

A Turning Point? Water Saving Technologies in North Gujarat's Groundwater Socio-ecology

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ABSTRACT

Introduction of technology brings about changes in socio-economic development of society, as in information technology and computers, and plastic industry. Micro-irrigation is one such technology, where water saving technology or devices is used, like drip and sprinklers. This technology saves water, energy, labour, pesticides and fertiliser as there is less scope for waste. Use of this technology increases production of crops if properly chosen and the technology is used correctly. The North Gujarat Initiative of International Water Management Institute initiated interventions using Water Saving Technologies (WST) in Banaskantha district five years ago. They also introduced vermiculture and horticulture along with WST. So a three-way intervention has brought a 'synergic' effect in the farmers' economy. The farm and non-farm economy has been changed significantly in Banaskantha district. A large increase in the farm income has brought a new dimension in the life-style of the adopter farmers' society. The introduction of technology has led to a 'movement' of technology adoption and perhaps reached a 'turning point'. WSTs are perhaps playing a strong role in pushing agriculture to a significantly higher level of resource-productivity.

Introduction

It has become a maxim that technology enhances the socio-economic development in a society. This is a worldwide phenomenon since centuries. One of the eminent authors of the historiography of the technical progress writes in his book 'Inside the Black Box' that "technical progress is inseparable from the history of civilisation itself, dealing as it does with human efforts to raise productivity under an extremely diverse range of environmental conditions" (Rosenberg, 1982). The technical progress, the diffusion of new technologies and finally the 'spin-off' in a typical technology makes the impact of technical progress upon productivity and growth. From telephone to television, automobile to mobile phone, information technology, hybrid seed to dry land farming and flood irrigation to micro irrigation – all these have established that they brought development and changes in the socio-economic conditions in a country. However the degrees of change depend on the internalisation of the technologies and their intensive and extensive uses in the society. For example, extensive and intensive use of technologies in medicine, communications and computers are changing the world scenario in a different dimension. The term 'technology' has been described or defined in many different ways and in many related things³.

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³ In the Longman – Dictionary of Contemporary English, "Technology" defined as – (1) knowledge about scientific or industrial methods or the use of these methods; (2) machinery and equipment used or developed as a result of this knowledge (p. 1481; 3rd edition, 1995).

The process of development of a particular technology gives rise to parallel development in some other technologies in order to provide alternative, competitive and appropriate solutions for different economic, geographical and social environment needs. Technological development also becomes necessary to mitigate the adverse effects of a particular technology, for example, the changes in plastic technology and mitigating its pollutants. It is seen that technological development encompasses and influences a very large segment of the society and the 'spin-offs' of technological development, in general, are beneficial to the society at large. On the whole, technological development is a continuous process and is inevitable. It benefits the society largely, provided appropriate checks and balances are applied to ensure that the adverse effects are avoided to the extent possible. It is also to be seen that whether the technology is reaching to the last person of the society so that total society gets the benefit of technology, whether it is mobile phone or micro-irrigation.

Micro-irrigation is a process of irrigation and practised where availability of irrigation water is scarce. Where water is available in plenty people go for conventional flood irrigation and furrow method of irrigation. In this method people realized later that plant gets water more than it needs. Plus there is loss of water due to evaporation, transportation (conveyance loss) and there is water-logging between the rows and between the plants. In water stressed areas, people have been traditionally applying water using earthen pots with tiny holes at the root zone of a plant. The same principle has been developed into a durable, portable, and affordable technology, during the last five decades. An entire amalgamation of technologies are today together known as water saving technology (WST). Eventually, especially after the second world war and with 'the creation of inexpensive, weather-resistant plastic' (Postel et al, 2001) made the development of drip or sprinkler irrigation easy although commercial perfection and large scale use took place in Israel before 40 years.

Compare to the conventional flood and furrow irrigation, the micro-irrigation system saves water, by reducing the loss of water due to transportation (conveyance loss) and evaporation between the plants. Since most types of weeds grow very less or not at all, weeding operation is all most nil, thus saving labour. The fertilisers and pesticides are used through pipes mixed with water flow therefore no extra labour is required for putting fertiliser at the plants roots (fertigation) or not to spray pesticide (chemigation) on them. It is found that using this technology the yield of crops increased by about 100% to 200% from the same unit of area (Sivanappan, 1994 and GGRC, 2008).

There are about eight different micro-irrigation systems are in practice now – such as (1) Micro Tube Drip, (2) Mini Sprinkler, (3) Micro Sprinkler, (4) Easy Drip/ KB Drip, (5) Inline Drip, (6) IDE Local Sprinkler, (7) Overhead Sprinkler and (8) Naan Sprinkler. Individually all these apparatus have their specific use, which depends on the soil condition, crop to be grown and water quality. There are many manufactureres world wide and in India also. However in India certain parts of the sprinklers and drips are imported. World's first commercial production started by Netafim; and in India, during 1989, Jain Irrigation started pioneer effective water-management through Drip Irrigation. Before Jain Irrigation, Netafim used to import and assemble the complete system.

“Micro-irrigation technologies (drip and sprinkler-based systems), first perfected in Israel during the 1960s, have spread to many other parts of the world, especially in the USA” (Shah and Keller, 2002). However it was during the 1970s this technology was introduced in India mostly

in the water stressed areas of Maharashtra and Southern India. “Micro-irrigation is especially well adapted for undulating terrain, shallow soils, porous soils, and water scarce areas. Saline/brackish water can also be used since water is applied daily, which keeps the moisture and salt stress at a minimum” (Sivanappan, 1994). “Two major environmental problems associated with the conventional method of irrigation, such as soil salinity and water logging, are also completely absent under DMI (Drip Method of Irrigation)” (Narayanamoorthy, 2004). In the same paper Narayanamoorthy cited from ICID (International Commission on Irrigation and Drainage) survey that area under micro-irrigation has increased from just 40 ha in 1960 to about 54,600 ha in 1975 and further to about 1.78 mha in 1991 [INCID, 1994]; according to recent estimates, the global area under micro-irrigation has roughly expanded by 75% since 1991, which could be approximately 2.8 mha (Narayanamoorthy, 2004). However, ICID database shows that India’s total irrigated area is 57.19 mha of which the area under sprinkler is 658,500 ha and area under micro-irrigation is 260,000 ha and total total area under sprinkler and micro-irrigation is 918,500 ha, that is, only 1.6% of the total irrigated area (ICID, 2008) Thus in India the area under micro-irrigation is a very small proportion of the total irrigated area. There are 35 countries in the world who are using drip irrigation systems including the USA; the USA alone accounts for over 35% of the world total drip irrigated area (Narayanamoorthy, 2004). The people have now realised that drip irrigation gives 2 times more yield, save water, labour, energy [if metered], increases income if there is good market price, and its many other positive outcomes. But this technology has not been internalised within the farmers’ society in compare to its scope. While discussing about the adoption of drip irrigation technology in North Gujarat in his book Dinesh Kumar inferred that it is not only that the ‘awareness’ was low among farmers regarding WST, but also that the necessary condition of ‘economic incentive’ was not up to a mark in favour of adoption (Kumar 2007, Ch 8, pp234-55). He further commented that North Gujarat was one of the ‘greatest paradoxical’ cases in groundwater management. His argument was, when cost of cultivation had increased due to the increased cost of abstraction of groundwater, people were not attempting noticeably for adopting WST or shifting to “low water-consuming crops that could help them maintain the net income from every unit of water and land used” (Kumar, 2007, 237).

