AN ECONOMIC APPRAISAL OF A HANDPUMP MAINTENANCE SYSTEM USING WOMEN MECHANICS

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INTERNATIONAL ECONOMICS & GEOGRAPHY

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Seema, Olle, our parents, need we say more..

TO WHOM IT MAY CONCERN

SUMMARY

When evaluating development projects, it is important to take into account effects which arise from differences in men's and women's social roles. In this study we evaluate the economic effects of training women as handpump mechanics, using a social cost-benefit Analysis.

In our analysis, two important types of difference emanating from gender, and which affect the Net Present Value (NPV) of the project, are differences in working characteristics and in expenditure patterns. To account for these differences, we have identified two gender-specific weights - the intensity factor and the gender income weight.

The economic analysis of the project, including adjustments for market failures and distortions, renders a positive numerical NPV under our base case assumptions. When adding the the intangible effects we identify, the positive result is strengthened. This positive NPV shows that the project has achieved greater economic efficiency by taking gender differences into account.

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LIST OF ABBREVIATIONS

BDO	- Block Development Office / Officer
CBA	- Cost Benefit Analysis
CRI	- Consumption Rate of Income
INR	- Indian Rupees; 3 INR is approximately 1 SEK
ITI	- Industrial Training Institute
NPV	- Net Present Value
PGN	- Practical Gender Needs
PHED	- Public Health Engineering Department
SGN	- Stragetical Gender Needs
SIDA	- Swedish International Development Authority
SRTP	- Social Rate of Time Preference
SWACH	- Sanitation, Water, Guineaworm Control and Community Health project
TRYSEM	- Training Rural Youth for Self Employment
UNICEF	- United Nations Children's Fund

To avoid confusion in terminology, we will define what we mean by the terms sex and gender. Sex: biological differences between men and women. Gender: social relations between sexes.

1. INTRODUCTION

When evaluating development projects, it is important to take into account effects which arise from differences in men's and women's social roles. In this study we will evaluate the effects of training women as handpump mechanics - a project which necessitates the consideration of gender specific effects. As cost-benefit analysis literature does not discuss the issue, we will introduce two concepts in our study - an intensity factor and a gender income weight. The intensity factor reflects the gender specific difference in value of unskilled labor, while the gender income weight accounts for the difference in social valuation of income accruing to men and women.

2. PURPOSE AND DELIMITATIONS

The purpose of this paper is to economically evaluate the effects of training women as mechanics for handpump maintenance by comparing this with the system where men are pump mistries. The method used is a social cost-benefit analysis. Our main difficulty is the valuation of gender specific effects, ideas on how to include this in our cost benefit analysis will therefore be discussed.

Our study has three major delimitations;

- We will consider only the effects that can be observed in the pilot project.
- The parameters used in the base case and in the sensitivity analysis are assumed to be constant over the project period.
- Adhering to a common accounting convention, we will regard all costs and benefits as occurring at the end of each calendar year. Furthermore we will not consider the option of not having a pump maintenance system, since access to clean water has been decleared a human right by the Government of India.

The disposition of the paper is as follows: Chapter 4 briefly presents the nature and theory of social cost-benefit analysis.

Chapter 5 consists of a discussion of women and development. Chapter 6 deals with the identification, quantification and valuation of costs and benefits. Here we also present the results from a base-case computation and a sensitivity analysis of the parameters and critical assumptions. Chapter 7 contains a summary of our conclusions and discusses the implications of our results.

3. BACKGROUND

In 1986, UNICEF, sponsored by SIDA, and the Rajasthan state government launched an Integrated Sanitation, Water, Guineaworm Control and Community Health project (SWACH) in the southernmost states of Rajasthan; Dungarpur and Banswara. In 1988, the Udaipur district was included in the project (UNICEF 1990a).

The villagers in the project area combine agriculture with animal husbandry and wage labor. The literacy rate is very low, 15-20% among males, and less than 5% among females (SIDA 1990a). The population is largely tribal.

An important aim of the SWACH project is to provide the villagers with clean water; this is achieved partly through installing handpumps. Merely supplying clean water is, however, not sufficient; the villagers must also use it. Therefore, substantial resources have been devoted to the education of villagers on hygiene and on the importance of using clean water.

The handpumps installed are India Mark II. Maintenance was not considered when constructing these pumps. It was assumed that competent professional mechanics would be called in from the district Public Health and Engineering Departments (PHED) to mend the pumps, using the appropriate tools and expertise (Black 1990). The sheer number of pumps installed in India has rendered this system unfeasible and the issue of maintenance is now of great concern.

The maintenance system developed in Rajasthan in 1981 was based on the training of locals as village pump mistries through a government sponsored program, TRYSEM (Training Rural Youth for Self Employment). The idea was that the pump maintenance should be brought within the socio-economic life of the village. Local mistries were trained and equipped with tools, and were expected to deal with the majority of the repairs without calling in the block mechanic or district repair team.

In 1988, SWACH trained 24 rural women as pump mistries. They are part of a pilot project intended to improve the maintenance system in the project area. The rationale behind the project is that the women are more motivated to keep the handpumps in working order, as they are immediately affected by a malfunctioning pump. Great care was taken in selecting the women in order to ensure individual suitability. It was also assured that the walking distance to the most remote pump was no more than five to six kilometers in order not to interfere with the women's household work. The women work in groups of three, partly because of the heavy tool kit, but primarily as it is felt that they need support from each other when breaking the tradition of only men performing technical tasks.

4. THE THEORY OF COST BENEFIT ANALYSIS[1]

Due to market failures, market or financialprices indicate only the private valuation of a good. In this financial valuation, the value to society as a whole is not necessarily reflected. To enhance decision making in public projects there is a need for an economic evaluation which incorporates the effects of market distortions, externalities and public goods. One method to organize information, and evaluate effects due to market and policy failures, is the Cost Benefit Analysis, CBA.

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[1] This chapter draws heavily on Bojö et al (1990).

The steps usually taken when performing a CBA are: (Bojö et al 1990, pp 59-61)

1. Deciding upon evaluation criteria and determining effects on income distribution.
2. Identifying, quantifying and valuing project costs and benefits.
3. Discounting.
4. Setting an appropriate time horizon.
5. Considering effects of uncertainty and risk.
6. Reviewing policy conclusions.

We will rather briefly describe and discuss these steps, summarizing the theories of Bojö et al, Dasgupta et al, Helmers, Little and Mirrlees, and Squire and Van der Tak. Our aim is not to present a complete exposition of the theories, but to give a recapitulation of theory relevant to our evaluation of handpump mechanics. After the theoretical discussion of each step we will generate the parameters for the empirical analysis in Chapter 6. Chapter 4 ends with a deliberation on the critique of using CBA as a method of evaluating projects.

4.1 Evaluation criteria and income distribution

The purpose of a CBA is to observe if there is a surplus to be gained by society over the lifetime of a project's impact. The idea is to find a measure which effectively summarizes all effects of the project on society. Most analysts will use one or several of the following measures: (Bojö et al 1990, p 62)

♦ Net Present Value (NPV) is the fundamental criterion from which all others are derived. NPV is the sum of benefits less the sum of costs in each period, brought together to a fixed point in time, 'today', by the use of a social discount rate. If the NPV is positive, the project generates a social surplus.

♦ Internal Rate of Return (IRR) is the discount rate that makes NPV equal zero.

♦ Benefit-Cost Ratio (BCR) is the value today of all benefits divided by the value today of all costs.

