIPTION	UNITS	UNIT COST	QUANTITY	Approved Budget	Actual and Committed Expenses as of 30 April 2008 against disbursements** of USD 74 000
		(USD)		(USD)	
Consultants internationally recruited or Secretariat Professional staff	Person-months	12 000	2	24 000	16 731
Retired Experts	Days	150	20	3 000	3 600
National/Local Consultants	Person-months	3 000	2	6 000	7 237
Duty travel – Int. Consultants or Secretariat Professional staff	International air tickets	2 500	5.5	13 750	23 829
Duty travel – National/Local consultants	National air tickets	500	8	4 000	3 332
DSA-International Consultants	Days	150	110	16 500	15 394
DSA-National/Local Consultants	Days	90	75	6 750	6 794
Local Transportation	Days	100	70	7 000	6 608
Publication of Final Report	Copies	5	1 000	5 000	2 500
Secretarial/logistical support	Lumpsum	6 500	1	6 500	6 475
Sub-total				**92 500**	**92 500**
FAO Support costs	Percentage	6%	of sub-total	5 550	5 550
Project TOTAL				**98 050**	**98 050**

** Disbursements: USD29 000 and USD45 000 = USD74 000

Final disbursement requested: USD24 050

Carlos Garces-Restrepo

IPTRID Programme Manager and Budget Holder

TF-NRLDD-TFAA110098156
Land and Water Division (NRL)
Natural Resources Management and Environment Department

Annex 1: SURVEY QUESTIONNAIRE

ORISSA Swiss PEP Survey

To be filled by the Interviewer

Date:

Name of the Farmer:

Village:

Panchayat:

Block:

District:

_____

Signature of the Investigator

A. WATER MANAGEMENT AND SYSTEM DESCRIPTION

Date of Installation of the pump: _____ / _____ / _____

Age of the pump:

Nature of water source: Permanent ☐ Not permanent ☐

Details about the source:

1. **Type of Water Resource and comments (size, depth)** 1. Pond 2. Well 3. River 4. Irrigation Canal

2. **Depth of water source**

Source	in metres
1. Pond	_____
2. Well	_____
3. River	_____
4. Irrigation Canal	_____

3. **Water source characteristics (lifting power required in metres)** 1. From (end of dry season) ☐ 2. To end of rainy season ☐

4. **Post pump water use efficiency with the PEP and cost (give unit if any)**

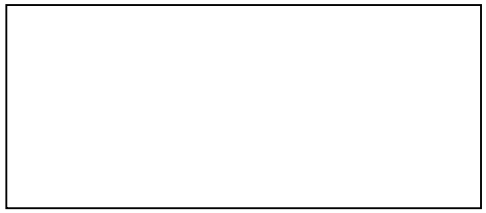
1. Canals	☐	☐	3. Post Pump Pipe	☐ ☐
2. Storage facility	☐	☐	4. Elevation of the pump	☐ ☐

5. **System Description**

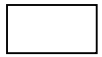
Pond  Storage 

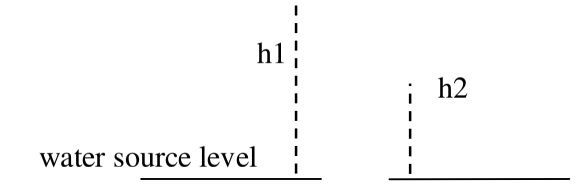
Well  **Pipe**

Pump  Canal 



6. **Pump operating situation**

pump level 



7. **Measurement of discharge**

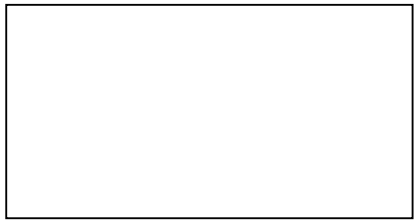
1. Volume (l)  2. Time (s)  3. Discharge (l/s) 