Most of the past literatures questioned and tried to find out the benefit-cost ratio of using drip irrigation as compared with conventional flood irrigation. Sivanappan found the incremental benefit – drip cost ratio for various crops ranges from 1.35 to 13.35 excluding water saving and 2.78 to 32.32 including water saving. It has also been proved that drip irrigation is technically feasible and socially acceptable for large, small and marginal farms provided they get tailored or custom-built systems at affordable price. The system is also suitable for hilly and undulated tracts, coastal and sand terrains; and to a great extent it is suitable for water scarce areas of South and Western India (Sivanappan, 1994). Alfalfa accounts for 13 per cent of the total water for irrigation in Gujarat according to some estimates; an experiment was conducted in North Gujarat and it is found that drip irrigation of alfalfa is economically viable compare to conventional irrigation as its B/C ratio is 1.28 to 2.78 when economic value of water is included (Kumar, 2007, p. 183). This also reduced water application from about 7 to 43 per cent and yield increased from 7.9 to 10.8 per cent (Kumar 2007, Table 6.2, and 6.3 pp. 189-192). Thus, using drip or sprinkler gives rise to higher yield, increases water productivity and help raise farmer’s crop income.

North Gujarat has been experiencing a ground water crisis for the last three decades or more. The farmers of North Gujarat largely depend on ground water for irrigation. People exploited ground

water more than they should, rather they have not used groundwater judiciously, and thereby the crisis has deepened further. “The region with perpetual water scarcity, with varied types of hydrology-deep alluvial, shallow alluvial and some hard rock zones, has responded with great resilience to face the crises of water” (Indu and Singh, 1999, p 22). Solutions to water crises brought in operation of various types of irrigation management structures – individual ownership firms to group co-operative companies. However there was no application of water saving technologies during those days in North Gujarat. Later it is witnessed that introduction of MI systems such as drips and sprinklers have improved the crop output during the last couple of years for those who have adopted the technology. “The North Gujarat Initiative [NGI] was started (in 2002) as an action research project to identify ways to establish local management regimes for addressing north Gujarat’s groundwater depletion problems in 30 villages” (Kumar, 2007, p. 315). They had introduced ‘(1) high-valued and water-efficient orchard crops replacing conventional crops like wheat, bajra; (2) water-saving micro-irrigation technologies for alfalfa, row crops such as cotton and castor, and orchard crops; and (3) vermi-composting and use of organic manure for all crops, replacing chemical fertilisers to ensure enhanced biomass utilisation efficiencies and improved primary productivity and water-retention of degraded soils’ (Kumar 2007, p. 315-6). Thus micro-irrigation devices, vermiculture and horticulture practices together came in vogue towards managing groundwater management in water-stressed North Gujarat. Many beneficiary farmers have changed the cropping pattern from usual traditional crops such as Bajra, Wheat and Alfalfa to high-return crops like Pomegranate, Grapes, Gooseberry and other fruits; some of them even cultivated flowers which they were hesitating to do earlier. Those who are still continuing with potato, cotton and ground nut are getting 2 to 3 times more production after adopting drip or sprinkler technology.

The adoption of WST was very slow. There were lots of ‘ifs and buts’, doubts and prejudices for adoption in the initial stage in year 2002. Eventually when farmers have seen the results of technology in demonstration plots they gradually came forward and started adopting the technology. However most of them were from medium and big farmers in the beginning. In 2005, Government of Gujarat introduced subsidies for micro-irrigation equipments with a new set up of GGRC (Gujarat Green Revolutionary Company). They came with an easy scheme of disbursing subsidy for the MI technology. The subsidy scheme of 50% plus a loan from banks with a more or less straight forward and transparent procedure (for details please see GGRC website, 2008), encouraged all categories of farmers, small and big, to adopt WSTs. The adoption rate has been increased to a very high figure soon after the subsidy was introduced. If one moves around the area where so much of adoption has taken place, one may feel that it’s like a “movement” of WST adoption in North Gujarat from a lone start in 2002 initiated by NGI, presently, there are other NGOs, who are working as partners with NGI, the pioneer of this movement in North Gujarat. This partnership has strengthened the intervention programme of NGI further.

During nineties, this technology was in a baby-stage and there were problems of affordability and acceptability also. A large acceptance started only 2-3 years ago, after the intervention of NGI in 2001-02. There are very few adopters who have adopted and continuously using the technology for more than 5 years. Therefore it is too early to see and appreciate its full benefits and constraints and it may take some more years to assess the socio-economic ‘impact’ till the technology gets properly integrated with the society of the locale.

There is literature available in the area of MI technology regarding its water productivity (Kumar 2007), benefit-cost ratio, increase in farm income (Sivanappan, 1994, Narayanamoorthy, 2004), technical efficiency, developing affordable designs for small plots of smaller farmers, potential market, and its use for poverty alleviation, (Postel, Polak, Gonzales and Keller 2001). However, very little literature is available regarding the study of changes in the socio-economic aspects of society among the adopter farmers. There are works on the effects of large irrigation systems in the society – direct and indirect (Bhattarai et al, 2007) but not specifically for MI technology. There is a good discussion on adoption and impacts of MI technology in Maharashtra and Gujarat by Regassa et al, in 2005 (Namara, Regassa E., et al, 2005). They talked about advantages and disadvantages of technologies, as well as the factors influencing the adoption in good details. They also talked about impact MI technology on women. In their study there is a thin discussion on poverty and women with respect to MI technology. It is a fact that introduction of a technology in a society brings changes in many ways – directly and indirectly both. The changes have many dimensions – social, economical, psychological and cultural also. In a work on awareness and perception of WST among farmers, it was found that level of awareness among farmers was low, drip system was least known, sprinklers were popular and perceptions of benefits and disadvantages was not very clear, however, the point of ‘water-saving’ by using MI system was almost agreed universally (Kumar 2007, ch 8, pp 233-255). But by the end of 2007, farmers’ concept regarding MI systems and WST has changed. This study aimed at examining: [1] who are the takers of MI technologies; [2] whether adoption of MI systems could improve farmers’ socio-economic conditions including income from crop production; and [3] the influence of intervention among adopters and non-adopters by the way of accepting modern agricultural technologies and agronomic practices.

We started with the following broader research questions:

1. Who are the adopters and what are their social and economic backgrounds?
2. Whether adopters accepted or used other allied water saving practices, which extended or deepened the use of the WST than only drip or sprinkler irrigation?
3. Whether the adopters brought more land under this technology or expanded the area under irrigation after adoption?
4. Do the adopters really achieve higher output and income due to MI adoption?
5. Do the farmers change their cropping pattern towards the high-valued crops simultaneously with MI adoption?
6. What are the changes found after the adoption in the socio-economic status of the farmers?
7. Are there impacts of MI introduction extended beyond the adopter families?

Specific Objectives of the Study are to:

1. Determine the socio-economic profile of adopter farmers
2. Analyze the changes in farming systems of the adopters associated with introduction of MI system
3. Assess the depth or intensiveness of MI system use among the adopter-farmers
4. Analyze the socio-economic impact of MI system adoption
 - a. On the household dynamic
 - b. Socio-economic status (crop productivity, economics, net income from farming, food security, asset building)
 - c. Village level dynamic--cropping systems, employment generation, exposure to new farming technology

Methodology:

We selected the study villages on the basis of the depth and extent of adoption of MI systems in the villages. The quantitative information was collected through a set of structured questionnaire which was administered among selected farmers. In order to realize the specific objectives, the following methodology was employed:

1. We analysed the changes in farming system and socio-economic impacts at the household level through “before-and-after” (longitudinal) comparison of adopters and “with-or-without” (cross sectional) comparison between adopters and non-adopters
2. Focus group discussion – among adopters and non-adopters separately in intervened and selected - villages were selected from the diocese of NGI and other agencies, to gather socio-economic information – cropping system, cropping pattern, agricultural labour scenario etc.