The criterion we will use in this study is the NPV. It is an easily understood concept and suits the evaluation needs of this project.

The above measures are sums of individual benefits and costs, with no consideration as to how they are distributed. For a decision maker, it is often of great interest to know to whom the benefits accrue, and who pays the costs. Therefore it is necessary to assess the income distribution effects of a project (Andersson & Bojö 1990).

Distributional weights are used to include the value of income distribution in the NPV. "Normally, benefits received, or costs borne, by disadvantaged groups are given relatively more weight than those which accrue to wealthier groups." (Dixon 1986, p 81) Assigning weights is clearly a subjective matter and could, some argue, render the results of the CBA useless. However, by not assigning any weights or ignoring the issue of income distribution effects, the implicit value judgment is that the prevailing income distribution in the society is optimal (Henry 1989).

In this study, the 'project' is training women as pump mistries. If this is not found viable from an economic point of view, the alternative is the system in use, male pump mistries. Whatever system is decided upon, the benefits will accrue to one of the poorest groups in India, which means the same distributional weight would be used in both cases. Consequently, as the project does not incur any change in income distribution in the above mentioned sense, we will not consider this effect.

However, it has been noted that income received by women is to a greater extent spent on the family, than is income received by men (Sen 1988, Sarin 1987). We argue this difference in

expenditure pattern means income accruing to women has a higher social value than income accruing to men; this will be discussed further in section 5.3. We will use the concept of distributional weights when evaluating income received by the mistries. 'Gender income weights' will reflect this difference in social valuation.

4.2 Identification of costs and benefits

When considering what factors to include in the CBA, the with/without (project) approach should be used (Bojö et al 1990). This means that only those factors that change due to the project should be included. Other elements such as sunk costs should be excluded as they do not affect the existence of the project. We will list and discuss those variables we consider to be costs and benefits in section 6.1.

4.3 Quantification and valuation of costs and benefits

The identified costs and benefits are quantified and then valued financially and economically. The economic valuation involves accounting for distortions and market imperfections, rectifying financial, or market, prices to reflect social valuation. If possible, intangible effects which have no market price are also valued. In section 6.2, we will discuss how we have quantified and valuated costs and benefits.

Foreign exchange and labor are often priced in highly regulated markets, and thus the financial valuation rarely reflects the social valuation. Our project does not compete with other projects for scarce foreign exchange[2] and therefore, according to Dasgupta (1972), the price of foreign exchange used in the project does not have to be adjusted. There are several theories on how to deal with the problem of labor, and we discuss some of these below.

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[2] We argue that the SWACH project does not use scarce foreign capital, since SIDA's contributions to SWACH through UNICEF are 'tagged' (personal communication, Berger).

When a project employs a person, there is a gain to society of what this person produces and also a loss to society as the new employment replaces his previous work. Due to political considerations, unemployment and imperfections in the labor market, this loss, the social opportunity cost of labor, can not always be directly inferred from prevailing market wage rates but must be estimated by other methods (Dasgupta 1972, p 201).

We will elaborate on the problems of measuring opportunity cost of labor during unemployment, as this is the prevailing situation in the project area.

When there is a surplus of labor, as there often is in the rural sector of developing countries, some argue[3] that the cost to society of utilizing this pool of unemployed for a project is zero, and hence no alternative social value is attached. There are three main arguments against this view:

♦ Unemployment in the rural sector is to a large extent seasonal (Helmers 1979). In the harvest season, the level of unemployment is much lower than at other times. Subsequently, the marginal productivity (MP) of the rural population will be higher during harvest time.

♦ The definitions of unemployment and marginal productivity of labor in rural areas are unclear. Unemployed rural people cannot afford to remain idle, and they therefore take up non-formal work when not employed. Officially these people are unemployed and have a MP and opportunity cost of zero, however, their non-formal occupation has a value to society. This aspect is even more relevant to the estimation of the MP of women, as women in rural areas generally perform unpaid work (see section 5.2).

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[3] One economist claiming this is Lewis. He argues that because of the surplus of labor, the marginal productivity of labor is zero (the MP curve is horizontal), and therefore also the alternative cost of labor is zero. See e g Lundahl (1987).

♦ There is a disutility from working, and if the pay is below a certain level, the reservation wage, unemployed will not find it worth the effort to work. Thus leisure has a value (Helmers 1979).

To conclude, it would be incorrect to assume a zero opportunity cost of labor simply because there is a surplus of labor. However, as the employment is part-time, the average MP of this worker must be lower than that of a worker in full-time employment.

We expect the opportunity cost of labor for unskilled workers to be higher than the reservation wage and lower than the official minimum wage. As the minimum wage is a politically determined price-floor, it seems unrealistic to assume a value of unskilled labor higher than this. In our empirical analysis we will use two different social opportunity costs of labor, the high value case being the minimum wage for unskilled labor in Rajasthan, INR 22. Our low value wage we base on Squire and van der Tak's (1975) rule of grain equivalence. According to this rule, no one will work for less pay than the equivalence of three kilos of grain. The price of three kilos of rice in a government ration store is INR 13.50.

Because of the high unemployment in the area we expect the true opportunity cost of labor to lie closer to the low value wage, and we will therefore use INR 13.50 as our base case.

4.4 Discounting

In order to make future benefits and costs comparable to present benefits and costs, they must be discounted. Most consumers believe that a dollar today is worth more than a dollar tomorrow, and find it easy to accept that the weight on consumption benefits should decline over time (Dasgupta et al 1972). The size of the discount factor is an expression of this intertemporal choice.

According to Bojö et al (1990, p 67), among others, there are three approaches to determining the social discount rate. These approaches are to a certain extent overlapping.

♦ The consumption rate of income (CRI) approach involves market data in determining consumers' preferences for consumption today versus consumption tomorrow. In practice, this value can be taken as the after tax return on risk-free bonds.

♦ The social opportunity cost of capital (SOC) approach takes into consideration the fact that public investments displace private investment, and that the rate at which this displacement occurs is the before tax profits on alternative investment opportunities.

♦ The social rate of time preference (SRTP) approach regards the social discount rate as an instrument for government policy. The parameter is assigned on the basis of a) the per capita income growth perspective, b) the rate at which the utility of increases in marginal income diminishes and, (sometimes) c) an estimation of consumers' rate of time preference.

In order to make our study nationally comparable, we will, as our base case rate, apply the discount factor used in similar analyses. In the Coimbatore study (UNICEF 1990b), a discount rate of 12% was used; usage of this rate was confirmed in personal communications (Bhandari). Moreover, in the sensitivity analysis we will see how our base case result reacts to a different rate. This alternative rate will be based on the consumption rate of income approach, i e the after tax return on risk free bonds. Tax exempt government savings schemes offer a rate of return of 9%, which we will use as our CRI. The higher rate implies that costs and benefits in the (distant) future are less important than short term costs and benefits.

4.5 Time horizon

The choice of a time horizon is interlinked with the choice of discount rate, as a low rate can be counterbalanced by a long time horizon. A CBA supposedly takes into account all effects of a project, no matter when they occur, and therefore an infinite time horizon should be used. However, as the effects of a project deteriorate after some time, most analysts limit the horizon to 50, 30 or 20 years (Bojö et al 1990, p 61).

Considering the uncertainty of the future after SWACH, it is difficult to justify a time horizon exceeding ten years. It is the long term effects of the intangible costs and benefits that will suffer in this short a time period. Nevertheless, for practical reasons, we will use a time horizon of ten years.