8. **Design of the system with distance**

1. Well:  a. Bricks  b. Rings 

2. Pump:  3. Pond : 

4. Storage: 



9. **System Maintenance**

1. Weak parts of the pump  2. Plastic piston 

3. Washers  4. Small metallic parts 

9. Any other specify …

10.	**How the problems was solved**	1. Farmer himself ☐	2. Existing Maintenance facility ☐
11.	**Other irrigation facilities available**	1. Traditional :	
		2. Electric: a. owned ☐	b. shared ☐ c. hired ☐
		3. Diesel pump a. owned ☐	b. shared ☐ c. hired ☐
Farmer's opinion on PEP operation			
12.	**Can pump operation be handled by any member of the family?**	1. Yes ☐	2. No ☐
13.	**If Yes, who are the members operating the pump?**		
14.	**Tenability of pumping (how long the pump can be used continuously?)**		

15. **Comfort of pumping**

1. Multi position along the pedals is an advantage
2. Stability due to concrete settlement
3. Advantage of the equalizer (facilitates the up and down motion of the pedal)
9. Any other, specify ...

16. **Farmer's opinion on maintenance**

1. Easy to maintain 2. Yet no maintenance 3. Continuously giving problems

17. **Major breaks if any**

18. **Minor breaks**

19. **Comparison with the traditional system**

1. Discharge is Less ☐ Equal ☐ Higher ☐
2. The irrigated area is Less ☐ Equal ☐ Higher ☐
3. Does the pump give satisfaction? Yes ☐ No ☐

20. **If the pump fails, what will you buy?**

1. Same pump ☐
2. Upgraded to diesel or other ☐

3. Back to traditional ☐

21. **Do you know the cost of equipment and maintenance?**

PEP	☐	☐
Diesel Pump	☐	☐
Other	☐	☐

Observations:

B. LAND DESCRIPTION AND MANAGEMENT

Land	1. Lowland	2. Upland	3. Level land
Soil	1. Sandy	2. Loam	3. Clay
Fence	1. Yes	2. No	

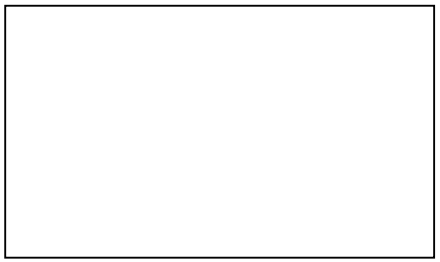
Land use (drawing, pump, cultivated land, land occupation 1st crop, land occupation 2nd crop)

Land occupation

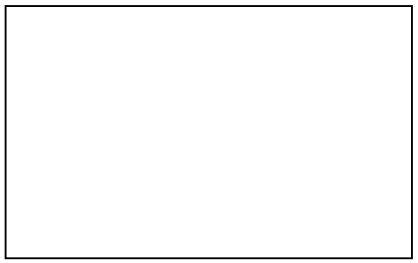
(L, l in metre to be measured)

1. Canals ⇨ 2. Pipe ⟶ 3. Furrow ---------

1st crop



2nd crop



Observations:

C. HOUSEHOLD DESCRIPTION

1.	**No. of family members**	Adults: M ☐ F ☐	Children: M ☐ F ☐
2.	**Age of the family members**	Adults: ☐ ☐ ☐	Children: ☐ ☐ ☐
3.	**Total farm area** *(in acres)*		
4.	**Total irrigated land**		
5.	**Area irrigated by pump**		
6.	**Operators of the pump**	1. Farmer	2. Wife 3. Children
7.	**Farm equipment**	1. Traditional: Oxen	Owned Hired
		2. Small mechanization	Owned Hired
		3. Tractor	Owned Hired

Observation :

D. CROP DESCRIPTIONS

Crop	Local name	Prod unit	Harvesting duration	Total prod kg	Unit cost rp	Total
Baingan						
Spinach						
Beans						
Potatoes						
Tomatoes						
Chilli						
Ladies finger						
Onions						
Cucumber						
Coriander						
Pumpkin						
Tarot	Kolokotia					
Cabbage						
Cauliflower						
Carrot						
Turnip						
Mehhed						

Peas						
Nursery						
Watermelon						
Bitter gourd						
Amaranthus						
Radish						
Ginger						
Beets						
Sunflower						
	Kakenda					
Total income						

Observations:

E. LAND DESCRIPTIONS

	Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	UnitProd a	Taprod	UnitProd b	TbProd
Rainy season																	
Flood period																	
Drought																	
Rabi season																	
Kharif season																	
Use of PEP																	
Crop 1a /Crop 1b																	
WR																	
Crop2a /Crop 2b																	
WR																	
Crop 3a /Crop3b																	
WR																	
Crop 4a /Crop 4b																	

	Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	unitProda	Taprod	unitProd b	TbProd
WR																	
Crop 5a /Crop 5b																	
WR																	
Crop 6a /Crop 6b																	
WR																	
Crop 7a /Crop 7b																	
Irrigation management																	
T Water supply																	
T Water requirement																	

Observations:

F. WORKSHOP INTERVIEW

Name of the artisan Date: _____/ _____ /_____

Field of Qualification

1.	**Activities**	1. PEP	2. Others
2.	**Period of activities for PEP**		
	Was the PEP main activity during the period		
	Percentage of income generated by PEP		
3.	**Number of pumps prepared** *(concrete and installation)*		
4.	**Investment**	1. Land : 2. storage facility:	3. Moulds: 4. Small assets:
5.	**Personnel**	Number of people during PEP activities: Cost of personnel: How many days requested for one pump:	
6.	**Supply of material for the pumps** *(Quantity and cost)*	Concrete: Iron: Elements of the pump:	
7.	**Workshop situation**	PEP maintenance: Other activity:	

8. **What about the personnel trained by the project?**

9. **Can the workshop start PEP activity within a short period?**

10. **Practical problems for the installation of PEP**

11. **Opinion of the artisan on PEP**

Depreciation of PEP

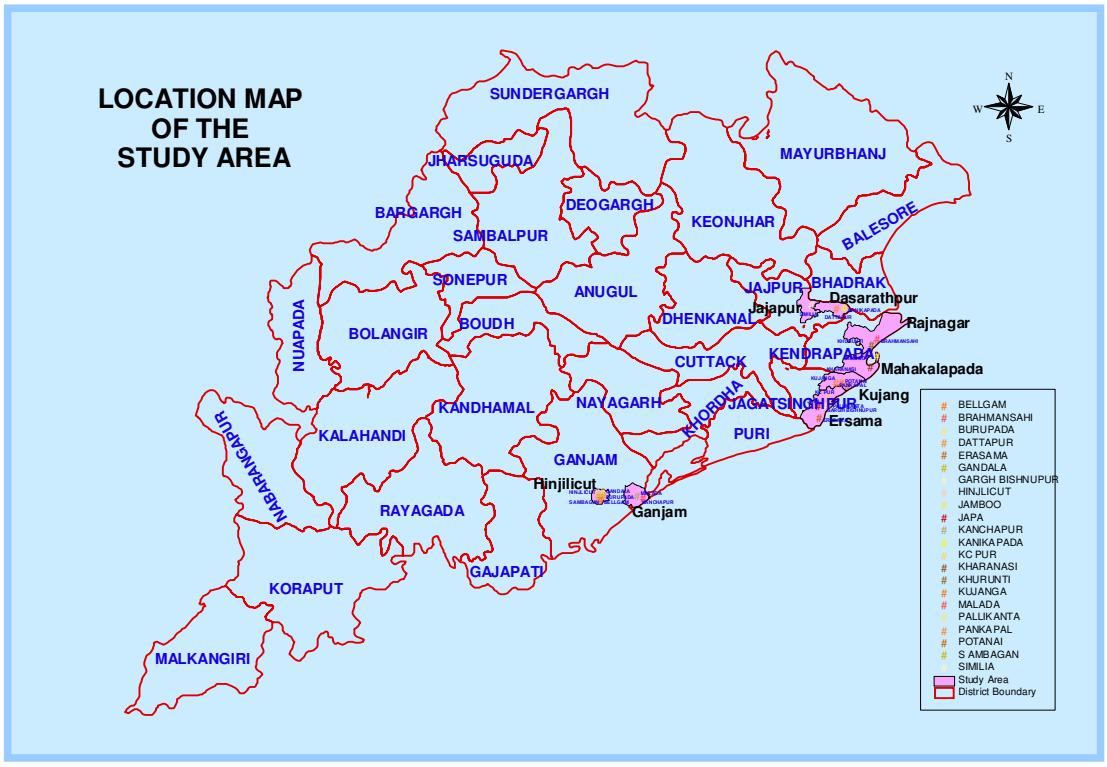
Weak parts

12. **Do farmers come to buy a PEP?** 1. Yes 2. No

Observations:

ANNEX 2

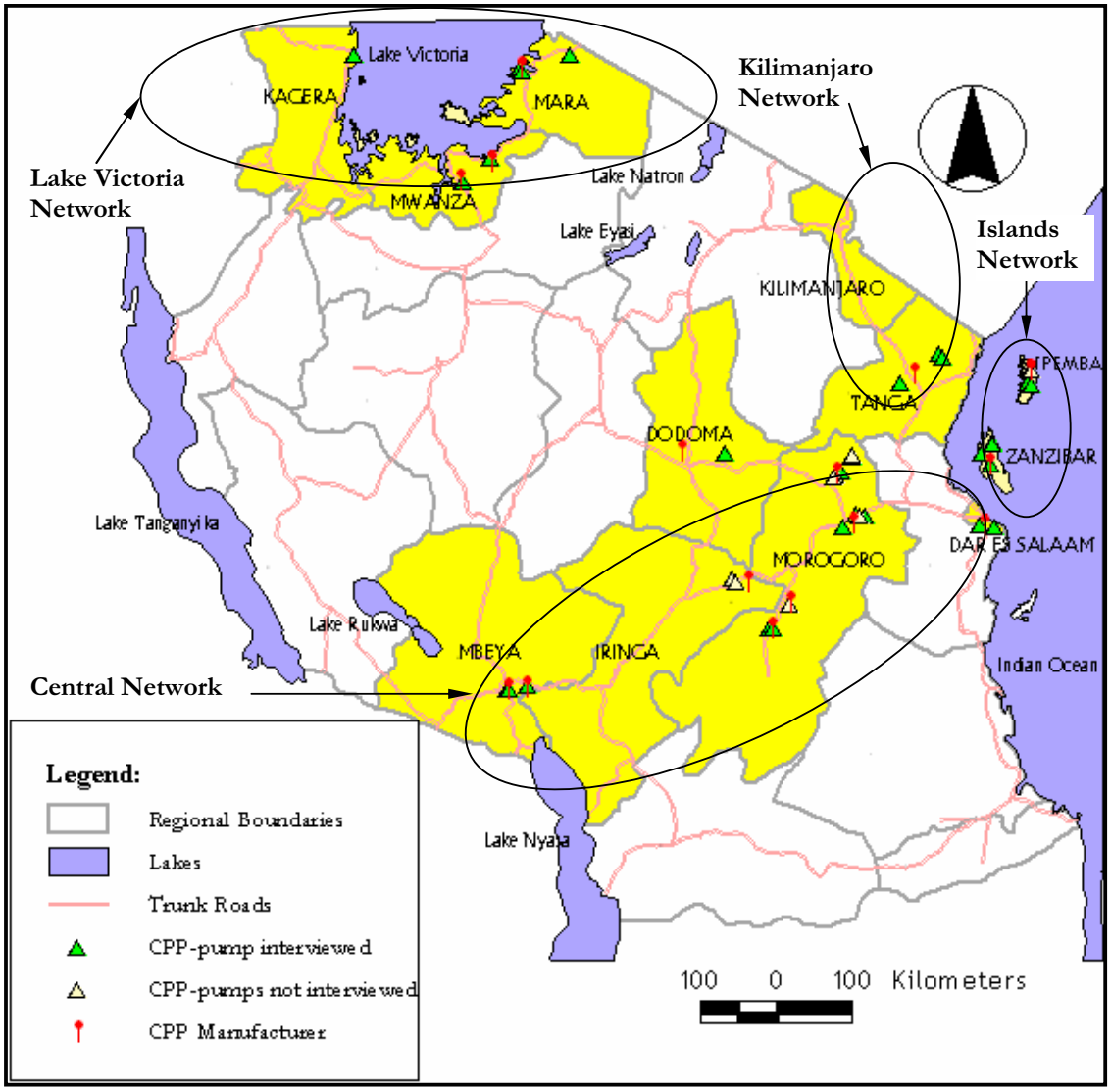
INDIA-State of ORISSA



APPENDIX 3:

TANZANIA

Location of PEP and manufacturers



Map of Tanzania showing location of PEP manufacturer workshops, PEP pump interviewed and non-interviewed. The regions painted yellow forms the three Networks (Central, Lake Victoria and Kilimanjaro Networks).