Sample size:

Villages were selected, with extensive adoption of MI systems that is where almost all the practices of WST are found, and where largest number of adopters are available, and some villages in contrary, that is where least number of practices of WST and has very less number of adopters in the villages. However we have selected non-adopters from the adopted villages also, to understand the reasons why an adopter’s neighbour still remains as non-adopter. We collected secondary information regarding adoption from NGI as they made the first intervention for MI system in North Gujarat. We also selected some villages from the very recently intervened villages from other districts like Patan and Mehsana, where mostly non-adopters were found. We have tried to select from the oldest adopters earlier than 2002 also, and avoided the recent adopters. The socio-economic changes cannot be seen with two years of income, as the income and consumption gap would be narrow, but we have had to select a few numbers of recent adopters also since we found that the surge of adoption was very high from 2005 onwards.

We selected 63 adopters randomly from 5 talukas of Banaskantha district as it is the first district of intervention. The 5 talukas are Amirgadh, Dantiwada, Deesa, Palanpur and Vadgam. The 32 non-adopters were randomly selected from the same talukas of Banaskantha district, but a few have been selected from the newly intervened talukas like Siddhpur of Patan district and Unjha of Mehsana district.

Weakness of data:

There is a general weakness of recall data present in the study. Secondly, the availability of adopter farmers with a longer time period of adoption was not found at large. About 26% adopters (16 households) were chosen from recent time – from 2006 and 2007. The adopters of lesser time period could not gain the benefit of the technology. Many of them could not use the technology properly due to less experience.

About the Study Area:

Our study area is mainly Banaskantha district in North Gujarat. The adopters are all from Banaskantha district; however some non-adopters are from Patan and Mehsana districts. There are five talukas namely, Amirgadh, Dantiwada, Deesa, Palanpur and Vadgam from Banaskantha district, one taluka Siddhpur from Patan district and one taluka Unjha from Mehsana district.

Thus there are seven talukas. The 63 adopters and 32 non-adopter farmers are from 35 villages from these talukas.

Total geographical area of Banaskantha is 10400.10 sq.km. Total population of Banaskantha is 2504244, of which rural population is 2228743, and urban population is 275501. The total farmers are 482803 and total Cultivable area: 819000 Hectares.

Explaining primary data: Selected Adopter and Non-adopter farmers

Profile of the farmers

The selected adopters are largely (56%) from large farmers' group owning more than 4 hectares of land. The total family members among the selected adopter households are 496 (51% male) The population in non-adopters' family is 189 (53% male) .In our selected sample we have the largest influence of Mali class (29%), followed by Patels (24%) and Chaudhuries (24%). All these three classes have a very divergent socio-cultural background, which eventually influence their decision making in cultivation and therefore in adopting new technology. In North Gujarat, particularly in Deesa taluka of Banskantha district, the Mali caste played a strong role in the economic development. In our sample, Malis are from Deesa and Dantiwada taluka. The Patels and Chaudhuries are mainly from Palanpur and Vadgam talukas and a very few from Deesa, among the selected households. The verbal history says (as we have heard from very elderly persons) that Malis came from Marwar of Rajasthan, Haryana and western part of Uttar Pradesh after the Second World War. Being outsiders, there is possibility of this community being more progressive and enterprising in their farming habits. In contrast, the relatively more localized communities of Jats and Thakors are lesser oriented towards maximizing returns from land and labour. These reflect on our samples too: in the case of non-adopters 66% households are the mix of Chaudhury, Patels and Thakors. Only 2 households are from *Mali*.

Total irrigated land is 436.54 ha; more than 86% land is irrigated. This is because all sample farmers have own source of ground water in their owned land. There are more than 63 borewells; there are farmers who have more than two borewells. The motors with HP ranging from 7.5 to 115; and the average HP of the motors is 23 HP.

Adoption of WST:

Micro-irrigation process has several technologies to dispense with. They are being accepted according to the holding of land, need of the crop, affordability of the farmers, and availability in the market including its after-sales services. This means that the technologies are space, price, service and need specific. The systems are; (1) Micro Tube Drip, (2) Mini Sprinkler, (3) Micro Sprinkler, (4) Easy Drip/KB Drip, (5) Inline/On line Drip, (6) IDE Local Sprinkler, (7) Overhead Sprinkler, and (8) Naan Sprinkler. Besides these technological equipments there are two more aspects, which brings out better results from the use of WST - they are Vermiculture and Horticulture. These two, that is use of vermi-compost and changes in the crop pattern towards horticulture have enhanced the production and thereby the income of adopters in North Gujarat. We have discussed about vermiculture and horticulture in later sections.

The eight different types of MI systems mentioned above, five of them are found in use among our selected farmers. They are: (1) Micro Tube Drip, (2) Mini Sprinkler, (3) Inline/On line Drip,

(4) Overhead Sprinkler, and (5) Naan Sprinkler. We have put the year-wise adoption of different systems of MI technology among the adopters in Annexure Table – 2 and also in charts. We have specifically shown the adoption of vermiculture and horticulture also. While big farmers are adopting the technology, the marginal and small farmers who could not get opportunity for adopting WST may go for vermiculture as they would have a ready market for the product like vermi-compost. Similarly, horticulture gives the highest income after adopting WST for it. The intelligent farmers grow vegetables in between the rows of orchards so long the flowering does not take place in the orchard trees. Many a time the farmers could recover more than 50% of their initial investment in WST.

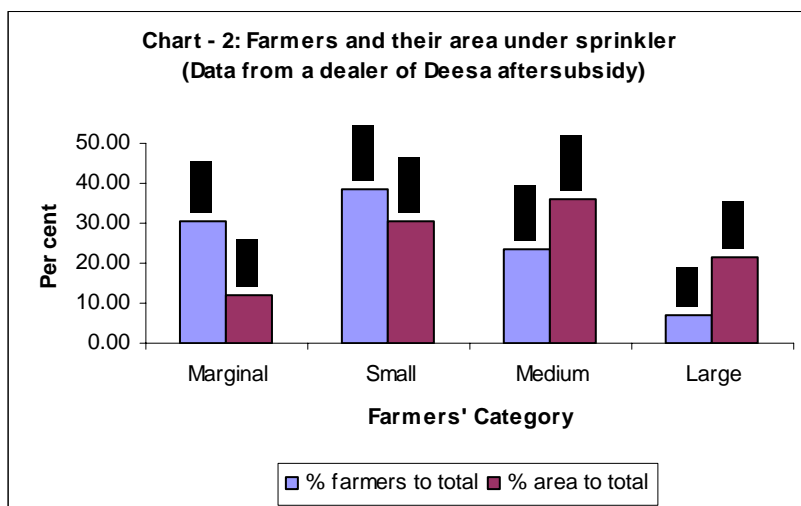
The adoption is continuously taking place after 2000 and more precisely after 2002, when NGI intervened with their action programme. In 2005 there was a boom of adoption of all types of systems after introduction of subsidy. However there is a decline in adoption of Micro-tube drip and overhead sprinkler systems. The system of overhead sprinkler was adopted in 1991, but lost its popularity after 1996, because farmers found it inconvenient to them. Later again some of them adopted in the year 2000, and after 2005 no new adoption was found for overhead sprinkler among the sample farmers. Micro tube has problem of clogging – reported by the farmers. Though many of the villagers do the minor repair and maintenance of these systems, however we found that sprinklers are popular among Deesa farmers and drip systems are popular in Palanpur and Vadgam area. It is of course for the convenience of the farmers and depending on the crop rotation or cropping pattern they follow. The Mali farmers of Deesa area have very large holdings, they grow groundnut after potatoes and prefer sprinklers; whereas Palanpur and Vadgam area farmers grow Cotton after Potatoes and they prefer drip irrigation. Of course many of Palanpur and Vadgam are shifting to sprinkler recently as they found that managing sprinklers is easier than managing drips. They feel that manoeuvring one place to other is easier for sprinkler than drips.

Who are the adopters? Our data says that large farmers adopted the technology more than the marginal and small farmers. The percentage of adoption varied from 50% to 85% among the above mentioned adopted technologies. The only difference found is in case of vermiculture that was adopted 70% by the marginal, small and medium farmers together. It may now change as after introducing subsidy small and medium farmers are taking risk to adopt the technology, as the burden of cash-risk is less.