4.6 Risk and uncertainty

When evaluating the effects of a project, there is always an amount of uncertainty involved, especially pertaining to forecasts and estimates of less tangible effects. The NPV of a project, when considering risk and uncertainty, is thus not expressed as a single figure, but rather a range of figures depending on the outcome of uncertain variables. To assess the effect of these uncertainties, we will perform a sensitivity analysis, using alternative values for the uncertain parameters.

4.7 Policy implications

Having arrived at a set of numbers representing the NPV of a project, it is up to the decision maker to pass a judgement as to the viability of the project. In order to make a qualified decision, the approximate size and sign of the intangible effects of the project will have to be presented along with the purely numerical result. Even though the ultimate choice will always be a subjective one, it is important to know what tradeoffs are involved in the decision.

4.8 Critique of CBA

A point of critique against the CBA approach is that it involves an attempt to measure the immeasurable, and to express all effects in monetary terms. However, decisions are continuously made, whether or not they are explicitly stated. The CBA approach is not perfect, but it seems to be the best approach available (Bojö et al 1990[4]).

It could be argued that a cost-effectiveness study would be more appropriate than a CBA when comparing the different maintenance systems. Such a study would show which system is most cost-effective, but it would not take into account the intangible effects of the respective systems. One of the reasons SWACH has for training women is to introduce skilled labor and technology to the most backward group of all, women. These effects cannot be captured in a cost-effectiveness study, and we therefore choose the CBA approach.

5. WOMEN AND DEVELOPMENT

In this chapter we have compiled some theories and thoughts pertaining to women and their role in development economics. This chapter will be used as a base for discussing the intangible benefits of the project.

5.1 Women in development

Any project that aims at development, and which affects women, needs to acknowledge the three different types of work that women perform. The 'reproductive' work includes the childbearing and nurturing responsibilities, which guarantee the maintenance and reproduction of the labor force. The 'productive' work is in the rural areas mainly concentrated to agriculture and in urban areas to work in informal sector enterprises. Furthermore, it is the women who take responsibility for the allocation of scarce resources to ensure the survival of their household when the

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[4] For further critique on CBA, see eg Dasgupta (1972), Little,Mirrlees (1974) among others.

government provision of housing, water and health are inadequate; this can be termed 'community managing' work. Out of these three roles it is only the productive role which is recognized as work; the reproductive and community managing activities are seen as natural and unproductive and are thus not valued (Moser 1989).

Failure to recognize all the three roles played by women implies that planning policies seldom relate to women's specific needs. Projects designed to improve conditions of the low-income families often actually increase the burden for women (and thereby perhaps worsen the situation for the entire family), or fail to reach this important group. If development projects are to succeed, there is a need to look at how the project affects both men and women, not only 'low-income families' (SIDA 1990b). Therefore, there is a need to introduce 'gender-awareness' when planning projects - taking into account the social relationship between the sexes, and how the genders and roles are affected by the project.

Women's gender needs can be subdivided into 'practical gender needs' and 'strategic gender needs'. Practical gender needs (PGN) are those needs which are linked to the socially accepted roles of women, i e better health care and easy access to water. The demands which satisfy these needs do not challenge women's traditional role in society, or the existing division of labor between the sexes; they are therefore seldom controversial. Strategic gender needs (SGN) are those needs which are formulated to achieve a more equitable society, both in terms of structure and the nature of relationships between men and women.

Over time, five approaches to development for women and gender planning have evolved. These are: the welfare approach, the equity approach, the anti-poverty approach, the efficiency approach, and the empowerment approach. We will account for the two most recent approaches as these are the ones most relevant to our study. Each approach can be evaluated in terms of which

of women's three roles it recognizes and which practical or strategic gender needs it meets (Moser 1989, p 1807 ff):

- The efficiency approach. This stresses that development projects should be economically efficient. The women are seen entirely in terms of delivery capacity and ability to extend the working day. Equity is seen as growing out of women's increased economic participation. This approach meets PGN at the cost of longer working hours and increased unpaid work. It is the most popular approach with governments and multilateral agencies.

- The empowerment approach. The purpose is to empower women through self-reliance. Colonial and neo-colonial, as well as male oppression, are seen as reasons for women's subordination. The SGN are met in terms of the triple role. The approach works through bottom-up mobilization around PGN, and is largely unsupported by governments and agencies.

A problem with development economics, and perhaps even more with gender-aware development, is that the long-term effects are unclear at the outset. It is impossible to say how a project will affect society and social structure in the long run. People are different, and an approach which is successful in one area might be disastrous in another country or culture. A development strategy which aims at changing social structure and gender roles in a country in order to improve women's status could easily prove a failure. The approaches which focus on strategic gender needs are less popular with government and multilateral agencies partly because of this reason. The efficiency approach, with its focus on economic viability and return on invested aid-money, is less challenging as it does not emphasize equity. If a project is economically more effective when focused on women, it should focus on women, and side-effects such as improvement in women's status might be considered an additional benefit. "The experience of the past ten years tells us that the key issue underlying the women in development concept is ultimately an economic one" (Moser 1989, p 1821).

The SWACH project's attitudes to women development has elements of both the efficiency and the empowerment approaches. The maintenance system using women was conceived in order to increase efficiency and reduce costs. Furthermore, enabling women to perform technical chores leads to empowerment and fulfillment of strategic gender needs through bottom-up mobilization. In section 6.2.2 we will discuss the benefits of the handpump maintenance systems with special reference to women.

5.2 Social value of women's labor

The basic observation underlying this section is that the work of women in rural Rajasthan is undervalued: household work is not given a financial value, and women receive lower wages for unskilled labor on the market. An effect of the undervaluation is that women work long days. If women's labor could be justly valued, this value would differ from the social value of men's labor. Hence the shadow wages, i e the gender adjusted social opportunity cost of labor, would be different for men and women.

In order to arrive at an average wage estimate for women, a financial valuation of what household work would be worth on the market has to be undertaken. According to Goldschmidt-Clermont (1987, p 12 ff) there are four principal methods of measuring or imputing the value of household non-market production. Measurements in physical units yield evaluations of the volume of inputs and outputs; measurements expressed in monetary terms yield evaluations of the imputed value of inputs or of the imputed value of outputs.

	INPUT	OUTPUT
VOLUME	Vol of labor input, time Vol of labor input, workers	Vol output by activity
VALUE	Wage, subst household worker Wage, market equivalent Wage, foregone Wage, minimum	Gross output value Value added

We will limit ourselves to a discussion of two methods; valuation of output in terms of market values of equivalent output - output valuation, and labor time input multiplied by estimated shadow wage - input valuation.

The method of output valuation has the advantage of being a relatively simple measurement. Output quantities can be acquired by use of questionnaires and market prices are readily available for most household work. The main disadvantage is that markets for household services often show a large degree of imperfection. The labor demanded does not have to be qualified or educated, causing a buyer's market to evolve when the market becomes saturated; something that leads to underpricing.

The input method eliminates the problem of choosing the right output price. There are, however, three potential difficulties with this method:

♦ A differentiation between 'own production' and 'economic production' must be made, separating tasks performed for the benefit of oneself and tasks performed for the benefit of others (Goldschmidt-Clermont 1987).

♦ The occurrence of 'multi-tasking', i e individuals performing several tasks simultaneously, must be taken into account, either by counting only the main task or seeing each task as performed one after the other.

♦ An estimate of an appropriate wage rate must be found.

