CMD

DEPARTMENT OF PUBLIC HEALTH ENGINEERING
R & D DIVISION, DHAKA

Draft Report

on

Evaluation of TARA-II pump with No.6 pump head and TARA Dev head at Mymensingh and Chapai Nawabganj District

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1. BACKGROUND

The Tara is a low-lift direct action hand pump developed during mid eightees in Bangladesh and now proving to be suitable for community water supply application in a number of other developing countries.

The pumps' main features are simplicity, low cost and ease of maintenance. It has been specially designed to make maximum use of materials and skills available in Bangladesh and it was adopted in 1987, as the standard hand pump for installation in areas of the country where the depth of the water table exceeds the suction limit (about 7.5m).

In some northern parts of the country, water table is declining beyond the capacity of Tara pump (18 metre) and therefore,Tara-II has been developed and field tested to lift water from 30 meters depth. Based on an evaluation by the R&D Committee in February, 1992 on the performance of Tara-II fitted with No.6 pump head, DPHE installed 150 Tara-II hand pumps in Chittagong, Mymensingh, Chapai Nawabganj and Naogaon districts during June to August, 1993.

As per the recommendation of the R & D committee, in the meantime, an alternative pump head has been developed and named as Tara Dev. This Tara Dev head has been fitted to 5 existing Tara-II hand pumps on an experimental basis.

Now, DPHE, under the DPHE-UNICEF Research and Development Programme plans to evaluate the performance of these two types of Tara -II hand pumps in respect of their technical, social and economic aspects in order to determine the better one from these two types.

2. TERMS OF REFERENCE

The terms of reference of the study is primarily to come up with a recommendation of the better pump from the technical, social and economic point of view. The detailed TOR of the study is appended in annexure-1.

3. OBJECTIVE OF THE STUDY

The overall objective of the study is to evaluate the performances of Tara-II hand pumps fitted with No.6 pump head and Tara-II hand pump with Tara Dev head in order to find out the better one in terms of technical, social and economic advantages.

The specific objectives of the study as envisaged in the TOR are to

i) assess the condition , suitability and performances of the pumps to lift water from 30 meters depth.

ii) compare the reactions of the users, particularly the women and children, on both types of pumps.

iii) compare the economic aspect in respect of investment, operation and maintenance.

iv) recommend the type of pump which is better from technical,social and economic point of view.

4. SCOPE OF THE STUDY

The evaluation study is carried out through a sample survey. It is limited to two districts namely, Chapai Nawabganj and Mymensingh. Numbers of each types of pumps inspected and studied are as follows :

Name of District	Name of Thana	Name of Union	Name of Village	TARA-II with No.6 Pumphead	TARA-II with TARA DEV. Head	Remark
Mymensingh	Gafargaon	Dattar - Bazar	Baraigaon	1	-	
		Moshakhali	Belabo	2	-	
		Pythol	Neoka	1	-	
		Pythol	Joyder-khali	1	-	
		Tengabo	Tengabo	1	-	
		Tengabo	Bamankhali	1	-	
	Fulbaria					
		Naogaon	Naogaon	1	-	
		Balian	Teligram	1	-	
		Deokhola	Balashar	1	-	
				10		
Chapai-Nawabganj	Sadar					
		Jhilim	Bhabuk	1	-	
		Jhilim	Balikapara	1	-	
		Jhilim	Balikapar	-	2	
		Jhilim	Dhinagar	-	1	
		Jhilim	Chanmushi-para	-	1*	*
	Gomostapur					
		Rohonpur	Bongpur	-	1	
		Rohonpur	Hirupra	-	1	
		Rohonpur	Islampur	1	-	
		Rohonpur	Station-para	1	-	
		Rohonpur	Laxmipur	1	-	
		Rohonpur	Noongola	1	-	
	Nachole					
		Nachole	Nasirabad	1	-	
		Nachole	Dheon	1	-	
		Nizampur	Nizampur	1	-	
		Nizampur	Fulkuri	1		
				10	5	

* The pump rod could not be pulled out because it was too tight.