For our objective, we tried to select the older adopters as old as possible so that we can see the effect of the rise in income among the adopter farmers. However, some adopters say, 16 (25%), are a bit young adopters in our sample; they adopted from 2005 onwards.

Who are adopting more after subsidy? One of the big dealers of Deesa explained that farmers in general, like to install WST in their total plot area available in one parcel or adjacent parcels together whatever land they own. Therefore, according to him whatever plot area the farmers declared for installing WSTs is their owned and operated land also. He gave us his data that he recorded for more than one year of his sales. We found from that data that out of the total adopters in his list, 7.15% are large farmers, medium farmers (23.74%), marginal (30.41%), small (38.70%) and (Chart – 1), that is about 69% new adopters are from marginal and small farmers' group. This shows the impact of subsidy.

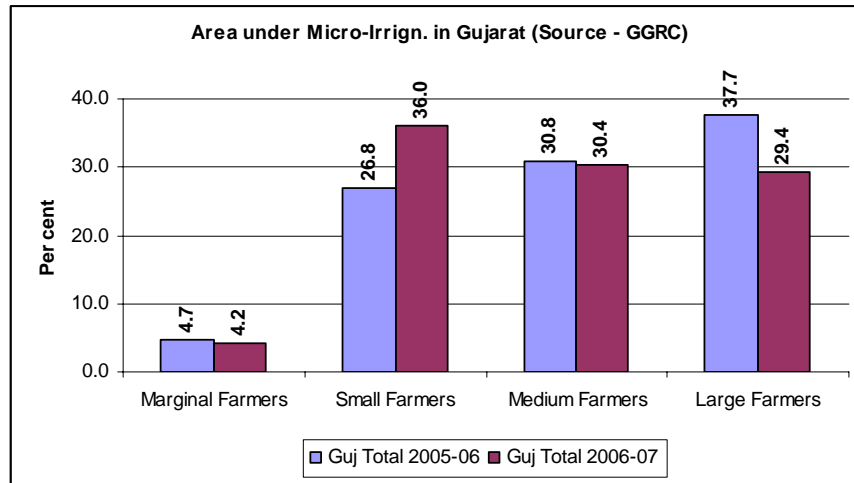
Chart – 2: Farmers and their area under sprinkler – a dealer’s data



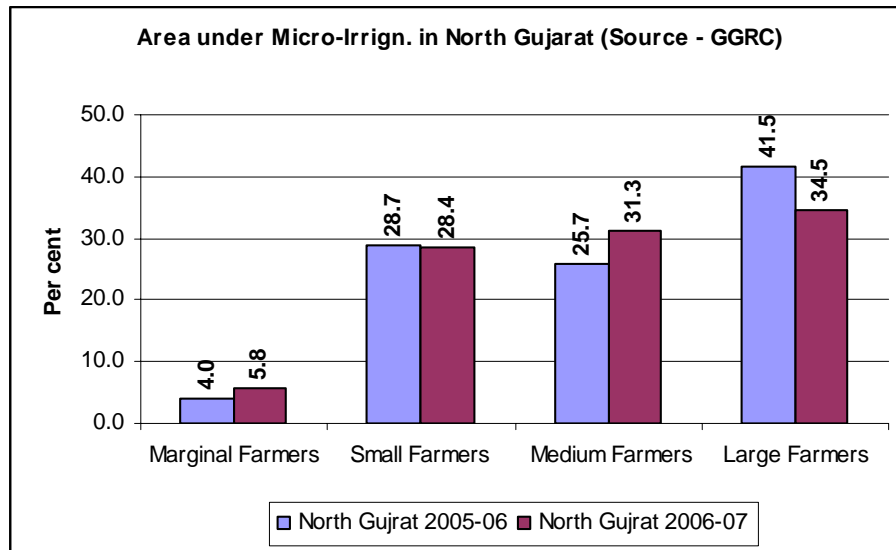
GGRC data also says that after subsidy the adoption of micro-irrigation technology has risen very substantially after 2005, and it is taking place among the marginal, small and medium size farmers during the last two years. Chart -3 and 4 show the situation of Gujarat and in three districts of North Gujarat (Banaskantha, Mehsana, and Patan) respectively for all kinds of micro-irrigation instruments adopted through GGRC. The subsidy of 50% plus 40% loan from bank means only 10% to be invested at the beginning of down payment. In our selected farmers, few of them are fresh adopters after 2005. Some farmers avoid subsidies because of the time and effort spent to obtain such benefits. Many of them have extended their area after adopting the technology since they could irrigate more area with the same amount of water. Many farmers adopted new equipments after the subsidy started. However subsidy enhanced the sale, but the effect of intervention before subsidy was commenced by NGI in 2002 and later by some other NGOs.

Our selected adopters are mainly 3 to 5 years old; only a few of them are 5 or even 12 years old adopters. Therefore it is difficult to find the impact of adoption so early. However we have seen the extent of adoption among users. Many of them changed from overhead sprinkler (1991, 1996) to inline drip system (2005) or to Naan sprinkler (2002) and also brought larger area of land under MI technology systems. The users of MI technology increased and extended in to various varieties of drips and sprinkler. The older adopters do not like to give much importance to subsidy. This has been reflected in the ranking for ‘reasons for adopting’ given by the adopter farmers for adopting the technology, which we have discussed in later section. Subsidy has boosted the adoption but adoption was initiated and accepted for the reasons of benefits

**Chart – 3: Area under Micro-Irrigation in Gujarat 2005-06 and 2006-07
(Source - GGRC)**



**Chart – 4: Area under Micro-Irrigation in North Gujarat 2005-06 and 2006-07
(Source - GGRC)**



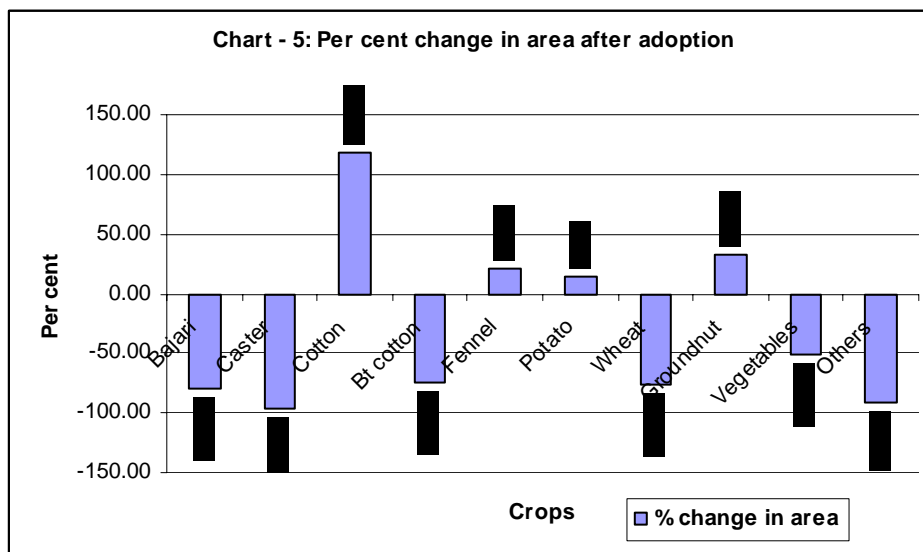
Changes in Cropping Pattern:

There is a shift in the cropping pattern among the selected adopter farmers, which we captured by ‘before and after’ information, the Chart – 5 shows the per cent changes in the crop-pattern.