When women perform wage labor they are often underpaid. One reason for this, Sen (1988) argues, is that the women's decisions concerning work are mediated through the household. It is the head of the household who determines the household utility function, and thereby sets the level of utility of work versus leisure for both sexes. When there is a male head of household, there is often an undervaluation of women's leisure and the

household work that they are required to do is not considered work, but merely a natural state of affairs. Sarin (1987) found that even in families where women were the sole earners of income, male members often referred to their wives as supplementary earners or dependants.

Undervaluation of a worker's leisure leads to underpricing of that worker's labor (Sen 1988). The women unskilled laborers seldom earn more than INR 12-15 per day, even though the official minimum wage for unskilled labor is INR 22 (personal communication, C Bhandari, Bhanti).

Another effect of undervaluation of leisure is the over-employment of women. Sarin (1987) concludes that in family survival strategies, there is a general asymmetry in the family's decisions regarding labor deployment, causing women to work much more than men during situations of poverty and crisis. The workload of women is often too great to leave room for the fulfillment of even basic personal needs. In rural Rajasthan it is not unusual that the total workload of a woman is as high as 14-16 hours per day[5].

Estimating a measure of the value of women's work, and using the output valuation method, we arrive at an approximate daily wage for household work of INR 12[6]. This is a financial valuation and does not take into account the imperfections of this market. In

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[5] This figure comes from interviews with C Bhandari and Bhanti. It was confirmed in the field study and is referred to in i e Bhatnagar and Saxena (1985), National Perspective Plan of Women (1988) and Report of the National Workshop on Conceptual Clarifications of Data Relating to Women's Work (1988).

[6] Our calculations are based on an interview with C Bhandari. If working in the market, a woman would earn INR 50 per month for each of the chores of washing clothes, cleaning the house and cleaning utensils. She would be paid an additional INR 100 per month for cooking and taking care of children, respectively. The total is INR 350; 350/30 is approximately 12.

addition to household work, the women usually work three or four hours per day in the field[7] (National Perspective Plan 1988, p 57), and during the months of the year when there is no field work, some women work as day laborers. By adding these three sources of income and rectifying for market imperfections and distortions, an economic valuation of a woman's work - the social opportunity cost - is found.

This social opportunity cost for women we expect to differ from that of men. This difference we will define as 'intensity factor', and it consists of three gender-related effects:

- Women work more hours per day.
- Women perform different tasks than men, and these tasks are differently valued.
- Women are less productive than men, since they rarely use any aids to facilitate or speed up the performance of the tasks.

The shadow wages for men and women are derived under section 6.2.1.

5.3 Gender income weights

In this section we discuss whether the expenditure pattern of women is more contributory to the welfare of society than that of men.

Women tend, according to Sen (1988), to spend more of their income on family necessities than do men. If this claim is true, a 'life-quality' index, rating consumption according to societal desirability[8], would rate women's consumption pattern higher than men's. The value to society of income accruing to women would be higher than the value of income accruing to men.

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[7] Landless women, however, work up to eight hours per day in the field.

[8] Food and health would, for example, have a higher rating on the life-quality index than cigarettes and alcohol as food increases the value of the working force while consumption of alcohol might be detrimental to society.

An objection can be made that there can be no difference in expenditure pattern of men and women since most are so poor[9] that all income is needed for survival. A second point of objection is that all generalizations of consumer expenditure patterns are unreliable (personal communication, Deegan). Furthermore, none of the authors that have put forward suggestions resembling those of Sen have referred to any statistical evidence to back their assertions.

We recognize these points of objection, but we still argue that the essence of Sen's claim is valid. From interviews, we have found that Sen's view is shared by many of the field workers in the area. In our field study we found that women tend to spend all their income on family necessities, while men spend some on personal items. Considering the effects on society of income generation through this project, there would be a greater value attached to employing female mistries than male.

As we neither have means nor time to conduct either a conclusive expenditure pattern study or devise a life-quality index, and as, to our knowledge, no such studies have been performed in the area, we do not have enough information to attempt to gender adjust the incomes generated by the project. We will, however, in the sensitivity analysis, see how large the gender income weight would have to be in order to be of critical importance.
This chapter has focused on the need of gender awareness in development projects. We have identified two factors where the costs or benefits are different because of gender. Firstly, the opportunity cost of employing women could be higher than that of men when taking into account the social value of women's unpaid labor. Secondly, society would gain by employing women since their expenditure pattern is generally more beneficial to society than men's. These two factors affect the NPV of the project in opposite directions. Although we have chosen not to quantify the

[9] 36% of the rural population in Rajasthan live below the poverty line (personal communication, Bhanti, C Bhandari).

gender income weight, it is an important gender-specific effect which should be included in a CBA.

6. EMPIRICAL ANALYSIS

6.1 Identification of costs and benefits

In this section we identify the costs and benefits that will be accounted for in the CBA. The with/without project approach is used, which means that only those costs and benefits which differ between the two systems will be considered. The 'with' project involves having women as pump mistries, the 'without' project is retaining the original system of male mistries.

The costs we have identified are:

1. Training costs including refresher courses.
2. Costs of tool kits and bicycles.
3. Costs of PHED campaigns.
4. Opportunity cost of labor.
5. Costs of handpump breakdown.

Other costs such as honorarium to mistries, fixed costs for regular maintenance, cost in selection of suitable trainees, costs of the fitter and administrative costs are equal for both systems, and are thus excluded using the with/without definition.

The identified benefits are:

1. Income generation.
2. Health awareness.
3. Human resource development.
4. Women empowerment.

The largest benefit of having a well functioning maintenance system is the provision of clean water. We have assumed this benefit equal for both systems, and there is no need to quantify it.

6.2 Quantification and valuation of costs and benefits[10]

All costs and benefits are calculated per handpump per year. We will compare the costs of maintaining one handpump under both systems. The future costs are projected from the prevailing situation, and we have assumed them constant in real terms over the time horizon. Our numerical NPV reflects a static picture of the cost structure. The reason for doing this is that we need a common unit of measurement to perform a comparative study of the two maintenance systems.

6.2.1 Quantification and valuation of costs

The cost data is comparatively easier to quantify and evaluate than the benefit data. Most of the cost data is collected from SWACH accounts and interviews in Udaipur and Banswara. Since one male mistry, or a team of three female mistries are supposed to maintain approximately thirty handpumps, we will divide all overhead costs, such as training and costs for tool kits, by thirty to acquire a cost measure per handpump.

1. Direct training costs.

There is a difference in training programs for men and women. Men are trained by the Industrial Training Institute, ITI, and women by the SWACH program. The SWACH program is a condensed version of the ITI scheme, but it also covers basic health and sanitation issues (personal communication, Audichia). Since we have not observed any negative differences in maintenance performance, and rather positive differences in sanitation information performance, we endorse the attitude of the SWACH training personnel and consider the SWACH program at least equal to the ITI program.

The cost per pump for training mistries is INR 135 for the female system and INR 42 for the male system.

[10] We have placed the longer calculations of this section in Appendix II. The figures in this section are rounded off.

Both male and female handpump mistries will go through a refresher course every second year. The cost per pump for this course is INR 5, which gives a cost per pump for every female mistry team of INR 15.

2. Costs of tool kits and bicycles.

A full tool kit for a handpump mistry costs about INR 3500. This tool kit is intended for usage on 30 handpumps, thus the cost per handpump is INR 117. For women this cost is borne by SWACH. The men have to buy their own tool kits, and these are subsidized by the government[11]. Calculating an average subsidy of 40%, the cost borne by the government is approximately INR 47 per handpump.