5. APPROACH AND METHODOLOGY

The overall objective is to evaluate Tara-II hand pumps with No.6 and Tara Dev heads taking into consideration their technical, social and economic aspect. The activities involved in the evaluation process are given in the Activity Flow Chart shown in Fig.1.

The chart identifies, in logical sequence, the various activities undertaken in evaluating the pumps. The significant activities undertaken are explained bellow:

Mobilisation:

After signing the contract, CMD mobilised its resources to commence the evaluation study. The team of consultants for the study and supporting staff were organised and office was set up. A series of discussions were held with the project's team members in order to orient the team with the project objectives.

Study and Review of Design/Drawings, Report and other Relevant Documents.:

All available pertinent documents such as design/drawings, lab and field test reports and other relevant literatures regarding the operation and maintenance characteristics of the pumps were collected and studied. A list of the documents are given in the reference.

Discussion and Consultation:

Organized discussions and consultations were held with DPHE and UNICEF officials to gather first hand information they possess by virtue of their experiences in the operation and maintenance of the two types of pumps. Besides, several visits were made in a manufacturing plant of Tara pump and discussions were made with the production officials.

A list of persons met and discussed are appended in Annexure-2.

Design and Development of Data Collection Format

A data collection format was developed to collect pertinent information regarding both types of pumps and users' reaction covering the following aspect.

- technical aspect such as operation and maintenance performances and suitability etc.

- social aspect such as preferences, acceptability, involvement in O&M, users friendliness and sustainability etc.

- economic aspect such as investment costs, O&M costs etc.

A sample of data collection format are appended in annexure-3.

6. DATA COLLECTION AND ANALYSIS

Physical inspections and observation of the facilities, pull out of pump components to assess their condition and other relevant information were collected using the developed format for this purpose. The process of data collection includes the following :

a. Visits and discussion:

i) visit to DPHE field office and obtain data/information regarding maintenance frequency, spare parts replacement, O&M Costs etc. It is pertinent to mention here that the record keeping is poor and information was obtained through interview/questioning.

ii) Interview the beneficiaries (specially children and female members) to obtain their reaction regarding usefulness preferences, operation and maintenance aspect.

b. Physical inspection and observation of pumps:

Physical conditions of the facilities were observed and studied to ascertain the condition of platform performances of pumps like

- head,
- pumping rate,
- discharge etc.

c. Pull out the pump components:

The pump and pump head components in all the 25 sites were pulled out to assess the conditions of various components such as

- pump assembly
- piston assembly
- footvalve assembly
- pump rod joints.

Relevant data on the performance of pump, users reaction, maintenance requirement etc. were collected from field and analyzed. The tabulated data and their analysis is enclosed in the annexure-4.& 5.

7. FINDINGS AND OBSERVATIONS

A. TARA PUMP WITH NO. 6 HEAD

Mymensingh Region

i) All the 10 pumps observed, delivered reasonable quantity of water ranging from 21.43 l/m to 30 l/m during pump operation.

ii) 3 Nos. (30%) of the platforms observed were found broken or cracked.

iii) 3 Nos. (30%) of the platforms were found dirty.

iv) 1 No. (10%) of the pumps makes excessive noise during operation, due to too much friction and lack of lubrication at moving parts of the pump head.

v) Excessive buoyancy was observed which result in too much upward thrust. This causes operational difficulty for the users. Women and children complain that they got tired after filling a bucket. The pump handles remain at down position which need enough strength to pull up.

vi) In 2 (20%) cases, user's made hole at the top and the bottom of pump rod to make it heavier to encounter the buoyancy.

vii) Similarly, in 2 (20%) cases, user's shortened the pump rod to 18.29m instead of 30m.

vii) 3 Nos (30%) of pumps head were loose at the top flange. It may be mentioned here that the static water level was within 6 meter in this region.

Chapai Nawabganj Region

i) 8 Nos. (80%) of the pumps delivered comparatively small quantity 8.57 l/m to 17.5 l/m of water during operation.

ii) 7 Nos. (70%) of the pumps needed 15 to 20 strokes to get water out of the pumps in the morning.

iii) 3 Nos. (30)% of the pumps observed were found noisy due to too much friction and lack of lubrication of the moving parts of the pump head.

iv) 1 No. (10%) of the pumps is hard to operate due to pump rod leakage and deformation of cup seal.

v) 4 Nos. (40%) of the pumps head were found to be loose at the top flange.

vi) 1 No. (10%) of the platform's condition was found dirty.