The adopter farmers tried for high return crops immediately after adoption of the technology. Though scarcity of water is a driver in adoption of WSTs, but higher incomes could also be a motivating factor behind investment for WSTs. The first change is noticed in Bajra crop that the area under Bajra was reduced by 79% over the surveyed areas. There is an increase in area in cotton, fennel, potato and groundnut by about 117%, 20%, 14% and 32% respectively. There is a shift of choice of cotton crop from Bt cotton to other cotton. All these four crops give higher return compare to other crops; however it does not mean that other crops are not grown at all. The reduction in the area of vegetable probably does not show the real picture. We have not captured the area in between the rows of orchards of different fruit crops; plenty of vegetables are grown in these rows particularly during the period the gestation period of getting the first

fruit to come. The horticulturists cover sometimes half of their investments of the drip or sprinkler within one or two seasons of vegetables growing. The sum total of those areas is quite large, which may show much increase in vegetable adoption, particularly among orchard farmers.

Chart – 5: Changes in Cropping Pattern before and after Adoption



Source: Field Data

Changes in crop income and production after adoption:

Farmers would like to see their benefits from a technology that increases their farm income. If the technology helps raising their farm income, then any progressive-looking farmers would agree to adopt the technology. Many earlier studies explained this through benefit-cost ratio. Here in this study, we have not calculated the benefit-cost ratio, however we have analysed the per cent of the net income per hectare increased after the adoption, over the net income per hectare, before adoption of WST.

Table – 2: Per cent of net income per hectare increased after adoption over the net income of before adoption of WST

| Farmers Category | Before adoption | | After adoption | | % of income increased over the income of before adoption of WST |
|------------------|-----------------|---------------------------|----------------|---------------------------|---|
| | Area (ha) | Avg. Net income (Rs) / ha | Area (ha)* | Avg. Net income (Rs) / ha | |
| Marginal - 1 | 1.5 | 14487 | 1.5 | 58100 | 301.05 |
| Small - 2 | 15.4 | 10761 | 10.3 | 40220 | 273.76 |
| Medium - 3 | 79.3 | 12108 | 55.6 | 47340 | 290.98 |
| Large - 4 | 492.5 | 13812 | 378.5 | 61947 | 348.50 |
| | 588.6 | 12792 | 446.0 | 51902 | 305.73 |

Source: Field Data; *Note: Some plots were not under WST

From the Table – 2, one can see that there is an over all increase per hectare net income by more than 300 per cent after using the water saving technology by the sample farmers. The marginal farmers got increment in income all most as same as the large farmers. The marginal farmers are usually more efficient in using their inputs; hence a return rate is higher. Note that the increases in income here could be due to different factors:

- more intensive use of land
- increased crop productivity
- higher market rates for crops
- change towards greater yielding crops

Table – 3: Per Cent Change in Per Hectare Income and Production after Adoption

| Crops | % increase in per hectare income after adoption | % change in per hectare production (yield) after adoption |
|----------------|---|---|
| Fennel | 89.67 | 2.04 |
| Potato | 105.82 | 5.78 |
| vegetables | 124.02 | Not Applicable |
| Wheat | 41.90 | -0.46 |
| Bajra (Kharif) | 274.54 | 32.48 |
| Bt cotton | 56.00 | 48.36 |
| Caster | 394.39 | 172.39 |
| Cotton | 153.84 | 46.93 |
| Fennel | 501.72 | 100.00 |
| Groundnut | 97.34 | 37.23 |
| Bajra (Summer) | 3.79 | -11.07 |

Source: Field data

The non-adopters farmers have received less yields per hectare from cultivating same crops. For comparison purpose we have shown only five important crops below. A five crop comparison is given below in Table – 4.

Table - 4: fewer yields received by Non-Adopter Farmers

| Crops - Non-Adopters | % of less yield received by non-adopters | % of more yield received after adoption by adopters |
|----------------------|--|---|
| Bajra | 10.9 | 32.48 |
| Cotton | 88.9 | 46.93 |
| Fennel | 66.3 | 100.00 |
| Potato | 35.6 | 5.78 |
| Wheat | 1.1 | -0.46 |

The yield of potato was found less in WST adopted areas last year compare to the non adopted area among our sample farmers. However the net return in rupees from potato was high by about

106%, this is because the quality of the potato grown in WST plots was very good. They were of better by similar size, better taste and glossy in look, so the potato of WST plots fetched more per price per kg than the potato of non-WST plots. The potato grown under sprinkler was sold by more than Rs 5/- a kg whereas the potato of non-WST plots got less than Rs 4 /- a kg. Last year potato was caught by a disease particularly in the adopters' plots. Many adopters complained about it. They also said that since the technology was new to them they could not be able to use it properly hence they did not get the right quantity of yield. About wheat, most of them used drip or sprinkler as experiments, and no proper reasoning was provided for the poor yield, probably like potato in wheat also they could not use the technology properly. Per hectare yield of potato ranged from 996 kg to 56000 kg and net income per hectare from potato varies from Rs 3102 (min) to Rs 1,49,684 (max), this may give some idea of why the over all yield is not significantly high after the adoption. Thirty eight farmers or about 60% farmers got less than average production per hectare of potato in the last year that they should have got from the adopted plots. This may explain that the technology was not properly internalised soon after the adoption.

Horticulture:

Horticulture, the art of garden cultivation through WST brought a new dimension in the life of farmers in North Gujarat. There was no such practice at large in cultivating fruits in a large scale except in few places and of not-so-good return crop like chiku and berry, before there has been any intervention of NGI-IWMI in North Gujarat. Many expressed their ignorance about it and expressed happiness after seeing the fruits from adopted orchards. Of course the credit goes towards the intervention. NGI started the intervention in a synergic way. The synergy of three - drip and sprinkler, new crop pattern, and practice of using vermicompost, all these three brought the changes among the adopter farmers. Now people are earning Rs1.51 lac from Papaya, Rs 1.96 lac from Mango, and Rs 2.30 lac from Pomegranate per hectare. The production of fruits takes more time than one season, depending on the fruit that has been chosen, Papaya takes 6 to 8 months, Mango takes about 3 years and Pomegranate about 18 months. During this gestation period farmers grow vegetables or any short-time crops in between the rows. They could get back sometimes half of their investment made on WST by one or two short-time crops. Thus an orchard holder can have two-way income. The area under horticulture fruits, total net income and net income per hectare are shown separately below in Table – 3.

Table – 3: Area under Horticulture and its Income

| Name | Area (ha) | Total Net Income (Rs) | Net Income (Rs Lac/ha) |
|--------------------|------------|-----------------------|------------------------|
| Chickoo | 1.5 | 16100 | 0.11 |
| Grapes | 1.4 | 171200 | 1.22 |
| Lemon | 8.0 | 180000 | 0.23 |
| Mango | 0.6 | 117500 | 1.96 |
| Papaya | 0.1 | 15100 | 1.51 |
| Pomegranate | 8.5 | 1954139 | 2.30 |
| Total Horticulture | 20.1 | 2454039 | 1.22 |

Source: Field Data

Vermiculture:

NGI introduced vermiculture in their project villages. The vermiculture produces vermicompost and using this compost the soil remains porous facilitates aeration at the root of the plants. It helps porosity of the soil and also helps keeping the moisture at the root region of the plants. Therefore, a few of our selected farmers particularly the marginal and small farmers, seeing the ready market opportunity, have adopted vermiculture to produce vermicompost as one of their enterprises. Eventually this has become a good source of income for them.

Thus Vermiculture has become an ancillary activity for WST users in this area. However this has been accepted and practised among the farmers of smaller land holdings in North Gujarat. This requires very less amount of investment and gives very high return within a shorter time period. In 2002, it was Rs. 500 per Kg, but after rapid adoption and replication of this activity across the region it has come down to Rs. 100 per kg to start with. It usually starts with 1 Kg. worms and 20 kg FYM. (Farm Yard Manure). The worms get doubled and prepare approx 10 kg compost within 50 to 60 days. By this way one kg worms can become 70 kg and produce 600 kg of compost in a year. (Source: NGI, Palanpur). In general the sale price ranges from Rs 1.80 to Rs 2/- per kg. Among our selected households the earliest adopter was in the year 2002. In our sample, 12 farmers are practicing this venture; of these 12, eight households (66%) are from smaller category of farmers. We found that return per Re of investment is Rs 6/- taking total production of 5 yrs from 2002 to 2006. The average gross income per year per household is about Rs 8000/- against the investment about Rs 1300 /-. This activity of vermiculture is generally looked after by the women folk of the households. Ajbaben saved Rs 72000 from her vermi-culture income and invested in overhead sprinklers and low cost drum kit for her small piece of land. One more example is Heeraben, for her it has become a livelihood (see box in the Annexure).