In order to facilitate women's mobility, SWACH plan to equip all female handpump mistries with bicycles at a cost of INR 85 per pump.

3. Costs of PHED campaigns.

The PHED (Public Health Engineering Department) carries out biannual campaigns, aiming at the repair of every pump which is out of order. An effective maintenance system means less resources being spent on these campaigns. The cost for the PHED of repairing one handpump varies from INR 250 to 600 depending on the distance that has to be covered by the repair team and the nature of the breakdown (personal communication, Bhargava). In Garli block, where we conducted most of the field study, the average breakdown rate for the spring 1990 campaign was approximately 25%, a percentage which has remained roughly the same over the past three years (UNICEF 1990a).

If we look at the number of repairs in Garli block of handpumps maintained by men and compare that to those maintained by women, we find a notable difference. For female mistries, the breakdown rate is about 6%, and for male mistries 27% (BDO, Banswara). Even

[11] The subsidies are 50% for tribals, 35% for scheduled castes and 25% for 'others' (personal communication, K Bhandari).

though the sample is very small[12] we consider the difference noteworthy. As we could not acquire these figures for the other blocks where women work, we will use the result from Garli block, keeping in mind the uncertainty of the values.

Using an average cost of INR 400 per handpump repaired by the PHED, and the average breakdown rates from Garli block, the average annual PHED repair cost per pump maintained by a female is INR 48. The annual cost for an average handpump tended by a male comes to INR 216.

4. Opportunity cost of labor.

During the period of training for the handpump mistries, as well as when they do maintenance or repair work, they cannot carry out any other work. Thus there is an indirect cost to society when the mistries are trained and when they work, which we will estimate at the social opportunity cost of labor.

The financial value attributed to a rural woman's work is either nil, if she only performs household work, or her wage if she is an income earner. The economic value, however, must include the social value of household work and community management, and her share of the value of agriculture produce, thus rendering a value higher than the financial. This economic value is the shadow wage for women.

A man works in agriculture and husbandry and maybe supplements this with wage-earnings during the months of the year when there is no field work to be done. The financial value of his work is the wage earned and, if he sells agricultural produce, these earnings. In order to estimate the economic value, i e the shadow wage, the social value of his labor in the fields will have to be added.

[12] Garli block has merely 4% of the total population in the project area. The average breakdown rate for the project as a whole is 24% (PHED, Udaipur). The 27% breakdown rate for men in Garli can thus not be seen as exceptional.

As we do not have the means to find the shadow wages for men and women using the technique outlined above, we will infer them by an alternative method that involves the intensity factor introduced in section 5.1. By setting a range of values within which we expect to find the intensity factor, and by multiplying this factor by a gender-neutral opportunity cost of labor, we obtain an interval estimate of the shadow wages for a days work. We will use the opportunity cost of labor derived in section 4.3 as the gender-neutral opportunity cost of labor; in our base case: INR 13.50, and in a high value case: INR 22.

Assuming society values one hour of 'production' as equal for men and women, irrespective of the task performed, and the productivity per hour is the same, then women contribute more to society in a day's work than men, as they work longer hours. If men work an average of eight hours per day and women work 14 hours per day, women contribute 1.75 times as much as men. Under the above assumption the intensity factor for women labor is 1.75.

If, however, men are more productive per hour worked, or the chores which men perform have a higher value to society, men might during their eight hours produce a value which is equal to, or exceeds, the women's 14 hours of work. However, it seems unlikely that men's work should be valued nearly twice as much as work performed by women. The intensity factor would thus not be below 1.00, giving the other extreme of a range within which we expect the intensity factor to lay.

We therefore estimate the shadow wage for men to be a minimum of INR 13.50 and a maximum of INR 22, depending on which measure of opportunity cost of labor we use. The women's shadow wages will, in addition, be dependent on the intensity factor and will be expressed in intervals: INR 13.50-23.65 and INR 22-38.50.

The opportunity cost per pump per year for training will be the number of days spent on training multiplied by the respective

shadow wages. In the base case the opportunity cost for men will be INR 61, in the high value case it will be INR 99. For women, the corresponding intervals are INR 71-124 and INR 115-202.

The time spent on performing maintenance and repair is the second source of opportunity cost to society. We have based our estimates of these costs on the field study as well as on personal communication. The base case opportunity cost of maintenance and repair for female handpump mistries is INR 100-175, in the high value case INR 163-285.

Our field study shows that men tend to do less preventive maintenance than women, something which we see as one of the determining factors of the difference in PHED repair frequency between men and women. Inhabitants of the villages with male mistries claimed that their pump mistry only showed up when they called him. Considering some male mistries have to travel up to 40 kilometers to some handpumps, this is not a very surprising finding. Consequently, we will assume that men spend nil hours on preventive maintenance.

Using the estimate of repair time per pump per year for women, 4.5 hours, and assuming that this corresponds to an average breakdown rate of 6%, the commensurable figure for men would be 7.5 hours.

The cost to society for maintenance and repair under the male system is INR 27 in the base case and INR 44 in the high value case.

5. Cost of handpump breakdown.

If a pump is out of order, women will have to walk to alternative, possibly infected, water sources. The cost of breakdown will thereby be directly proportional to the downtime of the pump, walking distance to alternative water source and the quality of this alternative source. The cost of downtime can be measured as the opportunity cost for women's labor for the extra

time spent on fetching water. An additional cost to society of a pump being out of order is the indirect financial loss of capital invested in the pump. In a study conducted in Coimbatore on the performance of the India Mark II (UNICEF 1990b), the indirect financial cost of downtime was calculated to INR 15 per day[13].

The opportunity cost of labor added to the indirect financial cost for every day that a handpump is out of order comes to INR 21-25 in the base case and INR 24-31 in the high value case.

Average downtime[14] for handpumps maintained by women is one to two days, for pumps maintained by men, four to five days. In the more remote and scattered areas, downtime exceeding 15 days is not uncommon. As the latter figure seems more a result of location and communication rather than maintenance system, we will base our calculations on four to five days.

Multiplying the cost per day by the average downtime, the cost of breakdown under the female maintenance system is approximately INR 31-37 using the base case opportunity cost and INR 36-47 using the high value cost. For the male system they are approximately INR 93-112 and INR 109-140, respectively.

The health hazard of drinking from possibly infected water sources is an intangible cost which is very difficult to quantify. An evaluation would include knowing the pattern of substitution of water sources among the villagers; data on probability of infection for different water sources in different

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[13] This was calculated as: the interest (12%) on capital cost + maintenance cost + depreciation cost (lifetime approximately 15 years) all divided by 365 to get the indirect financial loss of 15 INR per day (UNICEF 1990b, p 34).

[14] We base our estimates of average downtime for handpumps maintained by men and women from the results of our field study as well as from interviews with officials of SWACH, UNICEF and PHED, Udaipur.

areas at each point in time; and the value of health. None of this data is available, and we will therefore not quantitatively evaluate this effect.

6.2.2 Quantification and valuation of benefits

The benefits of having female mistries are to a large extent intangible. Rather than attempting to evaluate effects which are virtually impossible to measure, we have chosen to present the benefits qualitatively.

1. Income generation.

The benefit of receiving an income, and thereby being able to improve life for the family is an important element of the SWACH project. For several of the male mistries the maintenance work is their family's sole monetary income and a female mistry we spoke to was financing her husband's education through her honorariums from SWACH.