Following conditions were observed with respect to **below ground level components** of 20 Nos. pumps with No. 6 head inspected in both Mymensingh and Chapai Nawabganj districts:

i) In 9 cases (55%), cupseals were found worn or torn.

ii) 7 Nos. (35%) of the plastic wing check nuts were found cracked.

iii) 9 (45%) 'O' - Rings were found worn.

iv) 6 (30%) piston flap valves were found worn or torn.

v) In 3 cases (15%) foot valve flaps were found worn /torn.

vi) In 9 (45%) cases, 'O'-Ring dropped out of the foot valve groove during lifting of the foot valve.

vii) Scratch marks were observed in the pump rod.

B. **TARA DEV HEAD**

i) All the 5 pumps inspected were easy to operate.

ii) 4 out 5 pumps delivered water ranging from 21.92 l/m to 30 l/m during pump operation.

iii) The nylon-6 bearing bushes in fulcrum pin & hanger assembly were found to be worn with lot of pits/holes in 3 (60%) cases. The locking notch on the bearing bush outer were also found broken.

With respect to **below ground level components** following were observed :

iv) Cupseal in 3 (60%) cases were found worn/torn.

v) In 3 (60%) cases, 'O'-Rings were found worn.

vi) 1 No. (20%) plastic wing check nut was found broken/cracked.

vii) In 3 (60%) cases, 'O'-Rings dropped out of the foot valve groove during lifting of the foot valve.

viii) Scratch marks were observed in the pump rod.

No record was maintained regarding replacement of parts. However, attempts were made to obtain information in this respect through questioning. Based on this, a frequency table of replacement of parts since installation is prepared and shown in Annexure-5(e). From this table, life of each part may be determined on the basis of the frequency of replacement of a particular part:

1.	Leather cup seal	-	6 months
2.	Piston flap valve	-	18 months
3.	Foot valve flap	-	9 months
4.	O-ring	-	6 months
5.	Plastic wing check nut	-	9 months
6.	Nylon bearing bush (for Tara Dev head)	-	18 months

The above figures, however, may not reflect the true life of the parts because (i) actual frequency of replacements are not known for lack of record keeping and (ii) non-replacement of parts even after being worn out in many cases.

C. GENERAL

a) Lifting pump rod is difficult. It is even more difficult when Foot valve is lifted with it because in such cases, the foot valves often drops out of grapple hook.

b) It is very difficult to handle a pump rod of 29 meters long. Moreover, there always remains a risk of breaking or cracking at joints if it is not handled very carefully. On two occasions during the study, the pump rod was broken.

c) During lifting, in 12 cases, 'O'-Ring at foot valves dropped out of the grapple hook.

d) In 15 cases, split pins/cotter pins were found broken and were replaced by nails.

e) The iron parts of pump rod; e.g. connecting rod in No.6 head and top connector, rod and guide at foot valve guide assembly, grapple etc. in both types of head got rusted which may cause weakening of the parts and may also affect palatability.

f) Pump piston stucks/becomes tight at different places while lifting. This may be due to incorrect installation of well pipe, improper dimension of pipe diameter and deformation in socket making.

g) Due to long length of the pump rod of Tara-II, it is very difficult for the woman and children to lift the pump rod. A number of persons are needed to pull the pump rod from the tubewell. An external support of tree during the withdrawal of the pump rod from the well is required. However, the women can replace the parts after the pump rod is pulled out, but generally the women do not repair the faults.

h) Repair work of defects in top and bottom connector joints and pump rod joints are done by DPHE mechanics.

i) Parts of the pump like flap valve, piston plate, follower plate, washer, leather cup seal wing checkout, O'ring, foot valve body, guide rod are not available in the market at thana level. Spare parts are available in the nearest district head quarter markets but the quality of the available parts are poor.