Culturing these worms is very simple and we have found that composts from this gives about six times return if proper care is taken. Many marginal farmers have adopted it because of its small budget of investment and for its ready market in near by villages after the introduction of WST. . While large farmers adopted the WSTs like drips or sprinklers, marginal farmers went for vermiculture. The intervention of WST at a large scale has made a way to this vermicompost and opened a new opportunity for the marginal and small farmers. This is surely one of the indirect contributions of introducing WST. This can be compared as a type of catalytic or enhancing agent for better yields for a crop in a WST plot.

While understanding about the importance of vermiculture we hit upon a new aspect that there is a typical 'outlook' for WST from the viewpoint of women. We tried to capture that and have put it below.

Women's outlook in Micro Irrigation System in Agriculture:

Women play important roles in agriculture sector. They do seed preparation, binding, and watering, weeding, fertilizer application and harvesting, almost all operation are shared by them particularly when they are from smaller farmers' family. There is no difference in North Gujarat. They are also involved in livestock care in home. They have a daily domestic work like child rearing, cooking, washing clothes and mopping floors etc. Almost a similar scenario was found in the study of Junagadh district (Namara, 2005).

The water saving technologies has brought a change in their life-style. A lot of difference in workload of women reduced and there by reduced their uphill struggle in North Gujarat. Many of them have obtained knowledge of MI systems by attending workshops, trainings and exposure programs conducted by local NGOs like NGI-IWMI and other institutes. They are now aware of micro irrigation and of WST as they have facility to see in their own farm or in their neighbouring farms. Before adoption of MI system they were not able to recover much of their cost of cultivation using traditional flood irrigation (Viruben). About 77% women of selected farmers' households feel that cultivation has become much neat and tidy after the adoption of WST – whether it is drip or sprinkler, besides increase in production, saving water, power and labour. Now supply of electricity is more disciplined in timing, therefore women also can make schedule of their daily work conveniently.

By the last couple of years' of adoption the women of this region are well experienced in running the system and can even do some minor maintenance like clogging of the system and its minor fittings etc. Weeding work has reduced almost nil. Now they do not have to use hands for applying fertilizer as fertilizer is applying by mixing with water through pipes. The labour work has not decreased as such they said. The job like sowing, weeding, binding and packing of dry straw has become less, but plucking of vegetables and fruits and making them ready for the market has been increased. Since many farmers changed their cropping pattern towards vegetable (chilly, brinjal etc) cultivation and orchard plantation etc. the working pattern has changed (Anuben). So one kind of wage-labour is reduced but some other kind of wage-labour has emerged.

There is change of maintaining livestock in home. Some of the adopter farmer families have increased the number of their livestock after their income increased from the higher production. However there are differences in opinion about the size of livestock keeping, particularly after adopting MI system. One reason may be return on investment in livestock is lesser than the return on investment in land with WST. Another reason as they mentioned, the MI system has provided neat and clean agriculture system whereas managing livestock is still a messy job. A few families have increased the number of livestock because they have found some spare time from agriculture work while using MI system, so they are using their saved time in further income generating activities. However they do not prefer to increase the number of livestock any more. One interesting question was asked, at this point of discussion to all the women mentioned above that if they were given 5 livestock or 5 bighas of land (without MI system) what they would like to keep? They agreed for livestock. But, when asked the next alternative that if the same size of land be given with MI system what they would prefer? They quickly agreed for land with WST. They understand that using WST system, they would get higher income, some rest, a neat and clean field instead of messy work for maintaining livestock. According to them the net return from extra livestock is less than the net income from the extra acre of land with WST. Probably the marginal income from additional livestock would be less than the land with water saving technology.

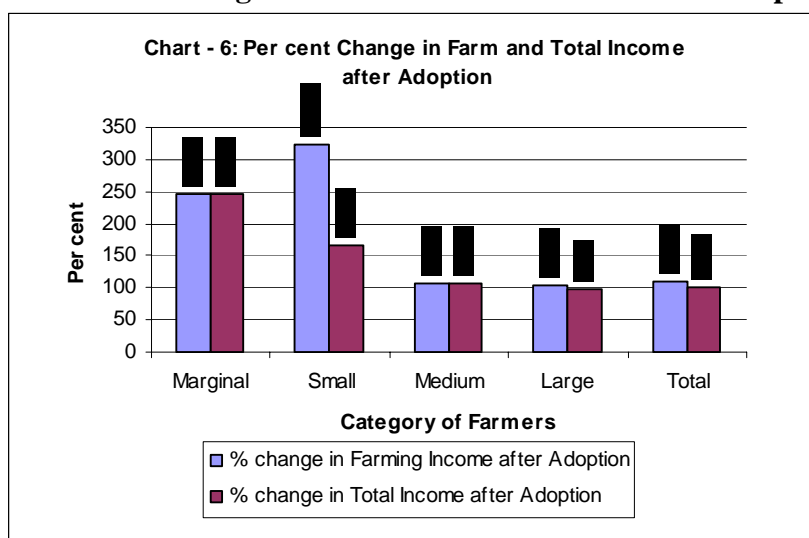
The women of adopter farmers have expressed firmly their view of sending their children away from the village to get better and higher education. They are now able to stake to pay higher tuition fees for their children including boarding and lodging for them. Some families have sent their children for higher and better studies to a distance place like Ahmedabad, Surat, Vallabh Vidyanagar and Anand.

One has to agree that women from landless households are deprived of getting wages from weeding kind of jobs. However they would be getting newly created other kinds of agriculture operations, like number of times picking of vegetables, preparing packages for marketing the harvested vegetables etc. However, we found the strenuous saga of women from small cultivators is reduced after the adoption of water saving technology.

Changes in Income among adopters:

About declaring income everyone becomes hesitant and reluctant. So is the case with farmers also. We only put the income what they said. But about the farming income we put the calculated net income from cultivation data that we have gathered. The selected adopters have earned more than 108% from their farm source during the study year and together from all source they have earned above 101%. Highest farm income was found among the small farmer – more than 324% of farm income. This higher farm income in the small farmers’ group might have been possible because income from vericompost is included within the farm income.

Chart – 6: Per cent Change in Farm and Total Income after Adoption



Source: Field Data

In our total samples, the actual amount of the farm income increased to nearly (Rs 25517350) Rs 2.5 crore after adoption of technology from (Rs 1267979) Rs 1.17 crore; and the total income including all sources (farm and non-farm both) increased to Rs 2.6 crore from Rs 1.25 crore. That means per household income has gone up from Rs 2 lac before adoption to more than Rs 4 lac after adoption. In this context it is noted that per household income from all sources among non-adopters is only Rs 54,766 and that of farm income is only Rs 45,188/-. Question is where this money has been used by the adopter farmers? We found a lot of changes reflected in their social life and living style and investments in agriculture equipments, consumers’ durables, savings and expenses on education.

Changes life-style after adoption

A sharp change is found in their investments, which is reflected first in the investment of irrigated land of agricultural equipments. This was captured by a simple method of the “before-

after” information. The gross irrigated land has increased more than 200% among them (Chart – 7). The farmers have taken land on lease and have irrigated them using micro-irrigation system, as they could irrigate more land by same available water and power supply. In flood irrigation 2 ha can be irrigated in 8 hr x 7 days i.e. 56 hrs in a week (not in horticulture). However WST can irrigate 1 ha in 2-3 hours, so irrigated area increased among adopter farmers. People earlier used to grow 2 crops, now they grow 3 crops and inter cropping also with horticulture so the gross irrigated area has been increased.