As both men and women who work as pump mistries come from low-income groups, the value of income could be considered the same for both sexes. However, if the women, as we have stated earlier, spend a larger share of their income on items which are socially desirable, the economic value of income accruing to women should be higher than that accruing to men. If it were possible to derive gender income weights, the income accruing to the male mistries should be weighed in order to show that society values their consumption pattern lower than that of the women. We will not estimate the magnitude of this weight, but in the sensitivity analysis we will see how large it needs to be in order to be of critical importance.

2. Health awareness.

An ambition of the government of Rajasthan is to improve health conditions in the state. Increasing the villagers' awareness of the importance of clean water for health is a benefit to society if the awareness results in changed habits and thereby augments health and productivity.

According to Boserup (1989) women are the bearers of traditions in a society. As a result, attempts to change attitudes and customs in a society are best mediated through women. By training women as mistries an investment in spreading the health message is also made. Mr Bhandari (personal communication) claimed female handpump mistries perform far better in sanitation information than do male, something which was confirmed by our field study. Women who have a feeling of responsibility for their water pump will have a greater incentive to propagate its use among other women, and thereby speed up acceptance of the handpump in the village.

The ITI scheme, under which the male mistries are trained, does not discuss the health aspects of clean water; consequently men repair the handpumps, but do not talk to the women (or men) about water and sanitation. During the SWACH refresher course the connection between clean water and health is stressed, and the participants are instructed to convey the message to the villagers. It seems, however, that the women are less apt to listen to the male mistries: "He tried to teach us, but we all laughed", one village woman answered when asked if the (male) mistry talked about health and sanitation.

To conclude; female mistries are more likely to effectively spread the health message to the villagers, thereby contributing to changing attitudes and habits with regards to water. The benefit of training women is, in this respect, higher than that of training men.

3. Human resource development.

Education is recognized as an important instrument in human resource development, yet women are often neglected when it comes to schooling. In Rajasthan only 11% of the students enrolled after sixth grade are female (Dayal 1989, p 26). This means that almost half of the population is never given a chance to develop their individual skills, nor can they fully partake in the development process. According to Sarin (1989) a common feature of Indian family survival strategies is that when the family

experiences economic problems, the education of women tends to be disregarded.

> "..Leaving questions of justice and fairness aside, women's disproportionate lack of education with its consequences in low productivity, as well as for the nutrition and health of their families, has adverse effects on the economy at large." (Moser 1989, p 1821 quoting World Bank (1979), Recognizing the 'Invisible' Women in Development, The World Bank Experience, Washington D C, p 2)

Society gains by increasing the level of education among women. By training women as pump mistries two 'show-case' effects are attained:

- Society's attitudes towards women and learning will be influenced. As women are seen taking care of handpumps successfully, it is proven that time and money spent on a girl's education is not wasted.
- Women gain confidence from seeing other women being able to do traditional men's work, including technical tasks. There is a new awareness about the abilities of women.

In the villages we visited, we could see a polarization in attitudes towards female capability. We asked women in villages where there was a female mistry, as well as villages where there was a male mistry, whether they thought that a woman could perform well in technical chores. In villages where there was a male handpump mistry, the women seemed baffled by the question and unanimously replied in the negative. The attitudes were totally opposite in villages where women had proved themselves to be good mechanics.

There was also a difference in openness about the performance of mistries. Where there was a man to tend the pumps, there seemed to be a sentiment of not interfering in the man's work, even though the functioning of the pumps greatly affects the lives of the women. In villages where a woman tended the pumps, however, women in general were less taciturn about the performance of the mistry.

Dr Bhatnagar, Project Officer for SWACH-UNICEF, commented on the fact that quite a number of the women the project had trained were recruited by other agencies and the state for further training, i e to nurses. She said at first she had been upset over this evolution, but then realized that even the basic training involved made these women more attractive for further advancement.

In sum, teaching women to maintain the pumps meets a practical gender need, but also lays the foundation for satisfying a strategic gender need.

Training men is, of course, also beneficial to society, and it is difficult to say whether or not this is less beneficial than of training women. In the long run, however, neglecting women's potential will slow down the development process, both because of the waste of man-power, and because women need to be enlightened in order to change attitudes in society.

4. Women empowerment.

The dictionary definition of empowerment is to give power or authority; women empowerment, however, is often interpreted as a quest for equality and equity. The SWACH project has enabled women to perform tasks previously reserved for men, which has increased these women's self-confidence and self-esteem and augmented the awareness of women's abilities.

Training of women as pump mistries means loosening the traditional division of labor between men and women in rural areas. In the project area, all tasks which include skill or aids are performed by men. In other words, women perform all agricultural work except plowing and marketing, which the men do as it involves using oxen; by the same token it is rare to see women use bicycles as a means of transportation. The female mistries felt a bicycle would facilitate their work, and asked if SWACH could provide bicycles for them. The fact that these women had already learned something technical gave them

confidence to seek means that would make their work easier and more efficient, even though this meant intruding further into the men's world.

If women began to employ equipment and tools which facilitate their work, it would substantially increase their productivity and shorten their working day.
In similar projects in Kenya (Narayan Parker 1988) and Ethiopia (Poluha 1989) women began to produce goods for market sale in order to finance the maintenance of their handpump. One way to measure the effects of their empowerment might be to value this produce at market price, and say that society, by giving women 'power' over the pumps, has benefitted by at least this amount.

As stated in section 5.1 the effects of gender-aware development are difficult to observe, and even more difficult to evaluate. We have tried to discuss some of the effects that the SWACH project has on women's lives and village development. In order to observe the long-term effects a follow-up study, looking at changes in attitudes and social structure, would have to be conducted. Supporting women too much might harm the family and social balance, possibly to the detriment of society.

In sum, we expect the value of intangible benefits to be larger under the female system than under the male system. Furthermore, we expect these benefits to increase over time, unless there are problems with social acceptance. Some of the benefits will occur in the form of reduced costs, i e the women could work in pairs instead of in groups of three. The full impact of the intangible benefits can hardly be seen within the short time horizon chosen for the analysis.

6.3 Base case results

In our base case we use the following parameters: discount rate of 12%; wage rate of INR 13.50; and an intensity factor ranging from 1 to 1.75. A numerical NPV is calculated by subtracting the discounted tangible costs for the male system from the

discounted tangible costs of the female system. The intangible effects are not included in our numerical NPV.

Using the base case parameters, we obtain a NPV of INR 318 to 734 per pump. A positive numerical NPV means the project, without considering intangible effects, is socially profitable. By implementing the system with female mistries, the cost to society of handpump maintenance is reduced.

The intangible effects should be added to the numerical NPV. The intangible benefits we have identified for the project are:

- increased confidence and self-esteem of women,
- increased awareness of women's potential,
- boosted impact of the health message, and,
- improved consumption pattern from mistry's income.

An intangible cost is the cost of reduced health depending on the quality of alternative water sources used when handpumps have broken down. The net value of intangible effects we take to be greater under the female system than under the male.

6.4 Sensitivity analysis

In order to obtain a picture of to what extent uncertainties about the parameters affect our final result, we will compute NPV under different parameter value assumptions.

Using a discount rate of 12%:

		Intensity factor	
		1.0	1.75
Base case	13.50	734	318
High value	22	529	-148

Using a discount rate of 9%:

		Intensity factor	
		1.0	1.75
Base case	13.50	868	397
High value	22	633	-134

The intangible effects should be added to these values.