j) As per the production manual, the number of parts in Tara Dev head assembly is 49 and that of No. 6 head assembly is 24. Assembly of Tara dev. head assembly is difficult and requires atleast two persons. A combination activities like (i) alignment of hanger assembly, fulcrum pin and handle, (ii) pushing down the pump rod against buoyancy, (iii) fitting fulcrum bush in correct position and (iv) tightening of special hex. nut are required to be done simultaneously.

k) Hand tool (combination of socket wrench and open ended wrench) fabricated and supplied is of poor quality. The socket worn out with few operations in the open ended portion.

l) The Rubber cupseal, recently provided could not be fitted and used because the dimension do not match with the existing piston and follower plate.

m) Of the total 25 Tara-II pumps observed, in six cases piston flap valve and in six cases FV flap were found damaged.

The newly designed flap valves were found to be more convenient to fit in.

n) In all cases, it was not possible to compare the preference of users regarding no. 6 and Tara Dev. heads because the both types of pump heads were not available or accessible to the same users. However, in the places where Tara Dev and No.6 are being used (in Sadar thana of Chapai Nawabganj), users prepare Tara Dev to No.6 head.

o) It has been observed that the maintenance requirements for below ground level components are same in both No.6 and Tara Dev. But requirement of maintenance of above ground component differs in Tara Dev head e.g. the bearing bush of fulcrum and hanger assembly of head assembly.

p) Capital cost of No.6 head including cost of material, carrying, sinking and construction of platform etc. are estimated at Tk.13,900.00. For Tara Dev head additional cost of Tk.12,00.00 is required. (Ref. annexure-5 f)

q) Regarding affordability and willingness is to pay for the maintenance cost, it appears that beneficiaries are generally reluctant to pay for the spares and bear the maintenance cost.

r) The mechanical efficiency of Tara Dev. head pumps were found to be more than the mechanical efficiency of no. 6 pump head (ref. Annexure 5d).

s) It has been observed that the design and construction of platforms are not standardised. Some of the platforms are small in size and the drains are short. In small platforms, water splashes out of the platform and drops on the surrounding ground and small drain discharges the waste water near the tubewell with possibility of stagnation of water.

It has been also been found that there is difference in height of the platforms. Some are too low or high making a uncomfortable for the users to pump be handle.

t) The stroke length of Tara Dev head is 225mm. The designed maximum stroke length of No.6 pump head is 272mm but in the field, the operating stroke length was at maximum 140mm.

u) The mechanical advantages of Tara Dev head and No.6 pump head are 1:2.6 and 1:4 respectively.

8. RECOMMENDATIONS

a) The excessive buoyancy in Mymensingh region is mostly due to static water level not too deep (6.7 metre). Efforts made by the users by making holes in pump rod and reducing length of pump rod to reduce the buoyancy upward thrust. Therefore, depending on the water table depth design for pump rod/foot valve setting depth should be standardized to a number of standards, say, at 20 meter depth and 30 meter depth. No modifications at site should be allowed, otherwise it may effect well life and durability of pump itself.

b) Pump rod having a length of 29 meters in one piece is difficult to handle. It bends on tree, roof tops etc. making it vulnerable to breaking or cracking at joints.

The pump rod may be made of pieces screwed in male-female parts. This may help dismantle the pump rod easily and thus make it convenient during handling.

c) The pump rod grazing may be due to mis-alignment of well or due to buckling while piston is pushed down. While the piston is in down stroke it works against the buoyancy/ upward thrust. Each long pipe, while under compression would buckle at any place, thus, grazes with well.

Centralizers may be used at regular intervals. If separate pipe sections are designed, centralizers may be used there. A more balancing may be obtain by calculating the entire pump rod weight and than a section of pipe at bottom be used to minimise the weight against buoyancy in such a way that the pump rod is under a little downward pull. This will avoid buckling of the pump rod. For example- 14m of 10mm Rod from top & 15m of 32mm pipe at bottom, total weight of which is appx. 20.6kg. Buoyancy effect of 15m of 32mm pipe is 14 kg. (appx.). This leaves appx. 5.4 kg. pull which can be easily lifted by the pump handle. In this case, 2m long pieces of Rod may be used with centralizers at each joint which may reduce the possibility of buckling and ease of lifting.

d) Iron parts inside the pump should be hot dip galvanized so that rusting is prevented.

e) Whenever foot valves are lifted, O-ring drop-out of the groove due to water pressure. Proper design development may be attempted.

f) During installation, greases were used at the fulcrum bushes and it was intended that the only polished stainless steel surface should work with nylon bush. But due to weather, the grease hardened and griped the free movement and thus breaking the locking notch of bush. This resulted in movement of nylon bush in the machined M.S. parts causing accelerated wear.