A large change found in agri-equipments. The percent of change found in Tractor (22.0%), Thresher (27.8%), Planter, (66.7%), Digger (128.6%), and others like Plough, Harrow and Cultivator (51.9%). If we go by the number and calculate the value multiplying by the average market price⁴ the sum total of asset of agri-equipments would be about Rs 58,10,000/-

Holding of live stock has significantly reduced such as Bullocks by 37.6%, Buffaloes by 7.5% and Cows by 28.2% after the adoption of WST by the sample farmers. Reduction in bullock holding could be explained by the fast mechanisation of cultivation that is prevailing in the study area. The reduction in holding of buffaloes and cows probably may be owing to the comparative income between the farm and dairy. This has been more obvious when we discussed with the women folk of the family noted above. If farmers get more yield and income from the same area of land by using micro irrigation system, they would like to be abstained from holding more livestock, particularly when marginal income is less from livestock. This has come out well when we discussed with women folk in the farmers’ family. About 32% people have taken new Life Insurance Policies after the hike in their farm income; the premium amount has increased by 61%. The total amount of premium went up to Rs 17.5 lac from Rs 11 lac. after the adoption. This shows their one source of increased in saving among the adopters. The farmers do have other postal savings and investment in gold and silver, but we did not inquire about those details.

A very interesting pattern is found in the investment in consumer durables. After adoption there is reduction in investment in radio (-4.2%), but an increase in the investment in TVs both colour and black and white; 38 colour TVs are being used of the 63 households. Before adoption only 17 households were using cycle, scooter, motorbike and cars and now after adoption there are 52 households are using any one of these vehicles. There is sharp rise in investments in this sector by 206%. Many of them have more than two motorbikes and scooter in their home. There is no importance of sewing machine now as there is a negative investment of 42% in this item. People can afford to go to a tailor for stitching purpose.

There is a sharp rise in private tuitions; about 77% families are able to spend for this purpose now, may some of them compulsory. The declared expenses on this private tuitions fees was about Rs 7 lac before adoption and now it is about Rs 23 lac, an increase of more than 3 folds; earlier there were only 11 households and now 47 households are spending for this purpose.

The other waves of effect in the locale:

Introducing the WST in this area has not only brought a change in the farming community, but it also has made some ripples in other corners of the society. This has brought a new business

⁴ Approximate price of each: Tractor 35 HP =Rs 3.5 lac; Cultivator = Rs 12,000; Planter = 30,000; Plough = 10,000; Thresher (Wheat) = Rs 90,000; Thresher (G.nut) = Rs 70,000; Trolley = 70,000; Disc-Harrow = Rs 35,000; Spray Pump = Rs 10,000; Pavda =Rs 8,000; Diggar = Rs 70,000

opportunity for the people who have business acumen, which has been reflected in the dealership of micro-irrigation equipment in Banaskantha. In 2002, there was no dealer for micro-irrigation equipments in Palanpur location. NGI-IWMI staffs used to go more than 150 kms away to Ahmedabad and Gandhinagar to purchase laterals, drippers and other materials and also used to do the fittings etc by themselves for the farmers. By the next one year in 2003 they could arrange three dealerships in Palanpur, two from IDE and one from Netafim, the best known international manufacturer of drip and sprinkler. During the last 5 years, there are 91 dealers have come into business of micro-irrigation in North Gujarat dealing with MI equipments; 72 are in Banaskantha, 11 in Mehsana and 8 in Patan. A research study of the multiplier effect may be taken up in the future.

Next is the cold storage for potatoes. Many potato farmers have become cold storage owners, either singularly or in groups. We met several potato growers who hold a dream to open a cold storage in Deesa taluka. The first cold storage of Banaskantha was established in 1985. In 2002, there were only 18 cold storages including 2 of government managed. Now there are 62 cold storages working in Deesa and Palanpur talukas of Banaskantha. One has to understand the spatial development due to the introduction of a farming technology in small area like north Gujarat. In Banaskantha there are 482803 cultivators and only about 4987 cultivators (1.03%) have adopted MI technology till January 2008; cultivable area of Banaskantha is 819000 and only 9495 hectares (1.16%) is under micro irrigation almost same as India's average area under micro-irrigation mentioned above (GGRC data). What could be the impact when at least 25% of the cultivators and 25% of the cultivable land would have MI technology?

We found that among our selected adopters, farmers who have made good savings out of farming particularly during the last few years, are interested in investing in non-farm sectors. Using WST they have now got that extra time which they are giving in education to their children. They put their children in non-farm business such as vegetables, whole sale shop, provisional store, dealership in MI equipments (Metafim and Jain etc). Some of them who have more savings they go for investing in cold storage that requires crores of rupees. We met a few of them who have started dreaming for it. This phenomenon of investing in dealership and cold storage was found generally among the potato growers of Deesa. However large horticulturists (pomegranate) are dreaming for some food processing factories.

The labour is saved when WST is adopted. So there is an impression that there will be unemployment. But it is not so, in fact a new generation of labour has emerged, specialised for WST work. Their wage is also high because a new skill is required. The labour rate for potato seed cutter is now Rs 175 a day or even more, which was Rs 80/- one year ago. It happens along with new technology, as in the case of Information Technology and computers.

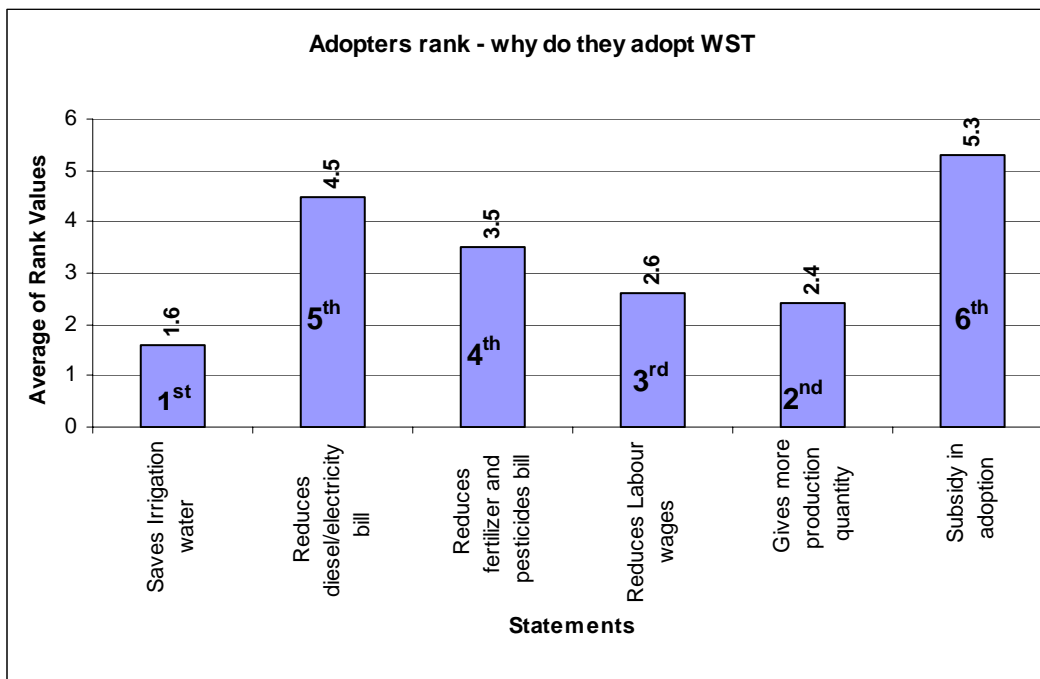
Why do they adopt and why they don't?