In our base case, the numerical NPV is positive regardless of the intensity factor chosen. With the high value shadow wage and assuming an intensity factor of 1.586 or above, the project's numerical NPV turns negative. The numerical NPV is sensitive to the assumption made about the size of the intensity factor. If we assume the intensity factor to be less than this switching value, the project will be economically profitable no matter what parameter values are assumed.

Using the same parameters as above, a gender income weight of 1.19 would render this numerical NPV (-148) zero, i e if we believe the social value of a woman spending INR 100 is equal to that of a man spending INR 119, the project is profitable even under the assumption of the least favorable parameters. However, it seems rather unlikely that the weight should be this large, but at least it gives an indication of the magnitude needed to make an impact on the result.

The costs which is primarily responsible for the relative costliness of the male mistries are those of the PHED campaigns. These cost are dependent on the number of pumps that break down during a campaign. As a consequence, the NPV is sensitive to assumptions made about handpump breakdown rates for men and women. Using the intensity factor 1.75 under the base case assumptions, a change in men's handpump breakdown rates from the Garli block average of 27.4% to the project area average of 24.7% decreases the numerical NPV from INR 318 to INR 183. This sensitivity of the NPV value should be held in mind as our observed breakdown rate was taken from a small sample, which limits its statistical reliability.

Furthermore it should be considered that preventive maintenance is a determining factor of the difference in breakdown rates. The care taken to minimize the distance to pumps when selecting the female pump mistries increases the possibilities of these

mistries to perform preventive maintenance. Thus the large difference in PHED campaign costs might not be a result of gender, but of distance to pumps.

7. DISCUSSION AND CONCLUSIONS

The economic analysis of the project, including adjustments for market failures and distortions, renders a positive numerical NPV under the base case assumptions. Adding the intangible effects will strengthen the positive result. The result is not adversely affected by changing the discount rate to the consumption rate of income. If the high value opportunity cost of labor is used, the numerical NPV is positive when an intensity factor of women's labor of 1.586 or less is assumed. In order to render the NPV positive under the least favorable assumptions, a gender income weight greater than 1.19 is needed. Furthermore, the NPV is sensitive to changes in the assumed breakdown rates of handpumps.

Two differences, emanating from gender, which affect the NPV of a project are differences in working characteristics and in expenditure patterns. To account for these differences we have identified two weights - the intensity factor and the gender income weight.

The intensity factor reflects the disparity in social opportunity cost of labor, a disparity which stems from the distinct roles men and women play in society. Failure to recognize these differences in valuation will render a NPV that does not indicate the true costs and benefits to society. In our analysis, a high opportunity cost of female labor would affect the NPV adversely.

Assuming that women's consumption has a higher value to society than men's, the social value of income accruing to women would be higher than that accruing to men. The gender income weight adjusts the NPV for this difference in valuation, and thereby

increases the NPV of a project utilizing female labor. In a project where income generation is significant, weighing income according to gender could even determine whether a project is deemed socially profitable or not.

This analysis compares two more or less identical maintenance systems, differing only in terms of who performs the maintenance, a man or a woman. The positive NPV shows that the project has achieved greater economic efficiency by taking gender differences into consideration.●

REFERENCE PERSONS

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Ms Rita Sarin, Advisor, Women's Development Programme DCO SIDA, New Delhi.

Mr Arun Surana, Junior Engineer, SWACH Udaipur.

Mr Wahid, Water Program Officer, UNICEF MNIO, New Delhi.

Mr Håkan Wilson, Former Consultant to Head of Sanitary and Water Department, UNICEF, New York.

FIELD STUDY INTERVIEWS

Mrs Bhagwati, handpump mistry and social animator, Garli Block.

Mr Gajanand, handpump mistry, Garli Block.

Miss Kamla, handpump mistry and social animator, Peepalkhunt Block.

Mrs Laxmi, handpump mistry and social animator, Garli Block.

Mr Ram, handpump mistry, Garli Block.

Mr Ramlal, handpump mistry, Garli Block.

Mrs Santosh, handpump mistry and social animator, Garli Block.

We also talked to the villagers in the villages Agarpura, Bhaghora, Bodia, Karampur, Madelda, Novabhader, Theekaria in Garli Block and Adhi Bheet in Peepalkhunt Block.

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APPENDIX I - THE FIELD STUDY.

We conducted our study in the district of Banswara, in Garli and Peepalkhunt Blocks. The reason for choosing the district of Banswara was that training female handpump mistries was first implemented here. Garli and Peepalkhunt blocks are the only two blocks in Banswara where there are female pump mistries. The villages we interviewed were chosen because of their availability. The heavy rains limited the number of villages possible to reach by jeep.

We conducted interviews in seven villages in Garli block, and one in Peepalkhunt. When interviewing a village, we first approached the villagers, asking them about the performance of their handpump mistry. Then we interviewed the handpump mistry concerned. All interviews were carried out as semi structured questionnaires with an interpreter (Mr Bhandari, SWACH, Banswara).

Interestingly, we often found a discrepancy between what services the mistry claimed to have performed, and the services the villagers felt they had received.

Unfortunately, due to not knowing the language we found it very hard to pose any questions that would reflect attitudes among the interviewees.

Questionnaire for handpump mistries.

1. Name/age? 2. Married/No of children? 3. Tribal/non-tribal?
4. Landowner/What size? 5. Total Income? 6. How do you spend it?
7. How much time per day do you spend on:

a	Work in the fields?	b	Handpump maintenance and repairs?
c	Other work?	d	Collecting wood?
e	Grazing Cattle?	f	Fetching water?
g	Cooking?	h	Cleaning/washing?

Total hours worked per day? How much does your husband/wife work?
8. How many handpumps do you serve?
9. Do you go every day to repair/maintain a pump?
10. Do you always repair a pump as soon as you hear it's broken?
11. Do you think it is important that all the pumps in a village are working?
12. When doing heavy repair, are you assisted?
13. What advantages do you feel you have as a pump mistry?
14. What disadvantages do you feel you have as a pump mistry?
15. Do you look after working pumps?
16. (Men) Do you have a full set of tools? How much did it cost? Were you subsidized?

Questions to the villagers.

1. Name of village?
2. Number of households?
3. Percentage tribals?
4. How many handpumps are there in the village?
5. How many of the handpumps are working?
6. What is the average downtime, from breakdown to fully repaired?
7. Do you have a male or a female mistry?
8. Does the mistry inform you of sanitation?
9. Do you drink handpump water?
10. How far do you have to walk if the handpumps are out of order?
11. Do you think women can be good mistries?
12. Do you think your mistry is doing a good job?
13. Does the mistry listen to you?

APPENDIX II

Calculations from section 6.2:

1. Direct training costs.
SWACH training: INR 1350 per mistry * three mistries divided by 30 pumps = INR 135

ITI training: INR 1250 per mistry divided by 30 pumps = INR 42

2. Costs of tool kit and bicycles.
Cost of tool kit, women: INR 3500 / 30 pumps = INR 117.

Cost of tool kit, men: INR 3500 * 0.40 (subsidy rate) / 30 pumps = INR 47.

3. Costs of PHED campaigns.
PHED cost of repair for average pump maintained by a female mistry:
INR 400 (average PHED cost) * 0.06 (percentage of pumps repaired)* 2 (twice yearly)=INR 48.

PHED cost of repair for average pump maintained by a male mistry:
INR 400 (average PHED cost) * 0.27 (percentage of pumps repaired)* 2 (twice yearly)=INR 216.