Stronger locking may be designed with periodic oiling. Gun metal bush may be tried instead of nylon.

g) Split/cotter pins rub constantly with the sharp edge of holes in different pins. This cuts the cotter pins very easily. Metal/Nylon washers may be used to avoid this.

h) In platforms, anchoring of the bottom flange may be extended so that it grips with the main platform to make it stronger.

i) The dimension of the rubber cupseal is to be adjusted, to make installation is easier. However proper gripping surface must be maintained to avoid seal slipping or buckling under pressure.

j) While lifting pump rod, the piston stucks with well wall. This may be due to the incorrect installation of well pipe i.e. pipe and socket joint directions or improper dimension of pipe diameter and deformation in socket making, mis aligned well pipe etc.

Installation to be carefully supervised. The cylinder pipe bore may be reduced a little so that the well pipe do not hinder the movement of piston in any way.This may be done by using a metal liner inside the cylinder or making the cylinder itself of metal. This will increase the well life greatly.

k) Adequate arrangement for routine maintenance may be made.

A tentative schedule for maintenance of hand pump is suggested below:

Daily

1. Lock and unlock the pump at hours agreed by the village.

2. Clean the well head.

Weekly

1. Through clean up of pump, well-head and surroundings.

2. Oil or grease all hinge pins, bearings, and sliding parts, after checking tat no rust has developed on them.

3. Record any comments from users about irregularities in working (tightness of parts, fall-off in water raised). Correct these when possible.

Monthly

1. check that all nuts and bolts are tight, and check that there is no evidence of loose connections on the pump rods.

2. check for symptoms of wear at the leathers, noting any comments from users about any falling off in the water raised.

Annually

1. Paint all exposed parts to prevent development of rust.

2. Repair any cracked concrete in the well-head and surrounds.

3. Check wear at handle bearings and replace parts as necessary.

4. check piston valve and foot valve; replace, if found leaking.

5. Check the pump rod and replace any defective lengths or connectors.

l) Arrangement is to be made so that common spare parts are readily available in or near the community.

m) A suitable community infrastructure is to be made for recovering the costs of maintenance and repair operations. An operation and maintenance committee may be formed in each union consisting of

- U P Chairman
- Ward Commissioner
- Mechanic, and
- Caretaker.

The Chairman shall be responsible for monitoring and supervision of proper maintenance, recording of maintenance including frequency, spares, cost etc. The caretaker shall collect contribution from users/beneficiaries for meeting the cost of repair and maintenance. Study to identify the appropriate community organisation/structure for this purpose may be undertaken.

o) Public sector may take the responsibility to encourage standardization, enforce quality control and provide extension support through training basic technical skills, periodic monitoring & refreshers' courses to maintain standards.

There are clear benefits to be gained by standardization. The issue of standardization is complex. Manufacturing monopolies may arise and bring their own problems of price, R & D etc. But without some standardization, difficulties of sustaining good and reliable water supply to vulnerable low-income groups in the rural areas are likely to be insuperable.

p) The design and construction of the platforms should be standardized such that the platforms are large enough to facilitate the use of tubewell water for all purposes (drinking, washing, bathing) as well as to prevent splashing of water outside the platform. The drain should be extended to such a length that their is no possibility for stagnation of waste water near platform i.e. minimum 3m. This will ensure achieving desired health impact.

The hight of the platform should be constructed such that it is comfortable for the users.

9. CONCLUSION

i). Depending on the ease of operation, mechanical efficiency and users' friendliness Tara-II with Tara Dev. head is a suitable technical option for deep water table area in Chapai Nawabganj region.

ii) For Mymensingh region, the depth of water level should be considered before allocating Tara-II pumps.