We requested farmers to give them ranks to six different statements using cards for each statement. The reaction of adopters and non-adopters are obviously found different. The adopters have given first rank that WST saves irrigation water and last rank to the role of subsidy (Chart – 7). Since we have collected the rank in cardinal numbers of 1 to 6, the highest average value would show the lowest value as the highest ordinal ranks.

The non-adopters have given the 1st rank to the shortage of fund showing that they do not have money to invest for MI technology (Chart – 8). In general non-adopters did not believe that the benefit can come out of the technology. However very lately they have started realising the benefit from WST after seeing tremendous changes in production quantity in their neighbourhood. Besides their crunch of fund the non-adopters have several other reasons for not accepting the technology. The MI technology needs certain basic requirements, such as (a) the own source of water in the farm, (b) supply of energy unless one is only using the gravitational flow like in drum kit. The drum kit is useful for very tiny piece of land. If the own land has many parcels and if they are scattered then it is difficult to get the benefit of installation of WST.

If the source of irrigation well has many partnerships then also it becomes a difficult proposition for installation of water saving technology as it will be difficult for equitable distribution of water. Plus all the members may not opine for the same types of technology. This we have seen in Siddhpur area, where new intervention work has been started. What is possible in Palanpur and Banaskantha taluka may not be possible at Siddhapur.

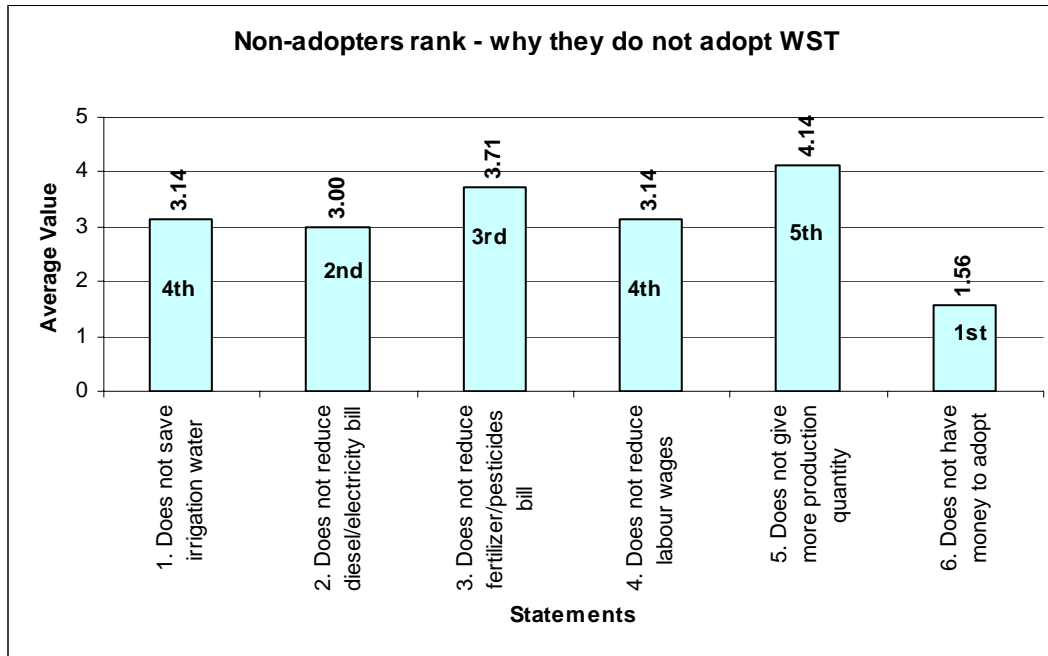
Chart – 7: Adopters rank – why do they adopt WST



In Siddhpur area single ownership borewells are not many. In Jagnathpura village of Unjha taluka we talked to one farmer. He said there are 35 bore wells in their village, only 4 bore wells have single ownership, another 31 have 7 to 15 partners on each, and how do they convince all partners to adopt drip systems? In this area water quality with more than 1000 TDS is also a problem of clogging for MI system said the local farmers. Recent availability of canal water in Samoda village and Saraswati River’s water discourages the installation of WST. The groundwater is available between 1000 to 1200 feet. Therefore the construction cost of well is very high about Rs 12 to 15 lac, they share among partners. In Kahoda village of Siddhpur taluka there are 75 to 80 bore wells in the village. In which 4-5 bore wells are of single well owners. Some bore wells have 70-75 partners. Farmers are small land holders (average 4-5 vighas), so

they feel WST is not economical for them. Government is not giving permission to construct new bore well. Many farmers rely on rain fed agriculture. This kind of problems keep the farmers away to be an adopter of MI system, even many of them understand the benefit of drip irrigation.

Chart – 8: Non-adopters rank – why they don’t adopt WST



Recently due to good rainfall for the last three years many farmers do not bother to go in for this technology. They feel that bad time may come after many years. Many non-adopters feel that getting loan from banks is quite challenging and too much time consuming, so farmers avoid going for water saving technology, even they would not go for availing subsidy. Some of them said that they had lot of debts which incurred during drought years and still could not repay – so can not take the risk of further bank loan for installing MI system. Priority of other social responsibility is another hurdle for a new venture like WST. Above all there is ignorance of the benefit of the MI systems and less severity of the crisis of irrigation water, beside lesser wishes for future prosperity.

In Conclusion

- The water saving technology for minor irrigation not only saves water, energy, and labour inputs but also increases farm income through higher production per unit of land.
- Instead stating the saving of water probably it would be appropriate to say that water is used more judiciously, since total time of pumping remains same but more area is irrigated particularly when the energy is not metered.

- Though labour is saved for some agricultural operations but a new generation of skilled labour has been emerged. Like potato seed-cutters who are earning Rs 175 a day, who were earning Rs 70/- a few years ago.
- It may also be said that the technology is adopted because of shortage of perennial supply of labour, as the adoption does not require many labour for several operations in agriculture by using diggers and planters.
- Introducing this technology pushes other ancillary occupations and its effect ripples around the locale - for instances coming up of large numbers of cold storage for potatoes, and dealerships of MI equipments.
- Vermiculture is a catalytic agent which has got very good entry as an auxiliary agency to get best result from the use of WST. In this enterprise women got a very good role where they have their say on the income from vermicompost. This also saves the ecology of cultivation in the area.
- Horticulture, a revolutionary change found in North Gujarat, which was possible only due to the unique three-way intervention work of NGI-IWMI. Very shortly there may be introduction of food processing industries as sooner or later production of varieties of fruits will be very high that needs to be marketed profitably.
- Hundred per cent increase in farm income using WST gives a solid base to the farmers to go for non-farm investment, which is the basic line of reasoning of economic development – that is surplus farm income should go for non-farm investment. A ‘synergic’ effect of spatial growth is already found in Deesa area – like the growth of large number of cold storages, increasing number of WST dealerships, and newly trained workmanship for WST maintenances, buildings, markets and private businesses. There are changes in the use home appliances, consumers’ durables, vehicles etc. A huge multiplier effect will be noticed in the area.
- Though we have not included the information of investment in own building, however we saw that most of the big farmer adopters have huge palatial building in their farm.
- Investing more in education from the extra income, particularly for higher education will give a further new dimension in the economic development in the future. Schools of International standard may come up soon.
- Thus we like to say the introduction of WST has more become a ‘movement’ in the farmers’ society. It is more like a ‘turning point’ for the farmers of the water scarce area in the long run cultivation system.
- WST adoption seems to be poor in dominantly canal-irrigated areas, area with multiple-ownership of wells and those where groundwater is highly saline.

- Subsidy has made a high surge of adoption but there are some complaints that the quality of the equipments is going down as there is lesser vigilance for controlling quality. This is to be carefully noticed for checking the downfall.
- There is vast scope for introducing WST for micro-irrigation since there is only just above 1% cultivable land is under micro irrigation. If 1% of adoption has brought this much change what can happen if 20% adoption is achieved?

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