4. Alternative cost of labor.
High value shadow wage interval for women = INR 22-38.50
High value shadow wage for men = INR 22

Low value shadow wage interval for women = INR 13.50-23.65
Low value shadow wage for men = INR 13.50

Alternative cost of labor per pump during training, women: 15 days (classroom) + 75 (field) * 0.5 (half-day); divided by 30 pumps, multiplied by three women equals 5.25 days.

High value case: 5.25 days * INR 22-38.50 = INR 115-202
Base case: 5.25 days * INR 13.50-23.65 = INR 71-124

Alternative cost of labor per pump during training, men: 90 days (classroom) + 90 (field) * 0.5 (half-day); divided by 30 pumps equals 4.5 days.

High value case: 4.5 days * INR 22 = INR 99
Base case: 4.5 days * INR 13.50 = INR 61

Alternative cost of labor per pump for maintenance and repairs, women:

Preventive maintenance (not conducted in a group): 1 hour (working time) multiplied by 24 (twice monthly) = 24 hours.

Regular maintenance: 3 (no of women working) * 2 (twice yearly) * 5 (travelling + working time) = 30 hours.

Maintenance of malfunctioning pumps: 5 hours (travel and work) * 8 to 10 times per year * 3 (no of women) divided by 30 (no of pumps) = 4 to 5 hours.

Total hours spent on maintenance and repairs = 59 divided by 8 hours per day = 7.4 days.

High value case: 7.4 days * INR 22-38.50 = INR 163-285
Base case: 7.4 days * INR 13.50-23.65 = INR 100-175

Alternative cost of labor per pump for maintenance and repairs, men:

Preventive maintenance: 0 hours.
Regular maintenance: 2 (twice yearly) * 5 (4 hours working time and 1 hour travelling time) = 10 hours.

Maintenance of malfunctioning pumps: using the break-down ratios found in Garli block, 6 % results in on average 4.5 hours repairs of malfunctioning pumps, 27 % would imply 7.5 hours spent on repairing malfunctioning pumps (27 / 6 * 4.5 / 3).

Total hours spent on maintenance and repairs = 17.5 divided by 8 hours per day = 2 days.

High value case: 2 days * INR 22 = INR 44
Base case: 2 days * INR 13.50 = INR 27

5. Cost of handpump breakdown.
Female system: INR 15 (indirect financial cost) + shadow wage of women * 3.33 (hours) all multiplied by 1.5 (average downtime) = INR 40-53 base case and INR 51-73 high value case.

Male system: INR 15 (indirect financial cost) + shadow wage of women * 3.33 all multiplied by 4.5 (days downtime) = INR 121-161 base case and INR 154-219 high value case.

BASE CASE 1.0 Break down 24.7%

COSTS	1990 WOMEN	MEN	1991 WOMEN	MEN	1992 WOMEN	MEN	1993 WOMEN	MEN	1994 WOMEN	MEN
TRAINING COST	135	42	0	0	0	0	0	0	0	0
REFRESHER COURSE	0	0	0	0	15	5	0	0	15	5
TOOLKIT	117	47	0	0	0	0	0	0	0	0
BICYCLE	85	0	0	0	0	0	0	0	0	0
PHED	44.4	197.6	44 4	197.6	44.4	197.6	44.4	197.6	44.4	197.6
OPP COST OF LABOR										
-TRAINING	70.875	60.75	0	0	0	0	0	0	0	0
-MAINT & REPAIR	99.5625	28.14020	99.5625	28.14020	99.5625	28.14020	99.5625	28.14020	99.5625	28.14020
COST OF BREAKDOWN	30.92906	92.78718	30.92906	92.78718	30.92906	92.78718	30.92906	92.78718	30.92906	92.78718
BENEFITS										
INCOME GENERATION	132	132	132	132	132	132	132	132	132	132
WOMEN - MEN	-102.222		114.5056		95.11934		91.28316		75.82855	

1995 WOMEN	MEN	1996 WOMEN	MEN	1997 WOMEN	MEN	1998 WOMEN	MEN	1999 WOMEN	MEN	2000 WOMEN	MEN	WOMEN	
0	0	0	0	0	0	0	0	0	0	0	0	-121	-38
0	0	15	5	0	0	15	5	0	0	15	5	-36	-12
0	0	0	0	0	0	0	0	0	0	0	0	-104	-42
0	0	0	0	0	0	0	0	0	0	0	0	-76	0
44.4	197.6	44.4	197.6	44.4	197.6	44.4	197.6	44.4	197.6	44.4	197.6	-264	-1173
0	0	0	0	0	0	0	0	0	0	0	0	-63	-54
99.5625	28.14020	99.5625	28.14020	99.5625	28.14020	99.5625	28.14020	99.5625	28.14020	99.5625	28.14020	-591	-167
30.92906	92.78718	30.92906	92.78718	30.92906	92.78718	30.92906	92.78718	30.92906	92.78718	30.92906	92.78718	-184	
132	132	132	13	132	132	132	132	132	132	132	132		
72.77038		60.45006		58.01210		48.19041		46.24689		38.41710		NPV	599
												TOT NPV	17060133

BASE CASE 1.75 Break down 24.7%

COSTS	1990 WOMEN	MEN	1991 WOMEN	MEN	1992 WOMEN	MEN	1993 WOMEN	MEN	1994 WOMEN	MEN
TRAINING COST	135	42	0	0	0	0	0	0	0	0
REFRESHER COURSE	0	0	0	0	15	5	0	0	15	5
TOOLKIT	117	47	0	0	0	0	0	0	0	0
BICYCLE	85	0	0	0	0	0	0	0	0	0
PHED	44.4	197.6	44.4	197.6	44.4	197.6	44.4	197.6	44.4	197.6
OPP COST OF LABOR										
-TRAINING	124.0312	60.75	0	0	0	0	0	0	0	0
-MAINT & REPAIR	174.2343	28.14020	174.2343	28.14020	174.2343	28.14020	174.2343	28.14020	174.2343	28.14020
COST OF BREAKDOWN	37.25085	111.7525	37.25085	111.7525	37.25085	111.7525	37.25085	111 7525	37.25085	111.7525
BENEFITS										
INCOME GENERATION	132	132	132	132	132	132	132	132	132	132
WOMEN - MEN	-205.065		65.05703		50.96883		51.86307		40.63204	

1995 WOMEN	MEN	1996 WOMEN	MEN	1997 WOMEN	MEN	1998 WOMEN	MEN	1999 WOMEN	MEN	2000 WOMEN	MEN	WOMEN	MEN	
0	0	0	0	0	0	0	0	0	0	0	0	0	-121	-38
0	0	15	5	0	0	15	5	0	0	0	15	5	-36	-12
0	0	0	0	0	0	0	0	0	0	0	0	0	-104	-42
0	0	0	0	0	0	0	0	0	0	0	0	0	-76	0
44.4	197.6	44.4	197.6	44.4	197.6	44.4	197.6	44.4	197.6	44.4	197.6	44.4	197.6	-264	-1173
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-111	-54
174.2343	28.14020	174.2343	28.14020	174.2343	28.14020	174.2343	28.14020	174.2343	28.14020	174.2343	28.14020	174.2343	28.14020	-1035	-167
37.25085	111.7525	37.25085	111.7525	37.25085	111.7525	37.25085	111.7525	37.25085	111.7525	37.25085	111.7525	37.25085	111.7525	-221	
132	132	132	132	132	132	132	132	132	132	132	132	132	132		
41.34492		32.39161		32.95991		25.82239		26.27544		20.58545			NPV		183
													TOT NPV		5210796

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